PRODUCT INFORMATION • TROSIFOL® IMPACT RESISTANT GLASS

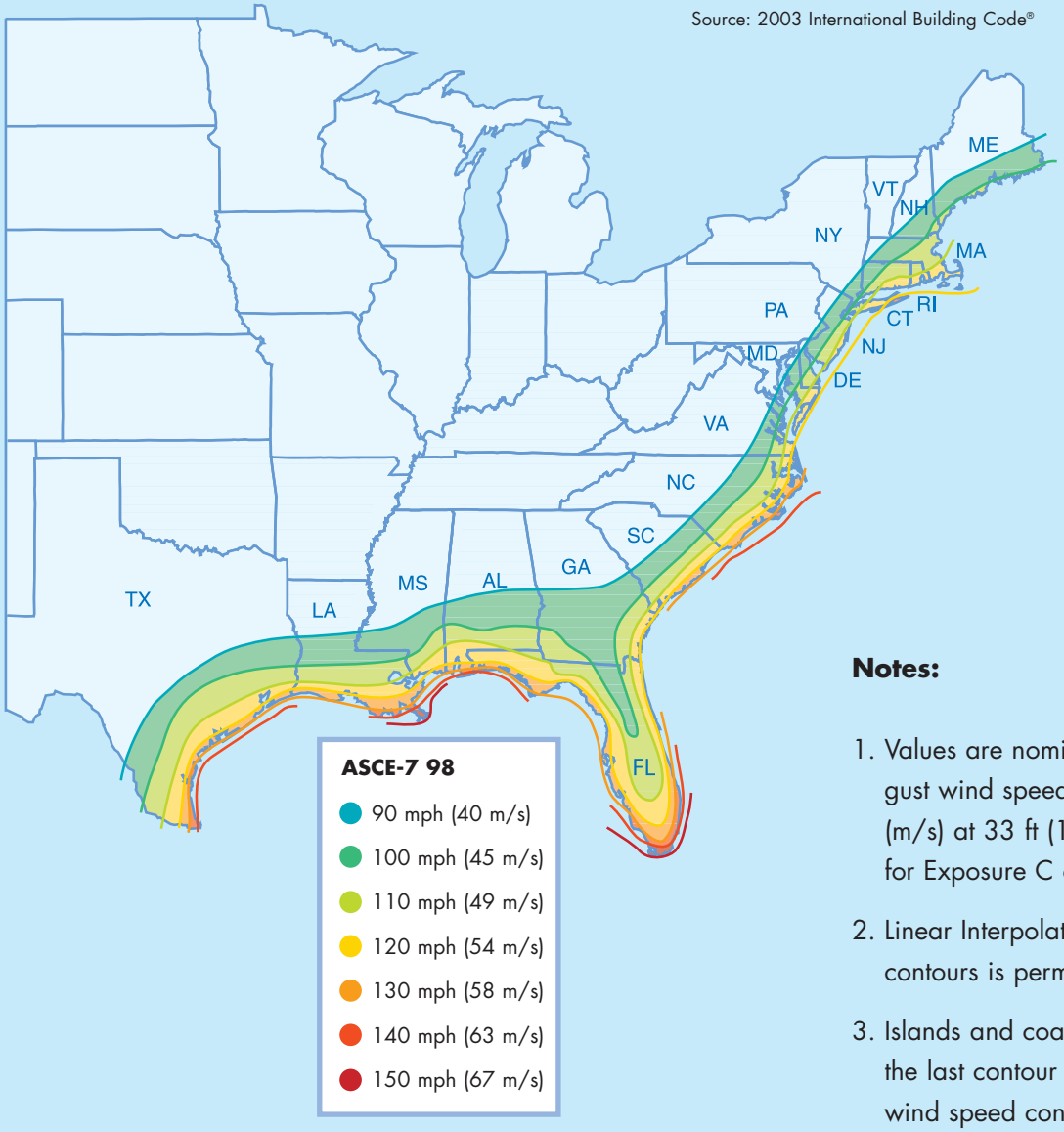
PROVIDING 24-HOUR WIND-BORNE DEBRIS PROTECTION

TROSIFOL®

HURRICANE MARKET GEOGRAPHY

FIGURE 1 – AVERAGE STORM WIND SPEEDS

Source: 2003 International Building Code®



Notes:

