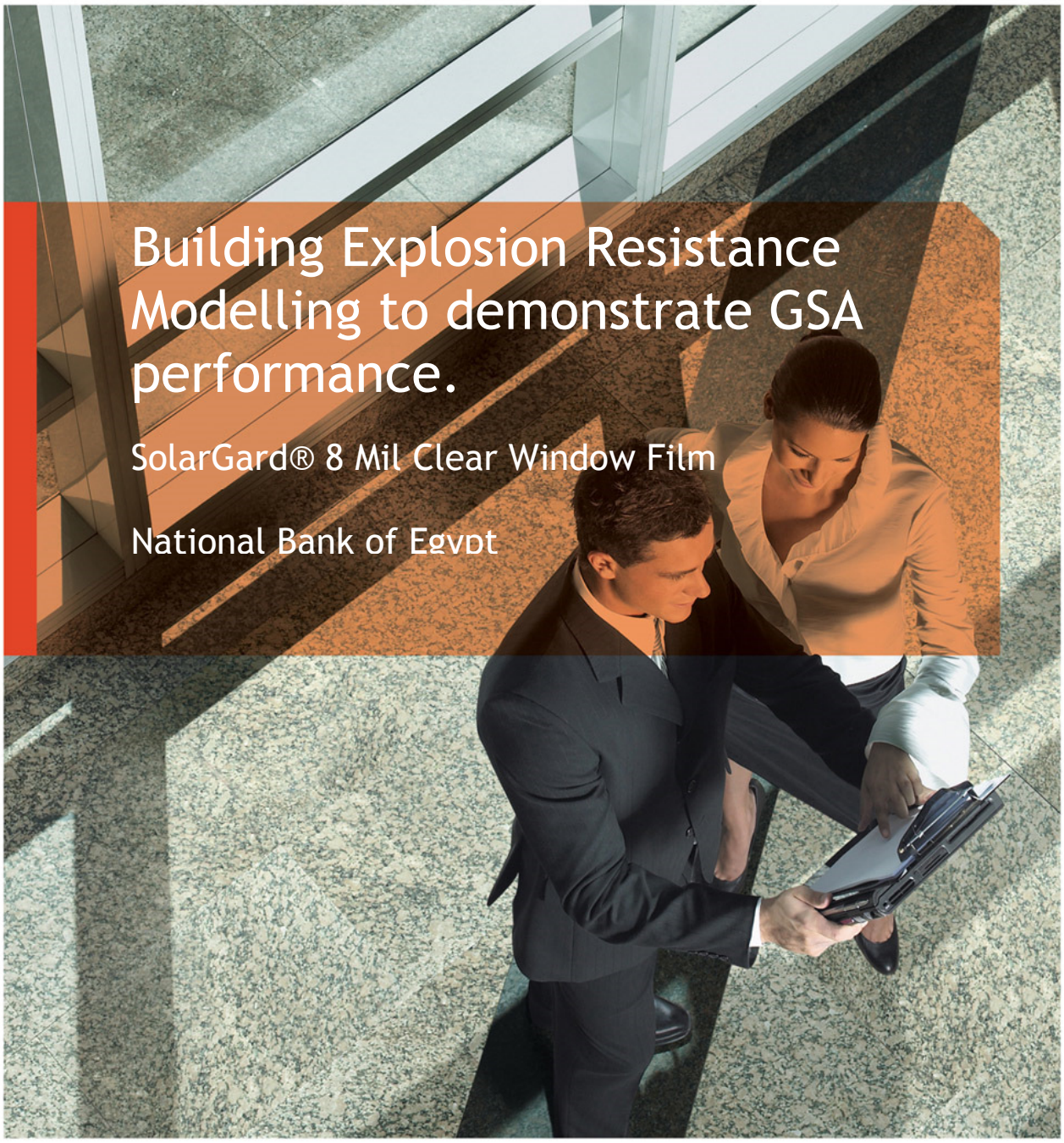
A better environment inside and out.℠



Building Explosion Resistance Modelling to demonstrate GSA performance.

