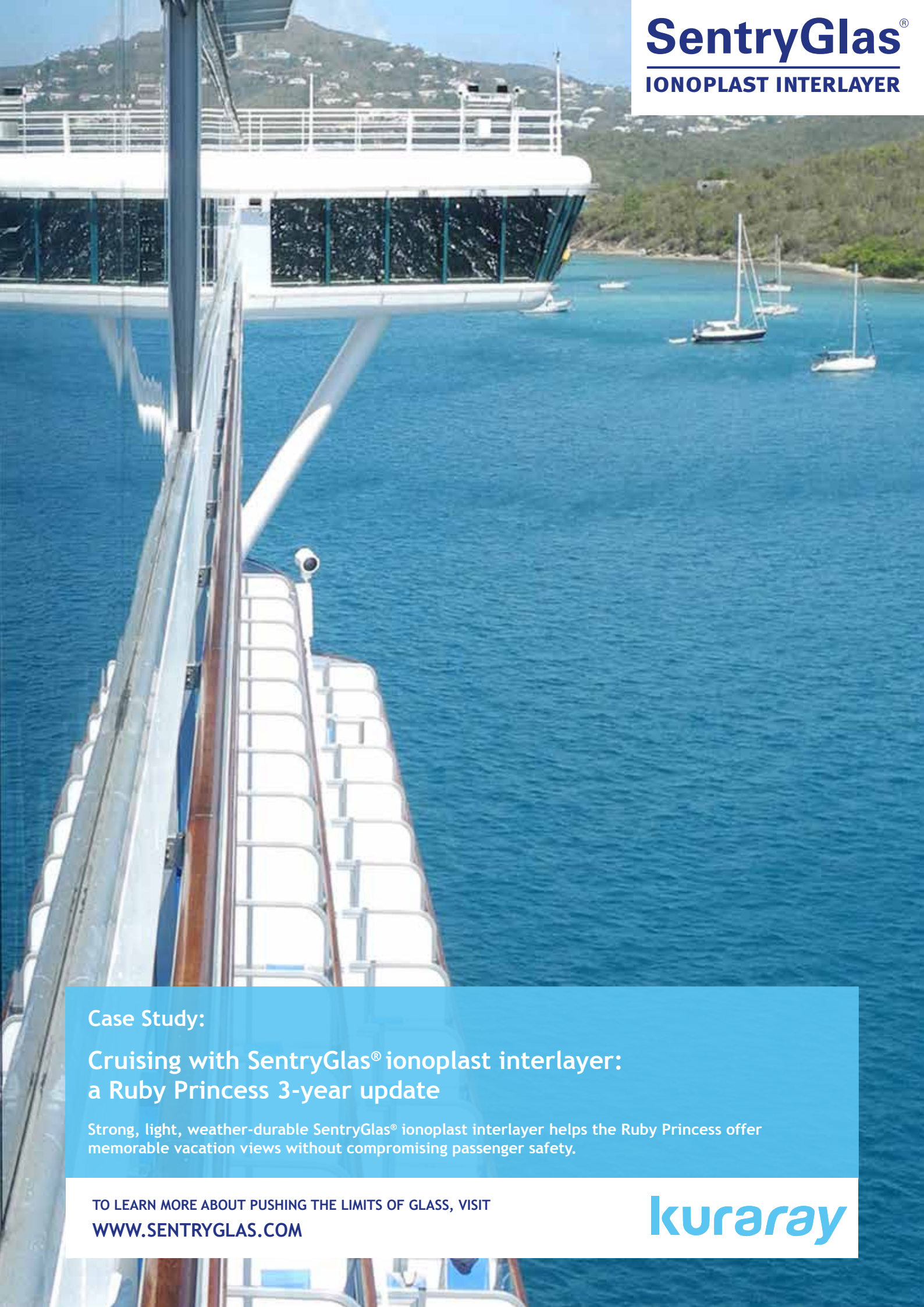

SentryGlas®
IONOPLAST INTERLAYER

Case Study:

Cruising with SentryGlas® ionoplast interlayer: a Ruby Princess 3-year update

Strong, light, weather-durable SentryGlas® ionoplast interlayer helps the Ruby Princess offer memorable vacation views without compromising passenger safety.

