

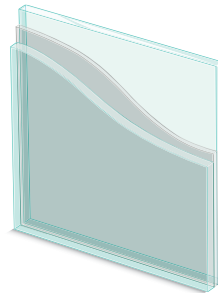
Introducing StormGlass™ Hurricane-Resistant Glass, where innovation meets “no-excuses” reliability.



In independent testing, StormGlass™ met test requirements for large glass sizes up to 50 square feet. That means the freedom to design larger glazed openings while meeting the most stringent building codes for hurricane resistance. And unlike traditional hurricane-resistant glazing, StormGlass™ is quick and trouble-free to produce. It's that kind of consistent innovation and reliable service you've come to expect from Oldcastle Glass®.

StormGlass™ Superior Technology

Our advanced interlayer technology is the thinnest of its kind in the hurricane-impact glazing market. StormGlass™ also features very high elastic modulus together with improved adhesion to glass. The benefits? StormGlass™ is one of the best performing and reliable products available. What's more, StormGlass™ affords the highest levels of protection, without compromising the optical quality of the glass.



In independent laboratory testing, StormGlass™ withstood design pressures in excess of 100 psf.



StormGlass™ Characteristics

- Meets the requirements for large missile and cyclic wind load.
- Tested at sizes up to 50 sq. ft.
- Testing at design pressures in excess of 100 psf.
- Rigid interlayer providing low deflection under cycling test.
- High adhesion between glass and interlayer.
- Interlayer insensitive to test temperature.
- Meets requirements of Miami Dade Protocols PA 201, PA 202, PA 203.
- Meets requirements of Florida Building Code Protocols TAS 201, TAS 202, TAS 203.
- Meets requirements of ASTM E1886 and ASTM E1996.
- Can be used in four sided structurally glazed applications.
- Available in insulating glass configurations.



Oldcastle Glass®

Where glass becomes architecture™

StormGlass™

Hurricane-Resistant Glass

Properties**Typical Commercial Configuration:** 1/4" Heat-Strengthened glass / 0.075" (1.90mm) StormGlass™ / 1/4" Heat-Strengthened Glass**Typical Residential Configuration:** 1/8" annealed glass / 0.075" (1.90mm) StormGlass™ / 1/8" annealed glass**Sizing****Maximum Producible Size:** 60" x 190"**Minimum Size:** 12" x 12"**StormGlass™ Meets or Exceeds the Following Standards**

UL 972	Burglary-Resistant Glazing
ASTM F1233 Class 1	Standard Test Method for Security Glazing
CPSC 16CFR 1201 Cat II	Safety Glazing
ANSI Z 97.1	Safety Glazing
ASTM E1886	Impact and Cyclic Pressures
Miami Dade Protocols	PA 201, PA 202, PA 203
Miami Dade NOA # 03-0514.15	Expires December 11, 2008

Product Configuration

Outboard Lite	Interlayer	Inboard Lite	Minimum Thickness	Average Thickness	Maximum Thickness	Weight lbs/sq ft
1/8" (3mm)	0.075" (1.90mm)	1/8" (3mm)	.301	.325	.347	3.8
3/16" (5mm)	0.075" (1.90mm)	3/16" (5mm)	.431	.445	.477	5.3
1/4" (6mm)	0.075" (1.90mm)	1/4" (6mm)	.509	.521	.567	6.8

Notes: For hurricane-resistant glazing applications StormGlass™ should be used as a component in a tested system. The actual glass thickness and the maximum size is determined by this system testing. When insulating glass is required StormGlass™ should preferably be used as the inboard lite of the unit.

Technical Assistance

Oldcastle Glass® has extensive experience in the design and testing of hurricane-impact glazing systems. Our technical department is available to offer guidance in the correct use of StormGlass™ in order to maximize the performance of the glazing system.

Storage

StormGlass™ should be stored as other laminated glass in a cool dry location. Deliveries of StormGlass™ should be scheduled so that it is not stored at the job site for more than 30 days.