SolarGard® 8 Mil Clear Window Film

National Bank of Egypt

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Introduction

The Use of Window Film to Reduce the Effects of Explosion

With countries across the world warning of the risks of terrorist attacks across the world and major worldwide events like the Olympics on the horizon, business owners should be regarding safety as an issue they cannot afford to take lightly.

The risk does not apply solely to large cities; the Royal Institute of British Architects (RIBA) now advises that building designers take counter-terrorism measures into consideration when designing public open spaces. This reflects the threat posed not just to large office buildings, but to public areas such as night clubs and shopping centres**.**

In an explosion, 90 percent of injuries are not caused by flying glass, rather than the explosion itself. It is vital, therefore, that steps be taken to ensure that glass windows, partitions and walls are sufficiently protected.

In an explosion, glass particles can travel at speeds of up to 150 mph. If a bomb explodes 400 metres away, glass from a broken window can hit a wall, 5 metres away, at a speed of 75 metres per second. In this scenario, glass particles of any size, even from strengthened windows that are designed to shatter into small pieces, are unquestionably lethal.

In order to protect staff and the general public, businesses have a responsibility to ensure that glass can be held together as one piece in the event of an explosion. One of the quickest, easiest and cheapest ways to do this is to install safety window film.

By reinforcing existing glass and helping to hold broken pieces together in the event of an explosion, safety window film greatly reduces the chance of glass causing property damage, injury or death. Because the latest safety and security films are flexible and able to stretch, they can absorb a significant amount of the shockwave caused by an explosion.
Ordinarily the force of an external bomb blast would push glass inward to the point of breaking, sending shattered glass throughout the building and jeopardizing everything in it. However, with safety film, even after the glass breaks, the film is able to “bend” with the force of the wave and hold the glass together as one piece.

About Building Information Modelling

Building Modelling is a sophisticated analysis process that simulates the effects of an explosion of different sizes and types and at different stand-off distances.

- Specialized software
- Trained explosion analysts
- Specific building information

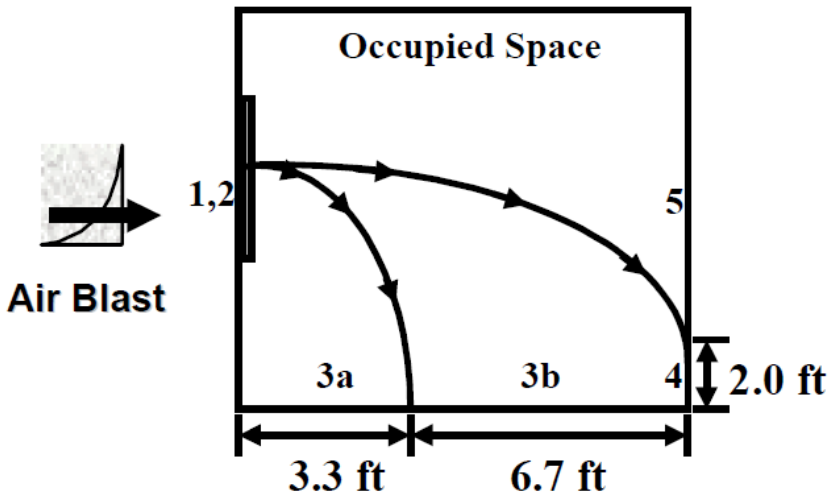
GSA Testing and Results

In response to the heightened concern about terrorism, the US Government and private industry are developing and testing new technologies to mitigate hazards to people in the vicinity of a terrorist bombing. In cooperation with the Defense Threat Reduction Agency, Applied Research Associates conducted tests to assess the capability of security window film to reduce the hazards of flying glass shards during an explosion. Propelled by the forces of a terrorist bomb, glass fragments cause large numbers of serious injuries.
The US General Services Administration (GSA) developed criteria for evaluation of acceptable levels of protection from the glass fragment hazards in a terrorist bombing. These criteria are part of the comprehensive security criteria (GSA Security Criteria, Final Working Version, January 1997) developed by the GSA, which includes physical security, electronic security, and many other criteria for blast considerations. The GSA has indicated that manufacturers must test their window products against the criteria to evaluate the performance of these products in blast if they want to be considered for use in GSA buildings.