1. Values are nominal design 3-second gust wind speeds in miles per hours (m/s) at 33 ft (10 m) above ground for Exposure C category.
2. Linear Interpolation between wind contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal areas.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.

Cover Photo:
Hurricane Rita between Cuba and Florida.
Source: Jeff Schmaltz, MODIS Rapid Response Team, NASA/GSFC.
Courtesy of NASA Visible Earth, http://visibleearth.nasa.gov

INTRODUCTION

Hurricane,
"a violent cyclonic storm with winds moving at 73 or more miles per hour originating in the tropics or off the coast of Africa." So states Webster's New World Dictionary. 2005's hurricane Katrina, the costliest natural disaster to strike the continental United States, is the way residents of the Gulf Coast of the United States define hurricane.

Building code consensus bodies such as the International Code Council (ICC) and the Florida Building Commission (Commission) have developed minimum codes and standards for adoption by local municipalities to protect its citizens and structures from the ravages of hurricane force winds. Today the International Building Code (IBC), the International Residential Code (IRC), the Florida Building Code (FBC) and the Texas Department of Insurance (TDI) form the nucleus of minimum building standards designed to protect dwellings from high wind events such as hurricanes.

The family of building codes consider windows, sliding glass doors, curtain walls and storefronts as part of the building envelop and therefore may be subject to damage from flying debris during a windstorm event. This debris, predominantly from adjacent roof material, is classed as "wind-borne debris" and may result in the failure of the glazing if impacted. Not only is breaching the envelope critical to the continued function of the building due to resultant over pressurization of the building but extensive damage to internal contents, including the occupants, may also result.

Chapter 16, Section 1609 in both the International Building Code and the Florida Building Code states in part, *"Glazing that receives positive pressure in the lower 60 feet (18.3 m) of a building shall be assumed to be openings and such glazing that receives positive pressure is impact resistant or covered with an impact resistant covering (e.g., shutters or plywood) meeting ASTM E 1886 and ASTM E 1996."*

One type of protective system used to resist impact from wind borne debris is laminated glass, a multifunctional glazing material produced by bonding minimum two lites of glass with layers of polyvinyl butyral (pvb) interlayer under heat and pressure. The Florida Building Code requires impact systems used in Broward and Miami-Dade counties to meet the test requirements of Miami-Dade TAS 201, 202 and 203. Both referenced test protocols are accepted within Florida. In coastal states outside of Florida only the ASTM E 1886/1996 impact standard is recognized.

Opening protection for windows, sliding glass doors, storefronts or curtain walls is required in the wind-borne debris regions. This region is defined as "areas within one mile of the coastal mean high water line or where the basic wind speed is 110 mph (49 m/s) or greater; or where the basic wind speed is 120 mph (54 m/s) or greater." This wind speed profile defines the "Hurricane Market." The coastal shorelines extending from the tip of Long Island, NY to Brownsville, TX, the island of Bermuda and the islands in the Caribbean Sea.

TESTING PROTOCOLS

The standard test protocols utilized today include the *ASTM E 1886-05, Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure, the ASTME E 1996-05, Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricanes.*

Miami-Dade and Broward counties in Florida comprise the High Velocity Hurricane Zone (HVHZ). There are different established test protocols similar to the ASTM protocols mentioned above required. The Florida Building Code, HVHZ section (Chapter 44) mandates that impact products be tested and certified to the TAS 201, 202 and 203 protocol.

