



WHITEPAPER:
**Incorporating innovative materials
for structural integrity**



Always high-performance glass

Content

Introduction: Why you need this guide.....3

SentryGlas® Plus for superior strength and elegance.....4

Why SentryGlas® Plus is stronger5

SentryGlas® Plus: enhanced tear strength and rigidity6

Specifying laminated glass with multiple interlayers7

More reasons why SentryGlas® Plus is safer than PVB.....8

Specifying ballistic, blast-proof and security glass9

Superior clarity: why SentryGlas® Plus is the clear choice10

SentryGlas® Plus: greater resistance to moisture12

SentryGlas® Plus means lighter panes13

Key architectural applications14

Environmental benefits.....16

Why ESG for high-performance glass.....18

Get expert technical advice20

Introduction

Who should read this white paper?

Senior architects working on ambitious and challenging projects that require elegant, innovative, robust and energy-efficient solutions featuring high-performance glass.

What will you learn from this guide?

How SentryGlas® Plus, an advanced interlayer material used in laminated safety glass, is up to 100 times stiffer and five times stronger than polyvinyl butyral (PVB) – enabling lighter panes to be specified for projects requiring large expanses of glass.

SentryGlas®

This advanced glass can:

- ✓ support heavier loads – making it suitable for structural applications in which glass is a primary material bearing weight and stress
- ✓ retain its aesthetic and function over time as it contains ionoplast polymer, known for its excellent adhesion properties and clarity
- ✓ maintain transparency and strength throughout its lifespan, providing consistently reliable protection
- ✓ offer advanced interlayers for improved safety post-breakage – reducing the risk of injury from falling or loose glass shards
- ✓ exhibit better edge stability so it is less prone to degradation and delamination when exposed to water or moisture
- ✓ withstand a broader range of temperatures
- ✓ offer significant advantages for ballistic, blast-proof and security glass applications
- ✓ have a more pronounced impact on energy efficiency than the thickness of the glass itself

Specify SentryGlas® Plus for superior strength and elegance

SentryGlas® Plus is an advanced interlayer material used in laminated safety glass. It provides architects with a more robust and durable option, enabling innovative designs that prioritise safety, aesthetics and longevity.

This results in enhanced durability, making the glass up to 100 times stiffer and five times stronger than Polyvinyl butyral (PVB). This increased strength allows for greater security and safety.

Other benefits include:

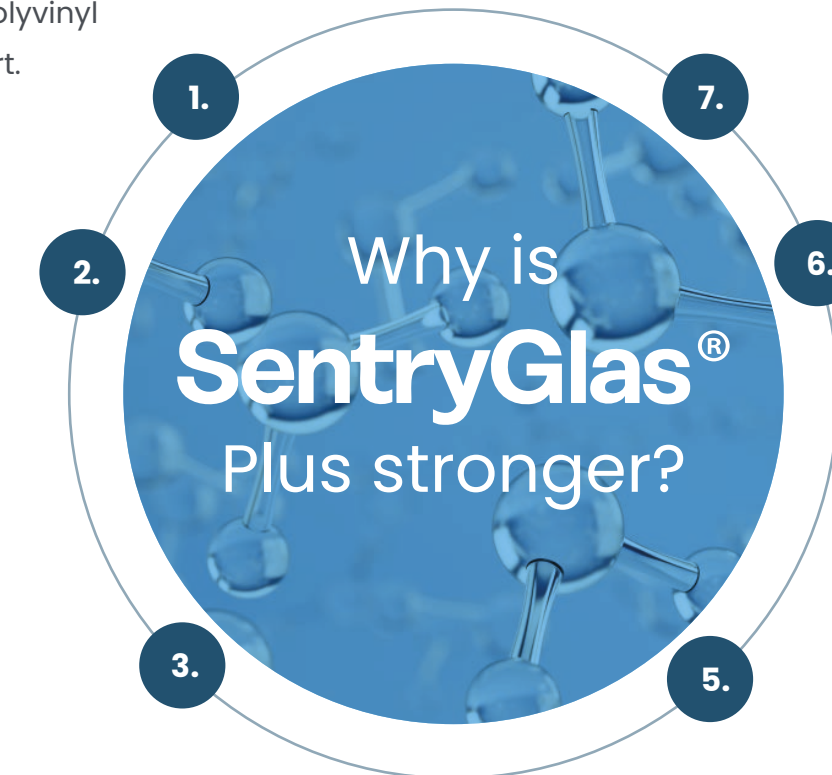
- ✓ higher resistance to weathering and edge stability issues
- ✓ thermal stability and superior performance in high temperatures
- ✓ greater stiffness, allowing for larger spans and less deflection under load – ideal for designs that require minimal framing, providing a more unobstructed view and a sleeker aesthetic

Developed by Kuraray in the mid-1990s, SentryGlas® Plus offered enhanced strength, durability, and environmental resistance where traditional PVB (polyvinyl butyral) interlayers were falling short.