The windows were mounted in enclosed concrete reaction structures. The response of each window was captured with high-speed film and still photography. An exterior high-speed camera and an exterior normal-speed video camera were used to capture the views of the structures and the explosive detonation for each test. The reaction structures were instrumented with pressure gages to measure the exterior reflected pressure on the specimens and the internal pressure in the structures.

The test charge was 600 lb. of Ammonium Nitrate and Fuel Oil (ANFO), which is equivalent to 500 lb. of TNT. The standoff distance to the structures was varied to affect specific peak pressures on the test specimens.
A thorough test matrix was developed to explore the effect of film thickness and attachment method on window response. The nominal window size for the tests was 4 ft by 5-1/2 ft. One-fourth inch thick annealed glass was used during testing. The windows were tested in commercially available aluminium storefront window frames. The glass type and film attachment method for each window is given in the summary and test description for each test. The GSA glass fragment hazard rating scheme is presented graphically and is described in the table which follows. The approach compares potential hazards based on the type and location of glass fragments interior and exterior to the test cubicle. These criteria indirectly reflect the velocity (hence hazard level) of fragments based on their distance from the original window position.

GSA Test Explanantion



Performance Condition	Protection Level	Hazard Level	Description of Window Glazing Response
1	Safe	None	Glazing does not break. No visible damage to glazing or frame.
2	Very High	None	Glazing cracks but is retained by the frame. Dusting or very small fragments near sill or on floor acceptable.
3a	High	Very Low	Glazing cracks. Fragments enter space and land on floor no further than 3.3 ft. from the window.
3b	High	Low	Glazing cracks. Fragments enter space and land on floor no further than 10 ft. from the window.
4	Medium	Medium	Glazing cracks. Fragments enter space and land on floor and impact a vertical witness panel at a distance of no more than 10 ft. from the window at a height no greater than 2 ft. above the floor.
5	Low	High	Glazing cracks and window system fails catastrophically. Fragments enter space impacting a vertical witness panel at a distance of no more than 10 ft. from the window at a height greater than 2 ft. above the floor.