In general, both test protocols require a minimum of three test specimens (systems) be submitted for small missile and/or large missile testing. The missile level, (A, B, C, D and E) is determined by the wind zones. The wind zone determines the level and weight of missile used as well as the impact speed. The large missile is composed of a 2 inch x 4 inch pine board fired out of an air cannon. Small missile testing (Level A) utilizes a set of ten, 2 gram steel balls designed to impact within a given radius on the glazing. Passage of the large missile test also qualifies those specimens for small missile applications. Fenestration assemblies and shutter systems mulled together shall be tested separately or tested by combining three specimens into one mounting frame separated only by the mullions.

Test specimens mounted on the wall for impact and cyclic testing.
Source: NCTL Laboratories of an air cannon.

HURRICANE MARKET GEOGRAPHY – DETAIL

FIGURE 2 – AVERAGE STORM WIND SPEEDS
▶ EASTERN GULF OF MEXICO AND SOUTHEASTERN U.S. HURRICANE COASTLINE

Source: 2003 International Building Code®

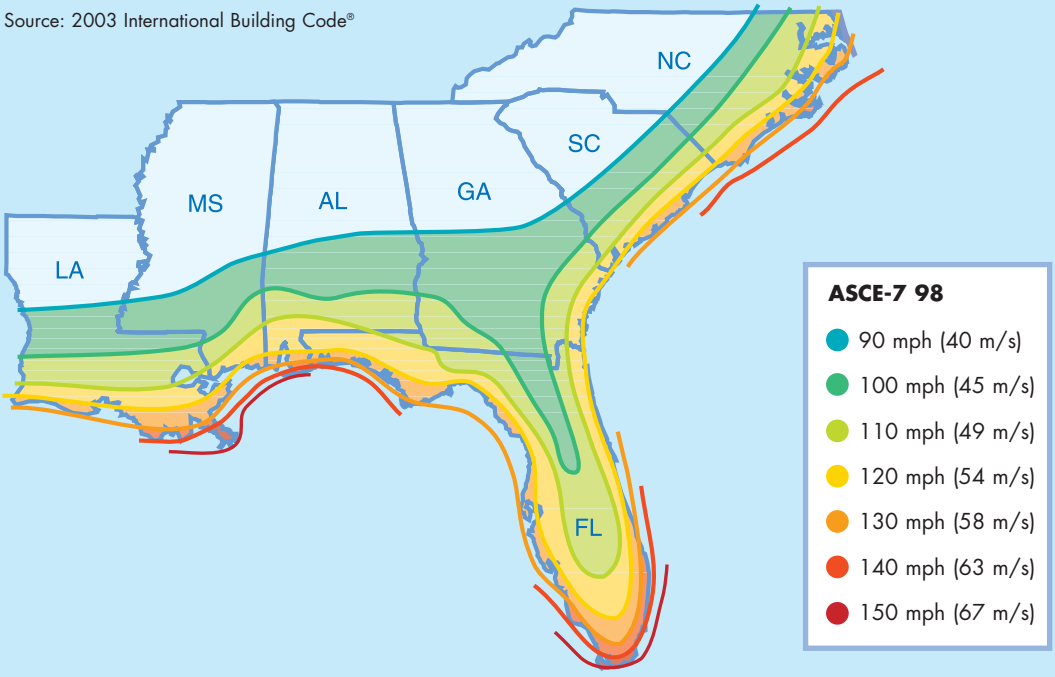


FIGURE 3 – AVERAGE STORM WIND SPEEDS
▶ MID AND NORTHERN ATLANTIC HURRICANE COASTLINE

Source: 2003 International Building Code®

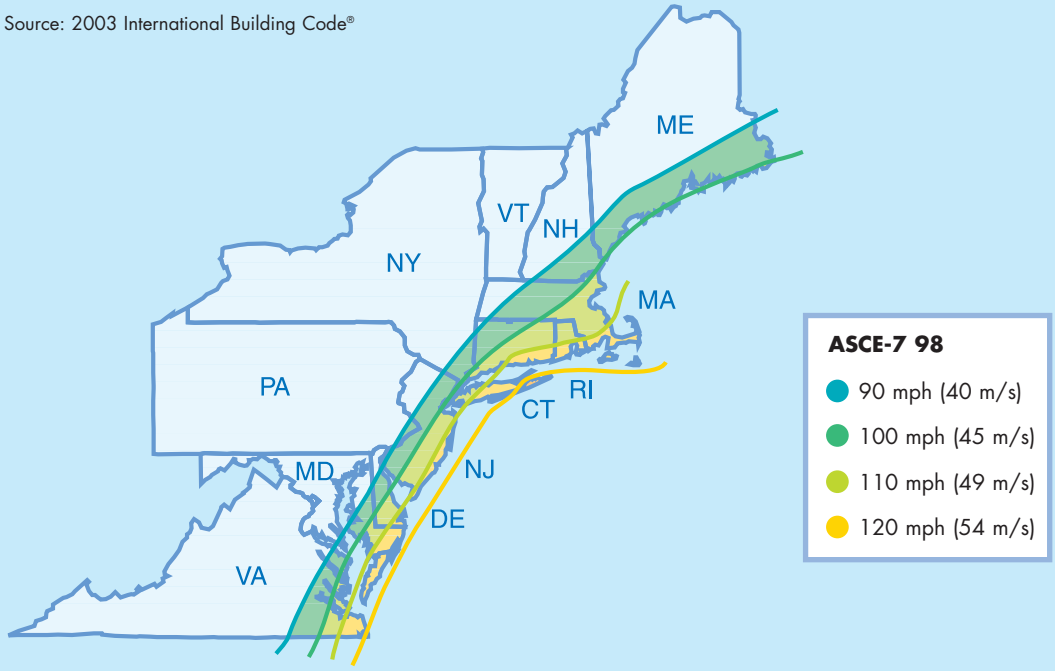


FIGURE 4 – ASTM E 1996 · APPLICABLE MISSILES

Level	Missile	Speed [f/s]	Speed [m/s]	Comment
A	2g +/– 5% Steel ball*	130	39.6	South Florida Small missile