SentryGlas® Plus features an ionoplast interlayer with a unique molecular structure, delivering superior strength, stiffness, adhesion, and clarity for lasting performance and aesthetics.

Ionoplast polymers are composed of highly cross-linked networks that include ionic bonds in addition to the covalent bonds typically found in polymers.

kuraray



Ionic bonds form between atoms when one atom donates one or more electrons to another atom, resulting in the formation of oppositely charged ions. These ions are then attracted to each other by electrostatic forces.

The structure is such that it allows for flexibility under low stress but becomes rigid under high stress, providing a unique combination of elasticity and toughness.

The presence of ionic cross-links contributes to several of SentryGlas® Plus's distinctive properties. These bonds are stronger and more stable than purely covalent bonds. This leads to increased mechanical strength and chemical stability.

Covalent bonds form when two atoms share one or more pairs of electrons. This type of bonding typically occurs between non-metal atoms that have similar electronegativities.



Enhanced tear strength and rigidity

Tear strength: The resistance to tearing when subjected to stress – is crucial for materials used as interlayers in laminated glass: these layers must hold the glass together even when broken. Higher tear strength materials such as the interlayer in SentryGlas® Plus can better resist propagating tears when damaged. This enhances the overall safety of the glass by preventing it from shattering into large, sharp pieces. Tear strength is critical in applications in which the glass must maintain its integrity and continue to provide a barrier even after an impact.

Rigidity / stiffness: The ability to resist deformation under load – is also essential because it affects how much the glass will flex or bend under force. More rigid materials used in laminated glass such as SentryGlas® Plus lead to less deflection. This makes the glass suitable for larger, more structurally demanding applications such as overhead glazing, floors or balustrades. It also contributes to better overall stability and durability, reducing the likelihood of breakage from physical stress and environmental factors.

Specifying laminated glass with multiple interlayers

The number of interlayers in a pane of SentryGlas® Plus laminated glass can vary depending on the specific requirements of the application, such as the level of safety, security or the structural load the glass needs to withstand.

Typically, a laminated glass pane consists of at least two layers of glass with one interlayer sandwiched between them. However, for additional strength, sound insulation or security requirements, multiple layers of glass and interlayers can be used.

For example, in more demanding applications – such as hurricane-resistant windows, security barriers or in architectural features – multiple SentryGlas® Plus interlayers may be employed between several layers of glass. This layering significantly enhances the pane’s impact resistance, structural integrity and safety features.

The exact configuration – how many layers of glass and interlayers are used – is determined by the project’s specifications, the required safety standards and the performance characteristics desired. The number of interlayers is tailored to meet the needs of each specific application.





More reasons why SentryGlas® Plus is safer than PVB

✓ Improved safety post-breakage

When glass breaks, SentryGlas® Plus helps to hold the fragments in place more firmly, compared with PVB. This reduces the risk of injury from falling or loose glass shards, a critical factor in public safety during accidents or disasters.

✓ Superior edge stability

SentryGlas® Plus offers greater edge stability than PVB, resisting moisture-induced degradation and delamination – ideal for outdoor and high-humidity environments where PVB may fail and compromise safety.

✓ Higher resistance to weather and natural forces

SentryGlas® Plus can withstand a broader range of temperatures. Its durability in the face of environmental stressors means that it maintains transparency and strength throughout its lifespan, providing consistently reliable protection.

✓ Enhanced load-carrying capacity

Due to its higher modulus of elasticity, SentryGlas® Plus can support heavier loads. This makes it suitable for structural applications where glass is the weight and stress bearing material, such as in floors, stairs and overhead glazing.

Overall, the choice of glass depends on the specific requirements of the project, including safety standards, environmental conditions and budget. However, for applications requiring the highest levels of safety and performance, SentryGlas® Plus is often the preferred choice.

Specifying ballistic, blast-proof and security glass

SentryGlas® Plus offers significant advantages for ballistic, blast-proof and security glass applications. This stems from its superior strength, stiffness and enhanced bonding characteristics, making it an excellent choice for safety and security-focused glass solutions for:

- Government buildings and Embassies
- Banks and Financial institutions
- Retail
- Residential property



Superior performance under impact: The interlayers can absorb and resist higher levels of impact energy. Superior bonding helps to hold the glass layers together even after impact. This reduces the risk of spalling (the splintering or chipping of glass fragments that can cause secondary injuries).