Cleaning and Maintenance

StormGlass™ should be cleaned and protected like any other glazing product. The installer should take steps to ensure that the surfaces are protected against possible damage by other trades and construction practices.

For routine cleaning, use a mild soap or detergent and luke-warm water. Uniformly spray cleaning solution and apply with a clean soft lint-free applicator and rinse thoroughly. Dry the glass surface with a clean grit-free cloth or squeegee. *Never allow any metal or hard parts of the cleaning equipment to come into contact with the glass surfaces.*

Guide Specifications

Glass shall be StormGlass™ by Oldcastle Glass® and be comprised of 1/4" heat-strengthened glass–0.075" StormGlass™ interlayer–1/4" heat-strengthened glass and meet the requirements of CPSC 16 CFR Cat II, ANSI Z 97.1, ASTM F1233 Class 1 and UL 972. Glass shall be permanently marked with the manufacturer's logo. For more information, call 1-866-OLDCASTLE(653-2278) or log on to www.oldcastleglass.com.

Hurricane Impact-Resistant Glass (Windborne Debris)

Introduction

The stringent code requirements of Florida and other coastal regions require that the building envelope be maintained during a hurricane. All elements of the building shell must resist the effects of windborne debris as well as sustained turbulent winds lasting several hours. Extensive research, following Hurricane Andrew in 1992, showed that breach of the envelope led to internal pressurization of the building. This effectively doubled the forces on major structural elements such as walls and roofs, leading to catastrophic failure.

The South Florida Building Code introduced hurricane-impact protection requirements in 1994. To meet these codes in south Florida, the glazing

must resist the penetration of either a large missile (a 9 lb wood 2" x 4" traveling at 50 feet per second/33mph) or small missiles (2 gram steel ball bearings traveling at 130 feet per second). These impacts are then followed by 9,000 inward and outward acting pressure cycles.

Other areas of the world are gradually introducing similar codes. The Texas Department of Insurance (TDI) has specified similar testing for property close to the Gulf Coast. The model code of SBCCI, which was used as the basis of the Florida Building Code that was made into law in 2002, includes windborne-debris protection requirements, as does the International Building Code.

Description

The latest national standard is the ASTM E1996 *Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Storm Shutters Impacted by Windborne Debris in Hurricanes*. It defines several other missiles applicable to different wind zones, building types and building heights, while incorporating the requirements of southern Florida. Tables 1 and 2 show the requirements of

ASTM E1996, with the southern Florida counties of Broward and Miami Dade being in Wind Zone 4. Essential facilities are hospitals, evacuation centers and command and control positions, which are required during emergencies. All other building types come under the category of Basic Protection, apart from a few specifically excluded uninhabited buildings such as greenhouses.

Table 1: ASTM E1996 Wind Zones and Missile Types (See Missile Types in Table 2, page 32)

System Height	Enhanced Protection (Essential Facilities)		Basic Protection	
	≤ 30 ft	> 30 ft	≤ 30 ft	> 30 ft
Wind Zone 1 110 - 120 mph + Hawaii	D	D	C	A
Wind Zone 2 120 - 130 mph more than 1 mile from coast	D	D	C	A
Wind Zone 3 130 - 140 mph or 120 - 140 within 1 mile of coast	E	D	D	A
Wind Zone 4 > 140mph (South Florida)	E	D	D	A

For systems intended to be used 30 feet and higher from ground level, a small missile is used. Following either the small or large missile impact, the specimens are subjected to pressure cycling, as described in Table 3 on the following page.

Each cycle takes between one and three seconds, so the complete test can last up-to 7 1/2 hours for each specimen. P_{pos} and P_{neg} are defined as the design pressures of the system being tested.

