English

Product Portfolio

Hurricane Glazing

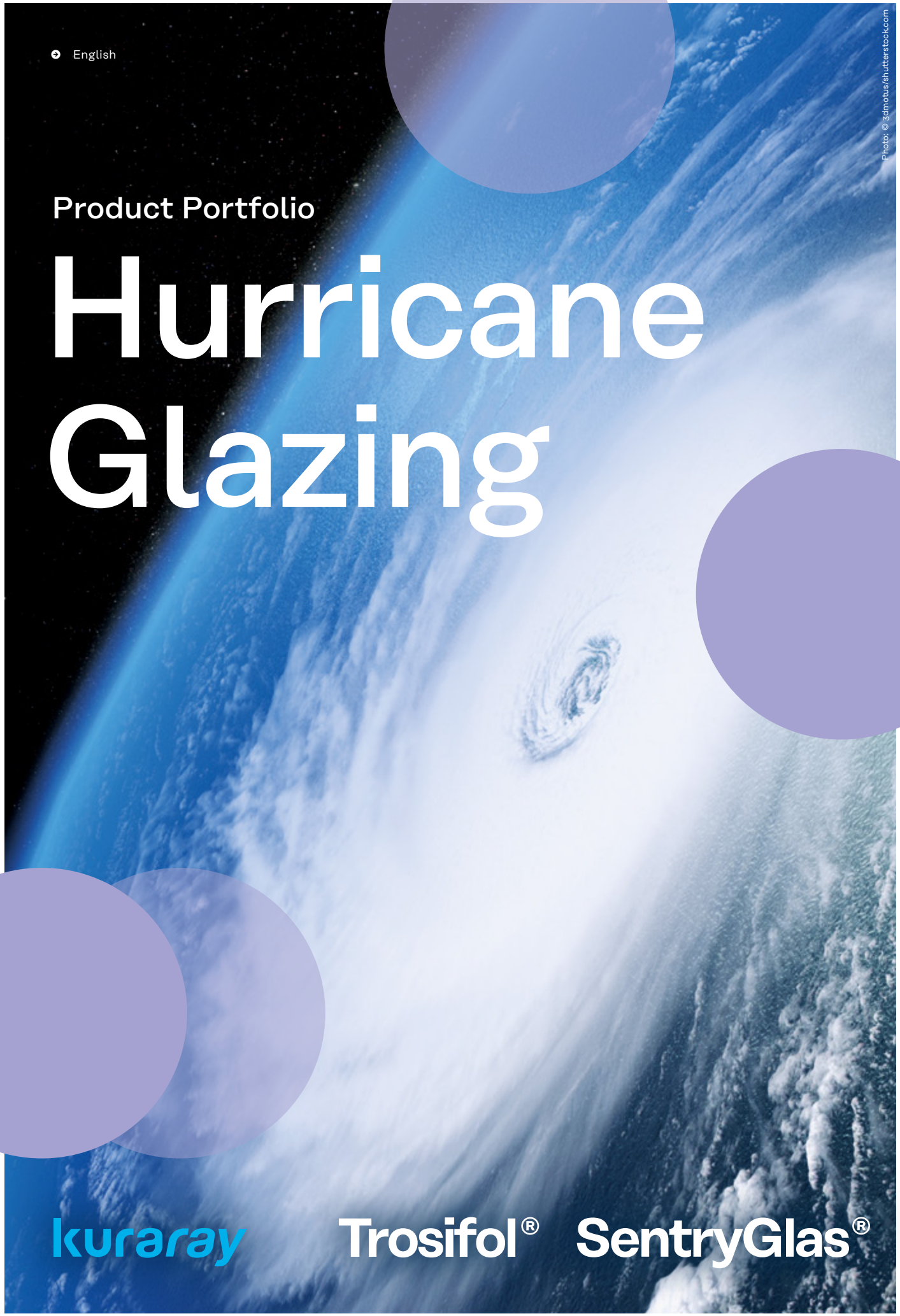


Photo: © 3dmotus/shutterstock.com

kuraray Trosifol® SentryGlas®

Hurricane rating sytem

Severe weather events such as hurricanes, cyclones, typhoons and tornados are capable of producing dam aging windborne debris.

Windborne debris has the potential to penetrate buildings and once the building envelope has been compromised the level of damage greatly increases. The use of hurricane impact windows is one critical component of the building that can greatly improve the resiliency of the building to extreme weather.