Blast mitigation: During an explosion, the shockwaves produced can cause catastrophic damage to standard glass. SentryGlas® Plus's interlayers absorb and dissipate a large amount of this energy, reducing the risk of the glass shattering. Even if the glass breaks, the interlayers keep the glass fragments in place, maintaining a barrier against flying debris and reducing injury.

Structural integrity: For blast-resistant applications, the integrity of the entire window system is critical. SentryGlas® Plus can be engineered to remain intact and in its frame even under extreme blast pressures.

Delaying tactics: In security scenarios in which the primary concern is forced entry through breaking and entering, the toughness of SentryGlas® Plus can significantly delay intruders. The difficulty in breaking through the glass provides additional time for response measures to be activated.

Durability and edge stability: Resistance to delamination and edge degradation plays a significant role in maintaining the protective properties of the glass over time. This is particularly important in environments in which the edges of the glass are exposed to the elements (which could otherwise lead to a weakening of the bond between the glass and the interlayer).



Superior clarity: Why SentryGlas® Plus is the clear choice

SentryGlas® Plus's enhanced optical clarity and durability make it an excellent choice for high-visibility and premium architectural applications. It remains clear and keeps its aesthetic integrity over time offers architects and designers the confidence to use glass in innovative ways, pushing the boundaries of design while meeting both the functional and aesthetic needs of modern architecture.

SentryGlas® Plus is compatible with the low-iron glass that is often used in applications in which maximum transparency and reduced colour distortion are key requirements. The low iron content reduces the natural green tint seen in standard glass, making it exceptionally clear.



The result is an ultra-clear laminated glass that is ideal for high-end applications such as shopping centres, retail parks, showrooms and other external glazing in which optical clarity is important. This ability to maintain clarity enhances the aesthetic appeal of the glass by ensuring that the true colour and transparency are preserved.

Enhanced aesthetics under different lighting conditions:

SentryGlas® Plus maintains its clarity under various lighting conditions. This is crucial for applications such as external glazing systems in which natural light plays a significant role in the overall aesthetics of a building. The superior light transmission properties of this glass ensure that views are unobstructed and that the interior spaces benefit from natural light without the interference of tint or distortion.

Long-term aesthetic maintenance:

Apart from its immediate aesthetic benefits, SentryGlas® Plus's resistance to delamination and edge defects also means that the visual quality of the glass remains intact longer than it might with PVB. SentryGlas® Plus's stronger adhesion to glass surfaces helps to prevent delamination issues, ensuring that the installation maintains its elegance year after year.



SentryGlas® Plus’s greater resistance to moisture

SentryGlas® Plus demonstrates significantly better moisture resistance than traditional PVB interlayers. This enhanced resistance is due to several key factors related to the chemical composition and its physical properties.

Its ionoplast polymer structure exhibits excellent hydrolytic stability, meaning it does not degrade or react adversely in the presence of water. Low water absorption prevents it from swelling and becoming cloudy, thereby maintaining both its transparency and adhesion to the glass over time. This resilience to moisture – and the general chemical stability of the product – make it a preferred choice in varied climatic conditions (from very wet to very dry) and in areas with significant temperature fluctuations. The glass maintains its mechanical properties across a wider range of temperatures, ensuring consistent performance without the risk of failure due to environmental stress.

In safety-critical uses like security glazing or hurricane windows, SentryGlas® Plus stays bonded under stress, ensuring long-term protection against impacts and moisture-related degradation.

SentryGlas® Plus means lighter panes

The high strength and stiffness of SentryGlas® Plus improves safety and also allows for the use of thinner glass panes compared with traditional PVB. This capability results in lighter, slimmer and more aesthetically pleasing architecture.

Superior mechanical strength enables SentryGlas® Plus to support loads that are comparable with PVB-laminated glass but with significantly thinner layers. This is because the increased interlayer stiffness effectively transfers and distributes the loads across the glass more efficiently – reducing bending and deflection under stress.

PVB’s lower stiffness requires thicker, heavier glass for structural performance, limiting design flexibility and increasing load on supporting structures.

Thickness and weight comparisons

In facades and overhead glazing, SentryGlas® Plus can reduce glass thickness while maintaining performance. For example, 8mm SentryGlas® Plus may match the strength of 10mm PVB, and 13.5mm SentryGlas® Plus can perform like 17.5mm PVB in security applications.