B	2 lb +/– .25 lb 2 x 4 lumber**	50	15.3	Some residential skylights
C	4.5 lb +/– .25 lb 2 x 4 lumber	40	12.2	Lower wind zones only
D	9 lb +/– .25 lb 2 x 4 lumber	50	15.3	South Florida Large missile
E	9 lb +/– .25 lb 2 x 4 lumber	80	24.4	Essential facilities only

* Three identical test specimens. Missile is a steel ball (2g).
30 small missile impacts at 80 ft/sec: 10 at center, 10 near long edge, 10 near corner.
All three specimens must survive impacts without penetration.

** Missile is 2 x 4 lumber weighing 9 lbs.
Two impact points at 50 ft/sec: one at center, one within 6" of a corner.
All three specimens must survive impacts without penetration before proceeding to cyclic pressure test.

FIGURE 5 – ASTM E 1996 · CYCLIC LOADING

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

* P_{MAX} is design pressure based on ASCE7-98 calculations.

WIND ZONE AND MISSILE TYPE

The heart of the impact and cyclic testing occurs during the cyclic portion. The test specimen must endure 4,500 positive cycles and 4,500 negative cycles to simulate the positive and negative pressures acting on a structure during a hurricane. These 1 1/2 second cycles may last up to 3 hours during each phase.

The deflection of the glazing makeup and the bite (depth of glazing in frame) are crucial at this phase of the testing. Trosifol XT 90 has been successfully tested and certifi ed to meet the stringent requirements of ASTM E 1996 and TAS 201, 203.