The Saffir-Simpson Hurricane scale is used to rate hurricanes. It uses wind as the primary measure of strength.

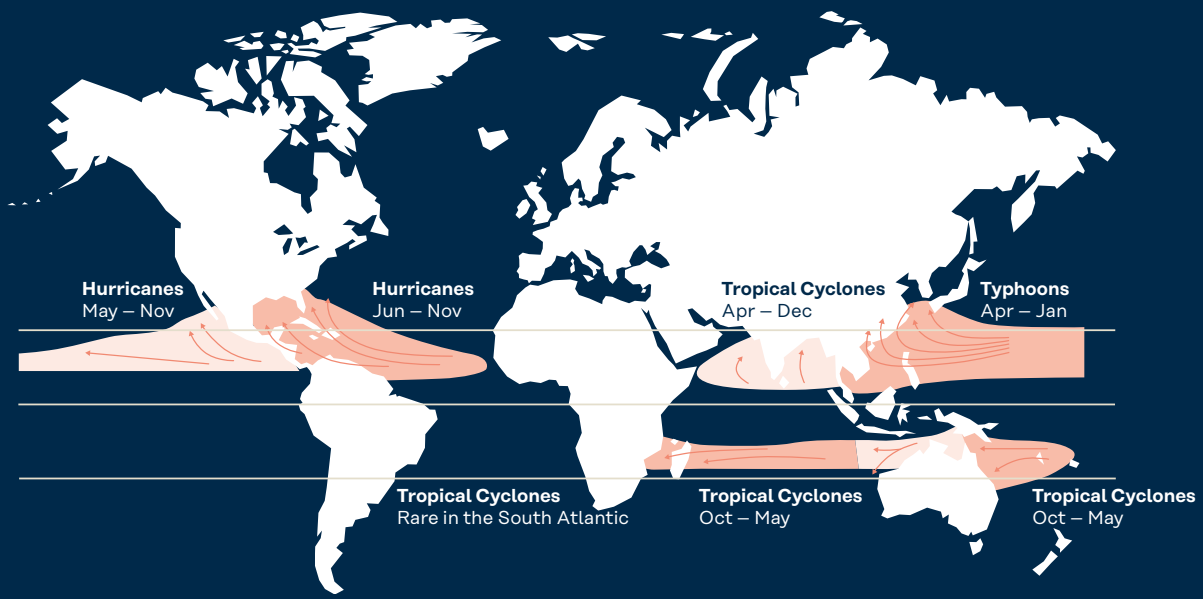
Saffir-Simpson Hurricane scale

Classification	Wind speed [km/h]	[mph]	Storm surge [m]	[ft]	Damage level
Tropical depression	63	<39		N/A	None
Tropical storm	63-118	39-73	0.3-0.9	1-3	Minimal
Category 1	119-153	74-95	1.2-1.5	4-5	Minimal
Category 2	154-177	96-110	1.8-2.4	6-8	Moderate
Category 3	178-208	111-129	2.7-3.7	9-12	Extensive
Category 4	209-251	130-156	4.0-5.5	13-18	Catastrophic
Category 5	>252	>157	>5.5	>18	Catastrophic



TAB 1 →

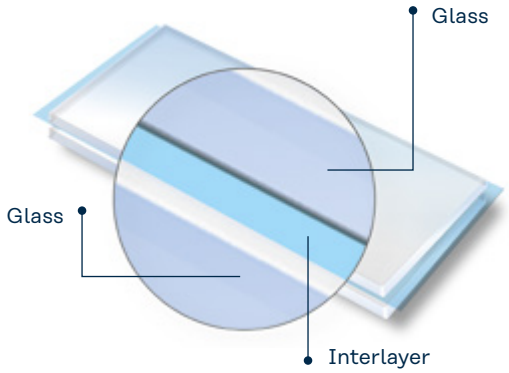
Cyclone · Hurricane · Typhoon – Natural phenomena



What is a hurricane impact resistant system?

Hurricane impact glazing systems combine impact resistant laminated glass into a framing system with the main purpose of maintaining the integrity of the building envelope by resisting the forces of high winds and rain, as well as resisting high impact forces from windborne debris. In addition, secondary considerations are to retain the glass in place if it breaks, providing security and preventing additional debris contribution during the wind event.