The reduction in glass thickness has a direct impact on its weight. Glass typically weighs about 2.5kg per mm thickness per square metre. Reducing the thickness from 10mm to 8mm in a square metre of glass cuts the weight from 25kg to 20kg. This reduction in weight makes the installation process easier and faster.

Aesthetic and practical benefits

Increased transparency:	Slimmer profiles:	Enhanced design flexibility:
Thinner glass offers less visual obstruction, which maximises natural light and enhances the views through the glass.	Thinner glass enables minimalist designs with slimmer frames, thanks to reduced structural load without compromising safety.	Reduced thickness and weight allow for larger glass spans and complex designs not feasible with heavier thicker PVB glass.



Key architectural applications

Facade systems: SentryGlas® Plus is used extensively in curtain walls and structural facades. The high strength and stiffness of the glass allow for larger spans with minimal support structures; this is particularly advantageous for creating expansive, clear views. This application is critical in high-rise buildings where wind load and safety requirements demand robust materials. The enhanced UV resistance of SentryGlas® Plus ensures that these facades maintain their clarity and structural integrity over long periods, contributing to the building's energy efficiency by providing better insulation.

Security Glazing: In embassies, government buildings and banks where security is a priority, SentryGlas® Plus is used to fabricate blast-resistant and bullet-resistant windows. Its superior binding strength ensures that – even under extreme conditions – the glass remains integral, providing vital protection against external threats.

Overhead Glazing: Applications such as skylights, canopies and atrium roofs benefit from SentryGlas® Plus's high load-bearing capacity and resistance to impact. Its ability to withstand large, dynamic loads without breaking or excessively deflecting is vital in geographical areas prone to severe weather, such as storms or heavy snowfall. This makes it a preferred material for overhead installations that protect against the elements while allowing natural light to enter into buildings.

Balustrades and Railings: Glass balustrades and railings made with SentryGlas® Plus offer not only a modern aesthetic with unobstructed views but also enhanced safety features. The high tear strength and superior edge stability prevent the glass from shattering into dangerous shards on impact – essential for public safety in high-traffic areas and balconies.

Flooring and Stairs: SentryGlas® Plus is suitable for use in structural glass flooring and staircases due to its enhanced load-bearing capabilities and resistance to delamination. These applications benefit from the product's clarity and durability, providing striking visual features that can handle the foot traffic and mechanical loads typical in commercial and public spaces.

Storm-Resistant Windows: In coastal areas, SentryGlas® Plus is ideal for storm-resistant glazing. The glass can withstand debris impacts and high wind pressures, crucial for maintaining the envelope of a building during extreme weather. This helps to prevent water and wind infiltration, which can lead to significant damage and even loss of life.



Sound Reduction: Although not its primary application, SentryGlas® Plus's density and stiffness also contribute to improved acoustic performance, making it suitable for use in areas where noise reduction is necessary, such as airports, schools and office buildings. By reducing sound transmission, the glass contributes to more comfortable and productive living and working environments.



Environmental Benefits

SentryGlas® Plus interlayers offer several significant environmental benefits that make them a preferable choice in green building designs and sustainable architecture. These benefits stem from the inherent properties of the material, its performance characteristics and its impact over the lifecycle of the building.

As the architecture and construction industries continue to move towards more sustainable practices, materials that offer both high performance and environmental benefits are likely to become increasingly prevalent.

Enhanced Durability and Longevity: SentryGlas® Plus's superior durability significantly extends the life of glass installations – reducing the need for frequent replacements. This longevity is crucial in reducing waste and the demand for new raw materials. Fewer resources are consumed over the life of a building – supporting sustainable building practices that aim to minimise environmental impact.

Recyclability and Waste Reduction: While the recycling of laminated glass is more challenging than that of single-pane glass due to the presence of interlayers, the long-term durability of SentryGlas® Plus reduces the frequency of glass replacement and waste generation. Additionally, efforts to improve the recyclability of laminated glass are ongoing, and advancements in separation technologies may enhance its sustainability in the future.

Contribution to Sustainable Building Certifications: Using SentryGlas® Plus can contribute to achieving higher ratings under various green building certifications such as LEED (Leadership in Energy and Environmental Design), BREEAM (Building Research Establishment Environmental Assessment Methodology) and others.

Energy Efficiency: Generally, thicker glass is more energy-efficient than thinner glass but the energy efficiency of SentryGlas® Plus involves several factors beyond the simple metric of glass thickness. Greater stiffness minimises deflection, ensuring better sealing around frames and reducing air leakage. Lower thermal conductivity reduces heat loss. Thinner glass (without reducing performance) can lead to better use of glazing technologies such as low-E coatings or optimal gas fills in double- or triple-glazed units. These technologies have a more pronounced impact on energy efficiency than the thickness of the glass.