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Hurricane Impact-Resistant Glass (Windborne Debris)

Description (continued)

Table 2: ASTM E1996—Applicable Missiles

Level	Missile	Speed (f/s)	Comment
A	2 g ± 5% steel ball	130	South Florida small missile
B	2 lb ± .25 lb 2 x 4 lumber	50	Some residential skylights
C	4.5 lb ± .25 lb 2 x 4 lumber	40	Lower wind zones only
D	9 lb ± .25 lb 2 x 4 lumber	50	South Florida large missile
E	9 lb ± .25 lb 2 x 4 lumber	80	Essential facilities only

Table 3: ASTM E1996—Cyclic Static Air Pressure Loading

Loading Sequence	Loading Direction	Air Pressure Cycles	Number of Cycles
1	Positive	0.2 to 0.5 P _{pos}	3,500
2	Positive	0.0 to 0.6 P _{pos}	300
3	Positive	0.5 to 0.8 P _{pos}	600
4	Positive	0.3 to 1.0 P _{pos}	100
5	Negative	0.3 to 1.0 P _{neg}	50
6	Negative	0.5 to 0.8 P _{neg}	1,050
7	Negative	0.0 to 0.6 P _{neg}	50
8	Negative	0.2 to 0.5 P _{neg}	3,350

Testing is carried out on the glazing system. Glass is therefore a component in this system, which includes aluminum, gaskets, sealants, weather-stripping, hardware and fasteners. Most codes require that three identical specimens be tested without penetration. All components used on the tested specimens must be carefully detailed on the test report so that exactly the same system is used in practice. Glass supplied by Oldcastle Glass® has been successfully tested in many glazing systems for both residential and commercial applications.

All the products supplied by Oldcastle Glass® for these types of applications have Component

Product Approvals from Dade County. Full details are available on request. This component product approval must be specified on the System Product Approval, which is owned by the manufacturer of the glazing system. By 2004, System Product Approval will be required in all of Florida.

Each of the test standards mentioned above has slight variations in such items as impact locations and pass/fail criteria. Careful examination of the standards is necessary to ensure that any testing is correctly performed.

Capabilities

Hurricane Impact-Resistant Glass Selection

Oldcastle Glass® supplies all the main types of laminated glass used for hurricane-resistant applications. (See Table 4 on the following page.) Usually, the laminate is made up of two pieces of glass of the same thickness; however, the two pieces of glass may be annealed, heat-strengthened or tempered, depending on the system in which it was tested.

For small missile performance, glass with an 0.060" PVB interlayer is normally adequate. For

best performance, the outer lite of glass should be tempered and the inner lite heat-strengthened.

For large missile performance up to about 25 sq. ft. and 65 psf design pressure, laminated glass with an 0.090" PVB interlayer is usually used. This is combined with various glass configurations, depending on the opening size, design pressure and window or glazing system design.

For higher-level performance, that is required for curtain wall, storefront and large residential

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Hurricane Impact-Resistant Glass (Windborne Debris)

Capabilities (continued)

applications, it is often necessary to use **StormGlass™**, a unique, high-performance interlayer by Oldcastle Glass®. Alternatively laminated glass containing a Saflex® HP interlayer by Solutia, or SentryGlas™ Plus by DuPont can be used. These products contain interlayers that are much stiffer than regular PVB, and that can sustain much greater design pressures during the pressure cycling phase of the test. In addition, they can be used in very large sizes, even exceeding 50 sq. ft. in some cases. These types of products are usually laminated between two lites of 3/16" or 1/4" heat-strengthened glass.

For the ultimate performance, it is necessary to use a glass-clad polycarbonate construction. The core of this 5-layer laminate is a thin polycarbonate sheet that is the strongest clear plastic available today. It is virtually unbreakable and therefore can resist the greatest forces.

Often, a window or glazing system will only have been tested with a small selection of the products detailed below, so it is essential to check with the system manufacturer in order to specify the correct one. None of the building codes permit the substitution of one product for another, without testing.