Typical construction of the laminated glass is two or more lites of heat strengthened or annealed glass with Trosifol® PVB or SentryGlas® ionoplast interlayer.



KEY BENEFITS OF LAMINATED GLASS IN HURRICANE WINDOW

- Glass remains intact even when broken providing a weather barrier that reduces the likelihood of total collapse of the building or widespread water damage
- The interlayer absorbs energy of the impact resisting penetration
- Prevents injuries related to flying glass and exposed shards
- When hurricane warning is issued no need to board up windows or activate / mount shutters. Ideal for homes that are not occupied during the hurricane season

ADDITIONAL BENEFITS FROM HURRICANE IMPACT WINDOWS

- UV protection
- Acoustic improvement
- Security/anti intrusion, bullet or blast resistance
- Improved safety with glass retention



➔ Porsche Design Tower, Miami, Florida, USA

Hurricane window system design guidelines

Hurricane testing is conducted on the whole system, which must pass both impact testing as well as positive and negative cyclic load testing.


Photo: © Ryan DeBerardinis/shutterstock

KEY FACTORS TO CONSIDER WHEN DESIGNING A SYSTEM

- Understand the local and international building code requirements for hurricane impact glazing
- The relevant test standards for hurricane impact resistant glazing
- Establish the wind zone and level of protection that will be required according to ASTM E1996 or TAS 201/203
- Whether the location and size of the building requires protection from small or large missile or both
- Consider the whole fenestration system including frame, attachments and glazing method not just the glass infill
- Type of glazing system: wet or dry
- Testing the glass as part of the whole system

HURRICANE CODES AND STANDARDS

- International Building Code section 1609.2 refers to protection of openings in windborne debris regions
- FEMA 320 - *Taking Shelter from the Storm: Building a Safe Room for Your Home or Small Business*
- FEMA 361 - *Safe Rooms for Tornadoes and Hurricanes*
- ICC 500 - Standard for the Design and Construction of Storm Shelters

TEST STANDARDS REFERENCED IN LOCAL BUILDING CODES

- ASTM E1886 - *Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems 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 Hurricanes*
- ISO 16932 - *Glass in building - Destructive windstorm-resistant security glazing - Test and classification*

MIAMI DADE AND BROWARD COUNTY (HIGH VELOCITY HURRICANE ZONES)

- TAS 201 *Impact Test Procedures*
- TAS 203 *Criteria for Testing Products Subject to Cyclic Wind Pressure Loading*


Photo: © solarseven/shutterstock.com

Cycling requirements

Inward acting pressure

Range	Number of cycles*
0.2 P_{MAX} to 0.5 P_{MAX}[2]	3,500
0.0 P_{MAX} to 0.6 P_{MAX}	300
0.5 P_{MAX} to 0.8 P_{MAX}	600
0.3 P_{MAX} to 1.0 P_{MAX}	100

Outward acting pressure

Range	Number of cycles
0.3 P_{MAX} to 1.0 P_{MAX}	50
0.5 P_{MAX} to 0.8 P_{MAX}	1,050
0.0 P_{MAX} to 0.6 P_{MAX}	50
0.2 P_{MAX} to 0.5 P_{MAX}	3,350

TAB 2 ➔ * ASTM E1996

After impact the whole system is subject to both positive and negative pressure, which simulates the hurricane approaching and leaving.