Impact Testing
Source: NCTL Laboratories

FIGURE 6 – ASTM E 1996 · WIND ZONES AND MISSILE TYPES

	Enhanced Protection [Essential Facilities]		Basic Protection	
System Height	**≤ 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 140 within 1 mile of coast	E	D	D	A
Wind Zone 4 – >140 mph (South Florida)	E	D	D	A

MIAMI-DADE

BUILDING CODE COMPLIANCE OFFICE (BCCO)
PRODUCT CONTROL DIVISION

MIAMI-DADE COUNTY, FLORIDA
METRO-DADE FLAGLER BUILDING
140 WEST FLAGLER STREET, SUITE 1603
MIAMI, FLORIDA 33130-1563
(305) 375-2901 FAX (305) 375-2908

NOTICE OF ACCEPTANCE (NOA)

Trosifol North America LTD
160 Bixby Road
Erin, NY 14838

SCOPE: This NOA is being issued under the applicable rules and regulations governing the use of construction materials. The documentation submitted has been reviewed by Miami-Dade County Product Control Division and accepted by the Board of Rules and Appeals (BORA) to be used in Miami Dade County and other areas where allowed by the Authority Having Jurisdiction (AHJ).

This NOA shall not be valid after the expiration date stated below. The Miami-Dade County Product Control Division (In Miami Dade County) and/or the AHJ (in areas other than Miami Dade County) reserve the right to have this product or material tested for quality assurance purposes. If this product or material fails to perform in the accepted manner, the manufacturer will incur the expense of such testing and the AHJ may immediately revoke, modify, or suspend the use of such product or material within their jurisdiction. BORA reserves the right to revoke this acceptance, if it is determined by Miami-Dade County Product Control Division that this product or material fails to meet the requirements of the applicable building code.
This product is approved as described herein, and has been designed to comply with the Florida Building Code including the High Velocity Hurricane Zone.
DESCRIPTION: Trosifol XT-90 Interlayer
APPROVAL DOCUMENT: Drawing No.XT-90, Sheets 1 of 1, titled "Trosifol XT-90 Interlayer for Laminate Glass" dated 12/19/05, prepared by Trosifol North America, LTD signed and sealed by V. J. Abraham PE. bearing the Miami-Dade County Product Control Approval stamp with the Notice of Acceptance number and approval date by the Miami-Dade County Product Control Division.
MISSILE IMPACT RATING: None
LABELING: Glass laminated with XT-90 shall be permanently marked in a corner of the glass with: a) Authorized Laminator name. b) Glass standard specifications. c) MDCPCA that stands for Miami-Dade County Product Control Approved.
RENEWAL of this NOA shall be considered after a renewal application has been filed and there has been no change in the applicable building code negatively affecting the performance of this product.
TERMINATION of this NOA will occur after the expiration date or if there has been a revision or change in the materials, use, and/or manufacture of the product or process. Misuse of this NOA as an endorsement of any product, for sales, advertising or any other purposes shall automatically terminate this NOA. Failure to comply with any section of this NOA shall be cause for termination and removal of NOA.
ADVERTISEMENT: The NOA number preceded by the words Miami-Dade County, Florida, and followed by the expiration date may be displayed in advertising literature. If any portion of the NOA is displayed, then it shall be done in its entirety.
INSPECTION: A copy of this entire NOA shall be provided to the user by the manufacturer or its distributors and shall be available for inspection at the job site at the request of the Building Official.
This NOA consists of this page, evidence page as well as approval document mentioned above.
The submitted documentation was reviewed by **Candido E. Font PE.**

04/27/06

PRODUCT CONTROL ACCEPTED

NOA No: 06-0109.06
Expiration Date: April 27, 2011
Approval Date: April 27, 2006

GLAZING SYSTEM

All testing parameters are designed around the glazing system. The system includes the laminated glass makeup and all associated components such as the frame extrusion, gaskets, anchors, sealants and weather stripping. All component parts must be listed on the submitted drawings. Any deviation affecting the structural component of the system in the manufacturer of product will require additional testing by the manufacturer. As laminates are considered as components in the system they must meet Miami-Dade criteria and pass the "plastics" check list. A Miami-Dade Notice of Acceptance (NOA) is issued for laminates and the registration number must be provided on all drawings and glazing for submittal for testing and product approval.