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Cruising with SentryGlas® ionoplast interlayer: a Ruby Princess 3-year update

The Ruby Princess saves approximately 50 tons of cruising princessweight by using Somec's light balustrade system made with SentryGlas® ionoplast interlayer instead of a standard polyvinyl butyral (PVB) interlayer.

The Italian shipbuilder Fincantieri adopted a new, light balustrade system from Somec Marine & Architectural Envelopes SRL (Italy), featuring the SentryGlas® ionoplast interlayer laminate, in order to reduce weight while ensuring compatibility with new safety standards from Lloyd's Register. Other benefits include enhanced structural performance, excellent post-glass-breakage strength and laminate edge durability in the marine environment.

The Ruby Princess, built by Fincantieri at the Monfalcone yards near Trieste, Italy, was christened in November 2008 in Fort Lauderdale, Florida (US), known for an active cruise industry serving the Caribbean. (In 2011, we sailed her and updated our images, shown here).

The $400m ship has a displacement of 113,000 gross tons, an overall length of 290 m (951 ft), a width of 36 m (118 ft)and a maximum speed of 23 knots. There are a total of 1,549 cabins spread over its 19 decks, accommodating up to 4,800 passengers – guests and crew included. Glass balustrades protect balconies on decks 8 to 15, and line the public areas on decks 14 through 18. They are also used as windscreens on decks 16 and 17.

Seen increasingly in the design of many of today's cruise ships and super-yachts, the use of glass enhances the passengers' views, provides a sense of openness to the outside, and brings in the natural light and beauty of the sea.

New Lloyd's Register standard poses weight challenge
Beyond their visual appeal, glass construction elements in the marine industry need to withstand both human and wave impacts, as well as and harsh climates, in order to ensure passenger safety. All glazing used on ships is subject to norms and standards developed by a national or international standards organisation (ISO, BS, EN) specific for marine applications. In addition, each cruise ship project is assigned to a marine classification society, such as Lloyd's, to ensure that the ship is built in accordance with approved plans and in full compliance with its classification rules.

In the case of the Ruby Princess, a 2005 change in Lloyd's Register's safety rules was applied to the design of her exterior glass balustrades. It required replacing tempered monolithic glass with tempered laminated glass for enhanced safety. This presented a significant challenge for the design of glass balustrades intended for the Ruby Princess.

"Changing from tempered glass to standard laminated glass with a PVB interlayer introduces a significant increase in weight," explains Sandro Casaccio, marine glazing segment leader at Glass Laminating Solutions "Where 10 mm (3/8") tempered glass was used previously for a cruise ship balustrade, The Kuraray Glass Laminating Solutions specialists (at that time working for DuPont) calculated that the change to standard PVB-based laminated glass would require an increase in thickness to 14 mm (9/16")to meet the same load-bearing capacity. This 4 mm (5/32") increase in glass thickness represents a weight increase of approximately 22 kg per sqm (4.5 lb per sqft)."

A thinner, lighter and more durable laminate using SentryGlas®
The change in safety rules and consequent increase in weight for standard balustrade systems prompted collaboration between Fincantieri and Somec Marine to find a new, lighter solution.

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"We were already familiar with the structural performance of laminates made with SentryGlas® ionoplast interlayer," says Christian Sossai, engineer at Somec. "Due to their much enhanced strength behavior and reduced laminate deflection versus a conventional PVB laminate, we were able to develop and propose a stronger and more secure balustrade system using a thinner laminate construction 6 mm (1/4") tempered tinted glass + 1.52 mm (60 mil) SentryGlas® + 4 mm (5/32") tempered tinted glass) of equivalent thickness and weight to the original monolithic tempered glass."