Wind speed and pressure

DETERMINING WIND SPEED AND PRESSURE

WIND SPEED VARIES BASED ON

- Risk category
- Geographic location

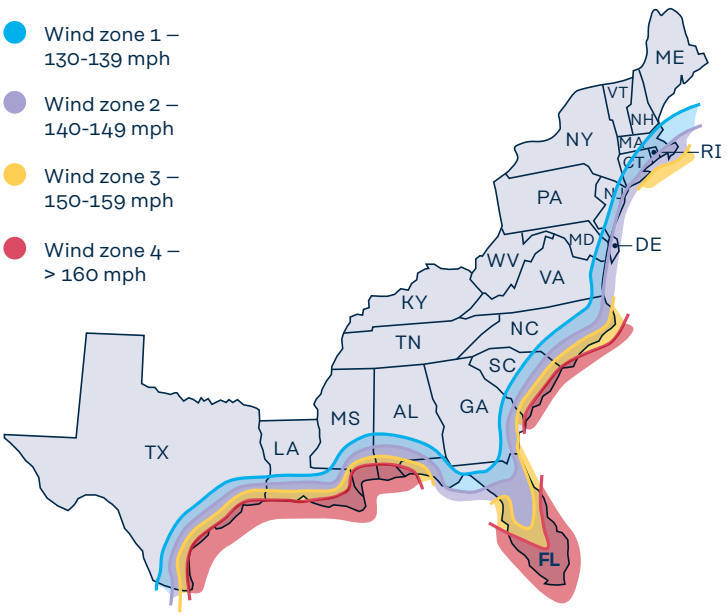
WIND PRESSURE VARIES BASED ON

- Wind speed
- Building type/occupancy
- Height
- Building footprint
- Opening or panel size
- Corner zones

Refer to ASCE 7 wind speed map

Storm wind speeds (risk category 2)

Eastern Gulf of Mexico and Southeastern US Hurricane coastline



Wet vs dry glazing

WET GLAZED

Traditional glazing method used for past 50 years in hurricane glazing with PVB. Use of a silicone sealant to bond the laminated glass to supporting structure.

- High level of precision and skill required to correctly wet glaze a hurricane framing system
- Special materials required
- Expensive, time consuming and labor intensive process
- If glass panel is broken, extra labor is required to cut through and remove the existing adhesive, clean the frame, and reapply the new adhesive.
- Depends heavily on skilled workers

DRY GLAZED

No use of sealant - recommend the use of a structural interlayer such as SentryGlas®.

- Dry glaze relies on structural interlayers such as SentryGlas®
- The rigid laminates provide sufficient post breakage strength to resist pull out during cyclic testing
- Ease of installation - no need for skilled labor
- Reduce cost in terms of labor
- Retrofits and repairs are easier
- Properly designed dry glazed systems can provide extremely high levels of protection

House still standing after Hurricane Michael 2018, Mexico Beach, Florida



Photo: © Johnny Milano

Product approval process

There are three main product approval agencies in North America:

Florida Product Approval - Florida

Notice of Acceptance NOA - HVHZ (Miami Dade and Broward County)

TDI - Texas Department of Insurance - Texas



BASIC STEPS FOR PRODUCT APPROVAL

1. DESIGN SYSTEM

- Product type
- Profiles and assemblies
- Target market

2. TESTING

- Air / water / structural
- Impact testing
- Cyclic load

3. CALCULATIONS

- Glass, anchors, material stresses and deflections

4. DRAWINGS

- Sizes, pressures, configurations

5. SUBMIT APPLICATION

Courtesy of Al Farooq Corporation

LAMINATOR SUPPLYING TO HURRICANE WINDOW MANUFACTURER

- Laminators that wish to supply to window manufacturers seeking MDC approval must be listed on the MDC approved laminator list. Your Kuraray representative can help you get on this list.
- Interlayers must also have an NOA to be used for a MDC product approval.
- All Kuraray interlayers products have an MDC NOA.

AIS interlayers for hurricane protection

Kuraray's Advanced Interlayer Solutions (AIS) Division, with the broadest portfolio of interlayers, has a solution for any design requirement. Some factors that drive the selection process are as follows:

SELECTION FACTORS

- Window or door size
- Type of glazing dry vs wet
- Design pressure
- Large vs small missile
- Framing system and bite size



Whatever your design criteria, AIS has an interlayer

All Kuraray interlayers have MDC NOA.

TROSIFOL® CLEAR*

- PVB interlayer
- Medium-high adhesion
- Available in rolls
- Caliper: 0.76, 1.14, 1.52 and 2.28 mm (30, 45, 60 and 90 mil)
- Width up to 321 cm (126 inches)

TROSIFOL® XT ULTRACLEAR

- PVB interlayer
- Medium adhesion
- Available in rolls
- Caliper: 2.28 mm (90 mil)
- Width up to 321 cm (126 inches)