Reduced Frame and Support Materials: SentryGlas® Plus allows for the use of lighter and thinner glass panes while maintaining or enhancing structural integrity – so the supporting frames and materials can also be reduced. This reduction not only decreases the amount of metal or other materials used in the construction but also minimises the environmental impact associated with extracting, processing and transporting these materials.

Safety and Hazard Prevention: SentryGlas® Plus can prevent glass from shattering. This can mitigate the environmental impact of storms by reducing debris and the need for extensive repairs and material replacements.



Why ESG Group Ltd for high-performance glass

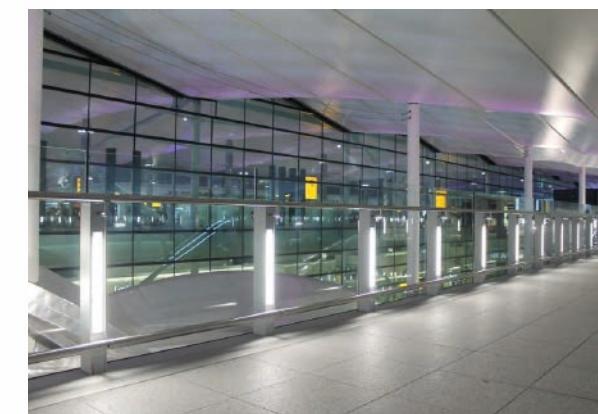
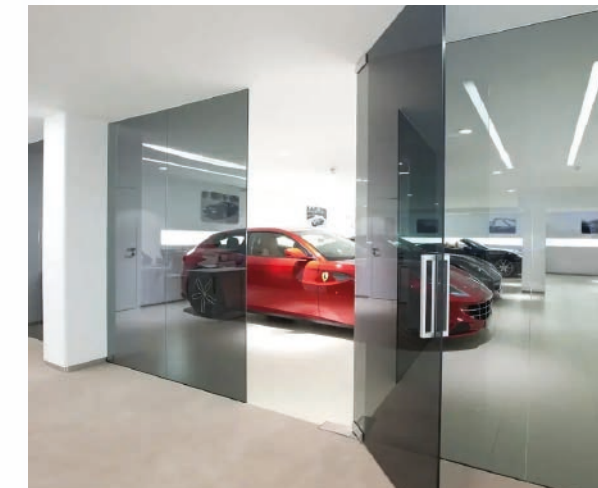
ESG Group Ltd is the UK's leading independent glass processor, providing superior quality, exceptional service and product innovation.

Operating from our Essex site of over 120,000 sq ft, we are ideally placed to service the whole of the UK with our extensive range of products.

Founded in 2003 and managed by the original core team, we share a collective knowledge and a combined manufacturing industry experience of more than 100 years.



Our entire range is fully BSI approved and includes architectural glass products such as balustrades, partition glass, roof canopies and flooring, right through to our technical glass ranges. These include Secure EN356, Ballistic and our industry-leading ESG Switchable™ LCD glass.



- ✓ **Capability:** our operational capacity allows us to manage large-scale projects efficiently. Projects have included Heathrow Airport, notably the award-winning Terminal 5 (voted best in the world at the 2019 Skytrax World Airport Awards).
- ✓ **Quality assurance:** our commitment to quality aligns with the stringent standards required, ensuring that projects meet all specifications and performance expectations.
- ✓ **First-time accuracy:** our commitment to first-time accuracy helps to avoid the delays and additional costs associated with reorders, enhancing operational efficiency.
- ✓ **Reliability and consistency:** our reliable service and consistent quality help you to maintain your reputation and meet client expectations.
- ✓ **Operational capability:** our ability to meet specific requirements, including bespoke orders and timely deliveries, makes us a reliable partner.
- ✓ **Reliable lead times and transport:** our proven track record of meeting delivery schedules ensures that projects stay on track, mitigating the risk of costly delays.
- ✓ **Competitive pricing:** high-quality products within budget
- ✓ **Strong relationships:** long-standing relationships and consistent reliability in service have built trust. These relationships are vital: trust and past performance heavily influence purchasing decisions.



Get Expert Technical Advice

Contact ESG for specialist advice on advanced products including toughened laminated glass, ballistic/blast-proof glass, switchable glass, acoustic glass, clarity non-reflective glass, eco glass, magnetic coatings and structural silicon bonding.

Our expert team will be pleased to answer all your technical questions and help specify the best glass for your next project.

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