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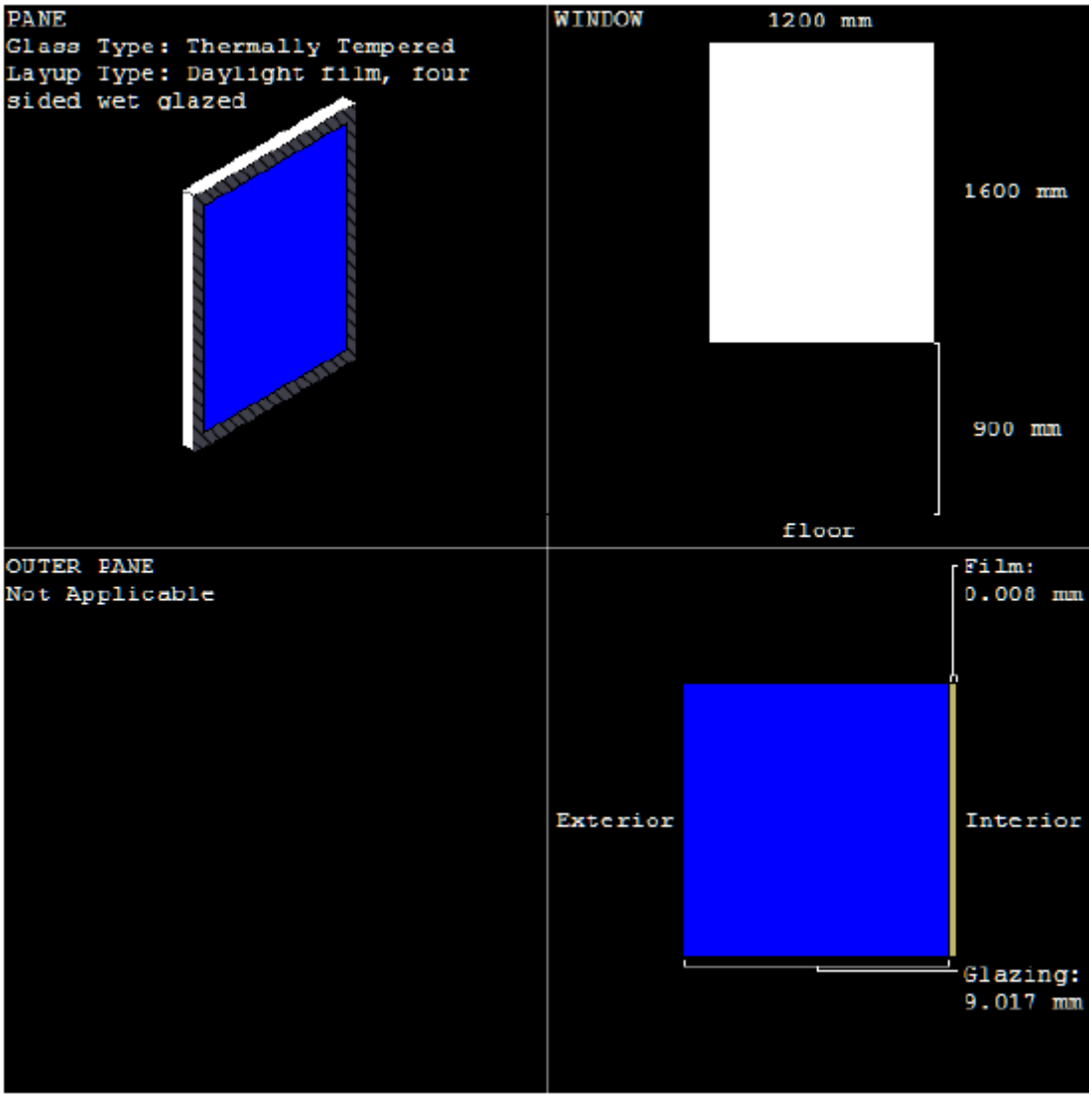
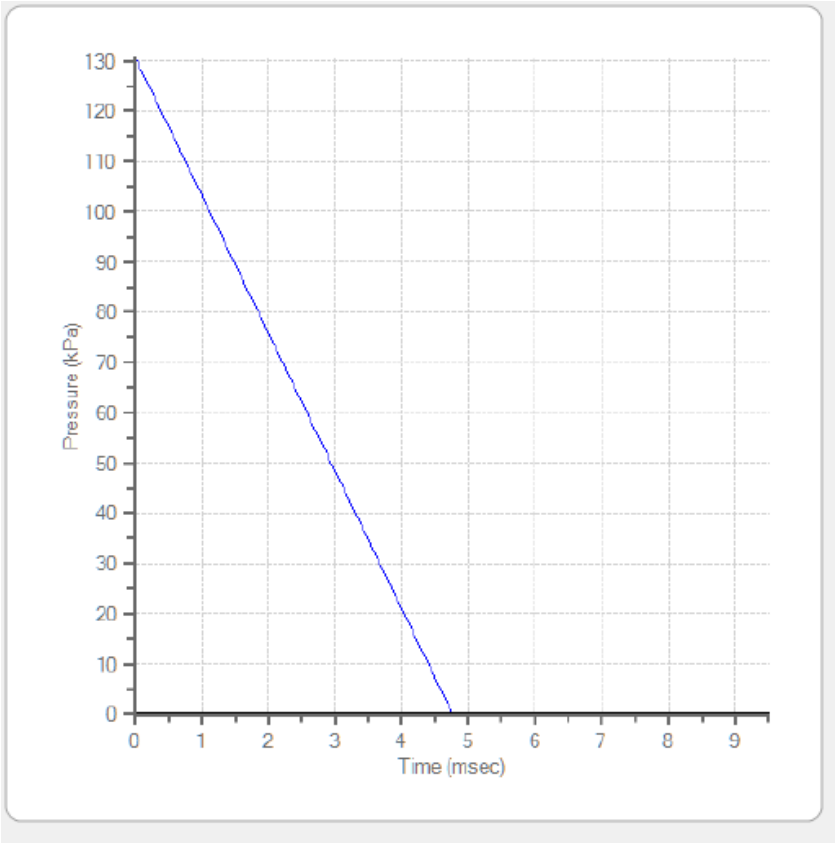
This calculation was performed using WINGARD LE 2.0. The window system is described as follows:
Height 1600 mm
Width 1200 mm
Sill Height 900 mm
Glazing Bite Specified Calculated
Glazing Bite Required 17.16 mm
The glazing for this window is a single pane unit. The glazing is as follows:
6 mm Thermally Tempered Daylight film, Edgpro
An illustration of this layup is shown below:



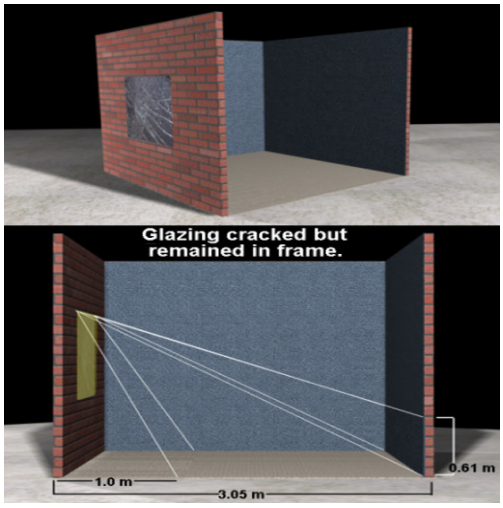
For an explosion of 10kg at 9 metres the blast load applied to this window has a peak pressure of 130.66kPa that linearly decays to zero in 4.764 msec. This corresponds to an impulse of 311.23 kPa-msec.

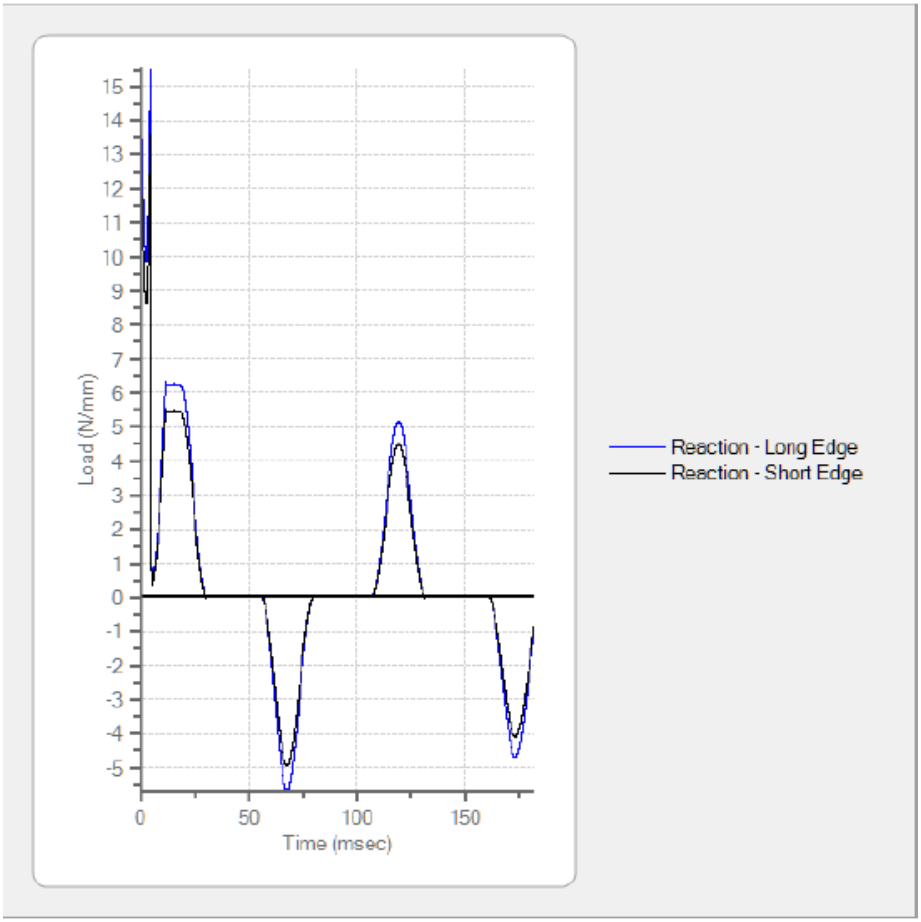
The airblast load for the 10kg device at 9m is illustrated below (others available on request).