SENTRYGLAS®**

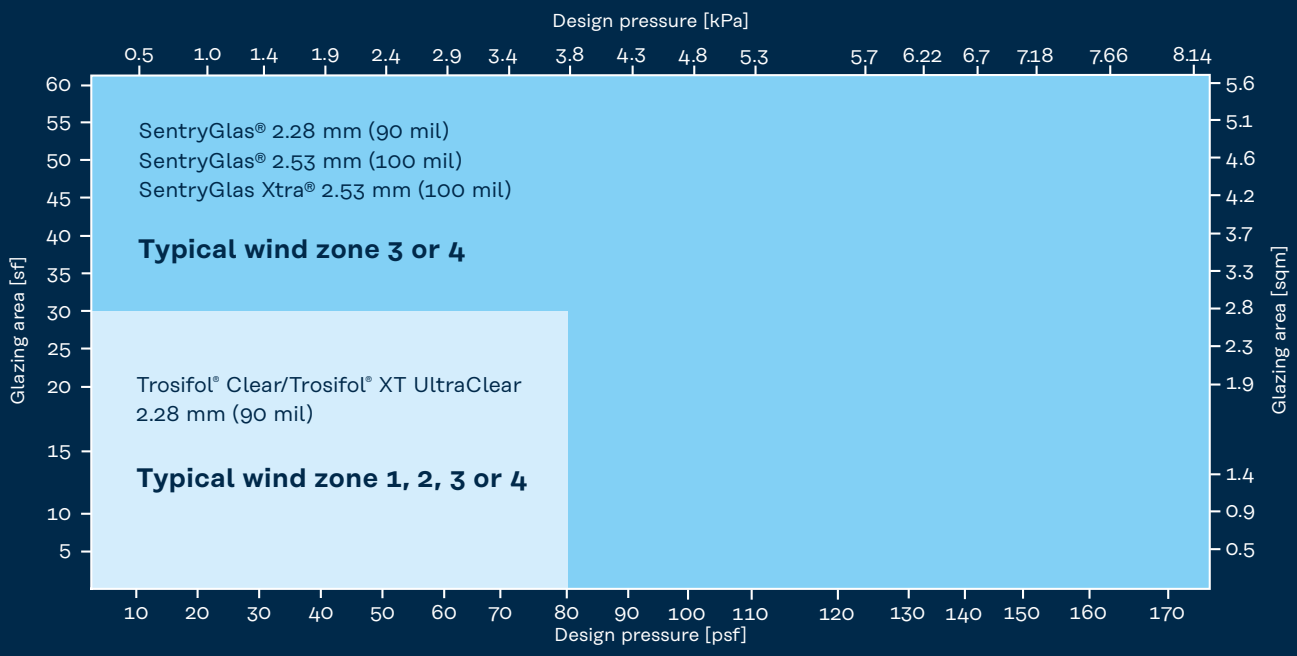
- Ionoplast interlayer
- 100 times stiffer and 5 times more tear resistant than PVB
- Available in sheets and rolls
- Caliper: 0.76, 0.89, 1.52, 2.28 and 2.53 mm (30, 35, 60, 90, 100 and 120 mil)
- Widths up to 330 cm (130 inches)

SENTRYGLAS XTRA®

- Latest generation of ionoplast interlayer
- Excellent adhesion to air side of glass without need for primer
- Haze formation less sensitive to autoclave cooling rate
- Caliper: 0.89, 1.52, 2.28 and 2.53 mm (35, 60, 90 and 100 mil)
- Widths up to 3300 mm (130 inches)

* Available in colors and tints also
** Available in Translucent White color also

How to choose interlayer based on window size and design pressure



Large missile level D with ¼" HS -0.090 " interlayer-¼" HS (6 mm HS - 2.28 mm (90 mil) interlayer - 6 mm)

Design pressures for hurricane systems*

Only SentryGlas® is recommended for use in dry glaze systems because of its high modulus.

Maximum design pressure for SentryGlas® is 8.14 Kpa (170 psf).
Maximum design pressure for PVB is 3.83 Kpa (80 psf).

SentryGlas® dry glazed

Short dimension [m]	[in]	GB 0.5" [kPa]	[psf]	GB 0.625" [kPa]	[psf]	GB 0.75" [kPa]	[psf]	GB 0.875" [kPa]	[psf]	GB 1" [kPa]	[psf]
0.91	36	4.55	95	5.75	120	6.94	145	7.18	150	7.18	150
1.07	42	3.83	80	4.79	100	5.99	125	6.94	145	7.18	150
1.22	48	3.35	70	4.31	90	5.27	110	5.99	125	6.94	145
1.37	54	3.11	65	3.83	80	4.55	95	5.27	110	6.22	130
1.52	60	2.63	55	3.35	70	4.07	85	4.79	100	5.51	115
1.68	66	2.39	50	3.11	65	3.83	80	4.31	90	5.03	105
1.82	72	2.15	45	2.87	60	3.35	70	4.07	85	4.55	95