TROSIFOL® interlayers bear the Miami-Dade Product Approval Notice of Acceptance number 06-0109.06 (see letter facing page).

PERFORMANCE

TROSIFOL® has developed special interlayer on the base of polyvinyl butyral (pvb) for outperformed hurricane protective glazing. The thickness of the pvb laminate is determined by the function to be served, i.e. safety, forced entry, impact protection from small or large missile, etc.

The generally accepted practice in the industry today is for small missile applications, (openings above 30 ft) a .060 interlayer is required. For large missile applications, (openings in the lower 30 feet), a .090 interlayer or greater is required to meet the impact test standards. For high performance applications (large opening sizes and high design pressures) an interlayer such as TROSIFOL®'s XTP100 pvb .100 is required. The opening size, frame extrusion, aspect ratio, glazing makeup, silicone, back bed and design pressures are integral components to choosing an interlayer type and thickness.

It is important to note that the glazing makeup tested in the lab must be the glazing makeup used in actual production. To comply with building code consensus standards, no components that affect the structural performance of an impact resistant glazing system may be substituted without a complete retest.

Typical impact test of a four-sided structural glazed unit.

Source: KELLEY Associates

ATTRIBUTES OF TROSIFOL® INTERLAYER

- Superior optical clarity due to using virgin PVB.
- Ability to provide a single extrusion in .090 thickness.
- Improved processability and significantly reduced contamination during lay-up.
- Labor cost savings.
- Can be delivered up to 130 inches in width.
- Excellent sound dampening characteristics.
- Provides 24 hour security.

SEALANT COMPATIBILITY

- No organic solvents on exposed edge
- Check with sealant manufacturer for sealant compatability with TROSIFOL® PVB interlayer.

FIGURE 7 – TROSIFOL® XT 90 PHYSICAL PROPERTIES

Property	Standard	Unit	Typical values XT 90
Density	ASTM D 792/EN ISO 1183-1	g/cm^3	1.070
Refractive index	ASTM D 542/EN ISO 489	–	1.481
Thermal conductivity	ASTM C 177/EN 12939	W/mK	0.20
Thermal expansion coefficient	ASTM D 696	$1/K \times 10^{-4}$	2.20
Specific heat	ASTM C 351	J/gK	1.84
Surface resistivity	ASTM D 412/IEC 60093	$\Omega \times 10^{11}$	2.0
Tensile strength	ASTM D 412/ISO 5327-3	MPa	> 23
Tensile elongation	ASTM D 412/ISO 5327-3	%	> 280

FIGURE 8 – TROSIFOL® SHIPPING AND STORAGE INFORMATION

With PE Interleaved Film	As Refrigerated Film / Without PE Interleaving
Storage in a packed state, without air-conditioning at maximum of +86°F (30°C)	Storage and transport refrigerated at ≤ 46°F (≤ 8°C)
Simple storage of left-over rolls in air-conditioned lay-up rooms with frequency changing glass ply sizes	Storage of left-over rolls: • Tightly sealed bag at ≤ 46°F (≤ 8°C) without controlled room humidty level • Open bag at ≤ 46°F (≤ 8°C) and 25 to 30% relative humidity
Blocking not possible	No PE waste

TROSIFOL® has seven strategic warehouse facilites throughout North America.
This assures timely delivery of interlayers.

Birmingham, AL, USA • Delta, BC, CANADA • Montreal, QC, CANADA
Los Angeles, CA, USA • Orlando, FL, USA • Scranton, PA, USA • Sunprarie, WI, USA

CONTACT

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6/2006

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