Part of the manufacturing process for Somec's new balustrade system was conducted in cooperation with Formator Safety Glass d.o.o. (Croatia), specialists in the production of tempered, heat-strengthened and laminated glass. The high stiffness of the ionoplast interlayer, up to 100 times that of PVB, means the glass laminate remains intact in the event of accidental breakage, while the dangerous glass fragments remain adhered to the interlayer. Accordingly, the potential danger to passengers is reduced and the structural capacity of the balustrade is retained.

Additionally, laminates made with SentryGlas® show excellent durability in marine conditions. Extensive product testing was performed, including salt spray fog testing, during which glass panels with SentryGlas® are exposed to 500 consecutive hours of salt spray. The tests showed that laminated glass panels made with SentryGlas® remained unchanged in terms of structural performance and transparency.

The exceptional edge stability of the laminates assured no undesired changes such as delamination, which can be caused by the humid marine environment.

Lighter façade panels enable more subtle supporting structures

For decades, interlayers made of polyvinyl butyral (PVB) have been the industry standard when producing laminated safety glass. Architects are well aware of the possibilities and limitations of such glass when used extensively in façade engineering, for roofing and window panels. In contrast, SentryGlas® enables an entirely new approach because the interlayer is over 100 times stiffer and five times stronger than PVB. As a consequence, there is an almost perfect transmission of load between two laminated sheets of glass, even at high temperatures, leading to the excellent flexural behavior of the glass when under load – also under direct sunlight in high summer. Accordingly, laminates with SentryGlas® show less than half the rate of deflection when compared to laminates with PVB, when under the same load, and thus almost the same behavior as monolithic glass of the same thickness.

In accordance with marine industry requirements, the new light balustrade system was extensively tested at facilities belonging to Somec Marine, in the presence of approver Lloyd's Register.

"Our testing verified the performance attributes of Somec's light balustrade system with SentryGlas® at a reduced thickness versus standard PVB laminates," confirms Mario Croce, manager of the Trieste design support center. "I believe the adoption of SentryGlas® interlayers will facilitate the replacement of tempered glass with tempered laminated glass in marine balustrades, increasing safety without compromising weight."

More than 5,000 square metres (53.820 sqft) of exterior laminated glass balustrades and windscreens protect passengers and crew of the cruise ship Ruby Princess, one of the largest vessels in the Princess Cruises fleet.

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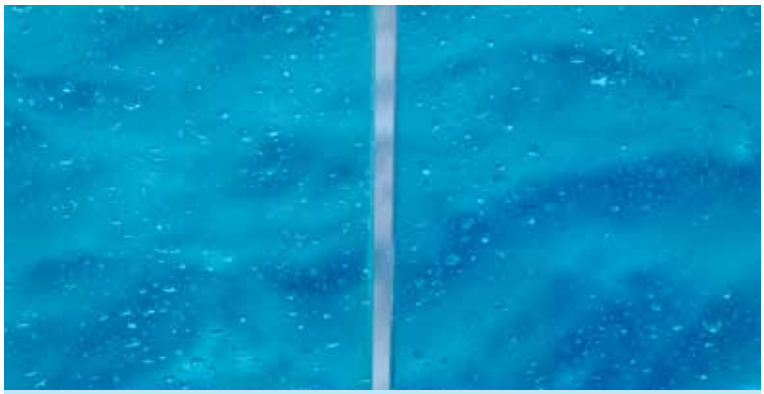

As well as improved strength and stiffness, other benefits of SentryGlas® include:

- **Safety:** In the event of breakage, glass fragments remain firmly bonded to the interlayer, reducing the chance for injury
- **Security:** SentryGlas® can be used in glazing that withstands bullets, hurricane-force winds and even bomb blasts
- **Durability:** SentryGlas® is extremely durable and resistant to clouding, even after years of exposure
- **Design Versatility:** SentryGlas® can be used in glass manufactured flat or curved, including annealed, toughened, heat-strengthened, spandrel, wired, patterned and color tinted glass
- **UV control:** SentryGlas® is available with or without UV transmittance

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