SentryGlas® wet glazed

Short dimension [m]	[in]	GB 0.5" [kPa]	[psf]	GB 0.625" [kPa]	[psf]	GB 0.75" [kPa]	[psf]	GB 0.875" [kPa]	[psf]	GB 1" [kPa]	[psf]
0.91	36	5.27	110	6.46	135	7.66	160	8.14	170	8.14	170
1.07	42	4.55	95	5.75	120	6.70	140	7.66	160	8.14	170
1.22	48	3.83	80	5.03	105	5.99	125	6.94	145	7.66	160
1.37	54	3.59	75	4.31	90	5.27	110	5.99	125	6.94	145
1.52	60	3.11	65	3.83	80	4.79	100	5.51	115	6.22	130
1.68	66	2.87	60	3.59	75	4.31	90	5.03	105	5.75	120
1.82	72	2.63	55	3.11	65	3.83	80	4.55	95	5.27	110

Trosifol® PVB wet glazed

Short dimension [m]	[in]	GB 0.5" [kPa]	[psf]	GB 0.625" [kPa]	[psf]	GB 0.75" [kPa]	[psf]	GB 0.875" [kPa]	[psf]	GB 1" [kPa]	[psf]
0.91	36	3.83	80	3.83	80	3.83	80	3.83	80	3.83	80
1.07	42	3.26	68	3.83	80	3.83	80	3.83	80	3.83	80
1.22	48	2.87	60	3.59	75	3.83	80	3.83	80	3.83	80
1.37	54										
1.52	60										
1.68	66										
1.82	72										

➔ * Large missile level D with ¼" HS – 0.090" interlayer – ¼" HS (6 mm HS – 2.28 mm interlayer – 6 mm)

Typical laminate constructions

Missile level	Missile	Missile speed [m/s]	[f/s]	Trosifol® PVB	SentryGlas®	SentryGlas Xtra®
A	2 g (31 grains), steel ball	39.62	130	6 mm HS 1.52 mm (60 mil) Trosifol® PVB 6 mm HS	6 mm HS 0.89 mm (35 mil) SentryGlas® 6 mm HS	
B	910 g (2 lb) 2 x 4 in 52.5 cm (1 ft-9 in) lumber	15.25	50	6 mm HS 1.52 mm (60 mil) Trosifol® PVB 6 mm HS	6 mm HS 0.89 mm (35 mil) SentryGlas® 6 mm HS	
C	2050 g (4.5 lb) 2 x 4 in 1.2 m (4 ft) lumber	12.19	40	6 mm HS 1.52 mm (60 mil) Trosifol® PVB 6 mm HS	6 mm HS 0.89 mm (35 mil) SentryGlas® 6 mm HS	
D	4100 g (9 lb) 2 x 4 in 2.4 m (8 ft) lumber	15.25	50	6 mm HS 2.28 mm (90 mil) Trosifol® PVB 6 mm HS	6 mm HS 2.28 mm (90 mil) SentryGlas® 6 mm HS	6 mm HS 2.53 mm (100 mil) SentryGlas Xtra® 6 mm HS
E	4101 g (9 lb) 2 x 4 in 2.4 m (8 ft) lumber	24.38	80	N/A	6 mm HS 4.56 mm (180 mil) SentryGlas® 6 mm HS“	

Hurricane projects using AIS interlayers



Photo: © YKK AP

➔ Jennie Sealy Hospital, Galveston / Texas, USA

- **Level E Hurricane - Jennie Sealy level E essential facilities**
- **20+ years of durability – Broward County Performance Arts Center**
- **International projects - Secrets The Vine, Cancun**
- **Building that survived a major hurricane - Gulfstream condominiums on North Padre Island**
- **Hurricane with bomb blast – Miami Federal Courthouse**
- **Hurricane and Structural glass - Dali Museum**

Detailed hurricane projects you can find here:

www.trosifol.com

Contact



FOR FURTHER INFORMATION
on products from Kuraray, please visit www.kuraray.com.
You can find further information on our Trosifol® and SentryGlas® products at www.trosifol.com.

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WORLD OF INTERLAYERS

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