Table 4: Oldcastle Glass® Hurricane Impact-Resistant Products

Product #	Description	Test	2 x 1/8" glass		2 x 3/16" glass		2 x 1/4" glass	
			Thickness inches	Weight lbs/ft ²	Thickness inches	Weight lbs/ft ²	Thickness inches	Weight lbs/ft ²
411000	Laminated glass with .060 PVB	Small Missile	0.31	3.58	0.44	5.21	0.56	6.53
412000	Laminated glass with .090 PVB	Large Missile	0.34	3.75	0.47	5.38	0.59	7.00
452000	Laminated glass with .100 HP PVB	Large Missile	0.35	3.77	0.48	5.40	0.60	7.02
462000	Laminated glass with .090 SGP	Large Missile	0.34	3.75	0.47	5.38	0.59	7.00
462500	Laminated glass with .100 SGP	Large Missile	0.35	3.77	0.48	5.40	0.60	7.02
472000	StormGlass™ by Oldcastle Glass®	Large Missile	0.33	3.67	0.46	5.30	0.56	6.76
422000	Glass-clad polycarbonate	Large Missile	0.43	4.29	0.55	5.88	0.68	7.50

Additional Important Information

All the laminates detailed in the table above can be supplied with tinted, reflective or Low-E glass to allow the designer and the engineer to control solar heat gain and glare in the building. As the impact codes are adopted by other municipalities outside south Florida, more hurricane impact-resistant glass will be supplied as insulating glass units. In this case, the laminated glass lite is usually the inboard lite of the insulating glass unit. For

detailed recommendations and glass selection, it is necessary to carefully examine all the requirements of the glazing system and the desired design pressure rating. Oldcastle Glass® has extensive experience with the testing of hurricane impact-resistant systems and welcomes the opportunity to discuss the selection of a suitable laminated glass for your application.

Hurricane Impact-Resistant Glass (Windborne Debris)

Additional Important Information (continued)

Tornadoes

The speeds of windborne debris and the peak wind pressures in tornadoes can, in many cases, be much higher than those specified in ASTM E1996.

The Federal Emergency Management Agency (FEMA) has produced a document titled *Design and Construction Guidance for Community Shelters*. This document presents test methods and construction guidance, and specifies a 15lb. wood 2x4 fired at 100 mph. This has approximately 14 times the energy of the large missile used in wind zone 4 of ASTM E1996.

Oldcastle Glass® can manufacture glass to meet these requirements; however, FEMA states in section 6.5, Windows: “Testing indicates that glass windows in any configuration are undesirable for use in tornado shelters. The thickness and weight of glass systems required to resist penetration and control glass spall, coupled with the associate expense of these systems, make them impractical for inclusion in shelter designs”.

Glass and glazing that are designed and tested to resist hurricane impact and cyclic pressure loads can, however, give considerable resistance and protection against lower categories of tornadoes.

Design Criteria

Details on the following important topics can be found in the Black Design Criteria Tab: Glazing Instructions, Thermal Stress, Deflection, Glass Design Loads, Glass Thickness Selection, Spontaneous Breakage of Tempered Glass, Roller Wave Distortion in Heat-treated Glass, Mock-ups and Warranties.

Specifications

A sample Section 08800 Specification for North America can be found in the Black Specifications Tab. Information specific to two-ply (two lites of glass) laminated glass can be found in Part 2 Products, 2.02 Materials.

For specifications on other laminated glass makeups, call 1-866-OLDCASTLE(653-2278) or log on to www.oldcastleglass.com and click on “Need Assistance with a Project,” click on “General Inquiry” and enter your request.

Contact Us

For any additional information, including details, technical data, specifications, technical assistance and samples, or to speak with an architectural specialist, call 1-866-OLDCASTLE(653-2278).

Visit Us on the Web

Log on to www.oldcastleglass.com for project photos, product colors, general inquiries and project assistance.

To view performance data on a wide range of glass makeups, or to build your own product specification, log on to www.oldcastleglass.com and choose GlasSelect™ 