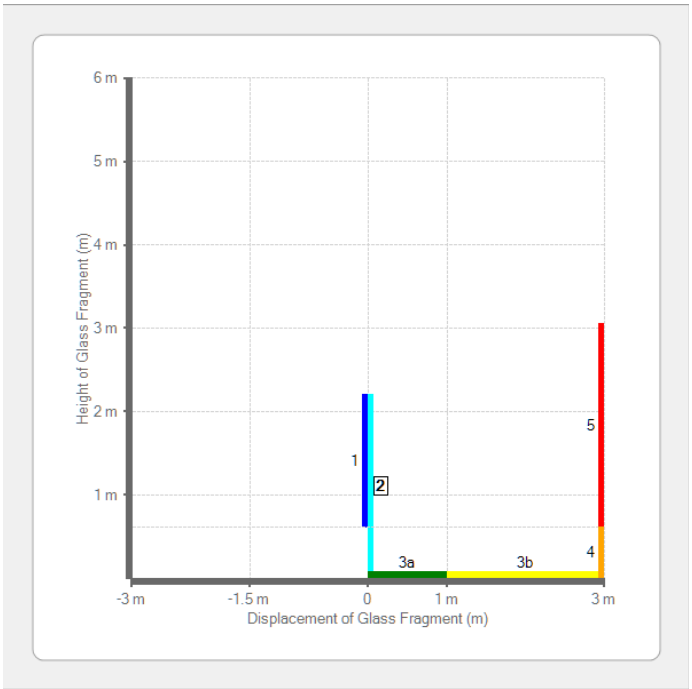
When subjected to this blast load WINGARD LE predicts that the window will respond as follows:

GSA Hazard Condition 2 (No fragments/debris). Relevant further relevant information is provided in the following graphics.





Dynamic Reactions



Fragment/Debris Flightpath

Executive Summary

The force of an explosion is not a linear function. When working with a small stand off distance the effects of a small change in distance or charge weight creates a much different outcome. The biggest effect that security window film is to prevent small pieces of glass flying at high velocity entering a building. The worst case scenario is that the whole panes leaves the frame and drops just inside the building although this can cause some injuries they will be nowhere near as severe as the option of not filming. This is seen as the 'Low Risk' option and in many cases is the preferred choice. Our alternative edge retention system to using structural silicone is Edgpro® which is a rubberized flexible system that has been tested to the GSA levels. It has demonstrated very similar performance to structural silicone.

Solar Gard® Window Films: It's All About Performance

For over 30 years, Solar Gard has been one of the most popular window film lines for professional installers throughout the world. Manufactured by Saint-Gobain in San Diego, Solar Gard is sold in more than 70 countries via company-owned distribution centers and independent dealers. Solar Gard window films are installed on several thousand homes, buildings and millions of vehicles every year.

Saint-Gobain is a global leader in the development, manufacture and distribution of specialty films for use in solar control and safety window films, and industrial applications.

Used for vehicles and buildings to keep out the sun's heat, filter out ultraviolet radiation and hold glass together in the event of breakage, Saint-Gobain delivers solutions for safety, security, glare, energy use and C02 emission reduction. Distributed through a network of independent certified dealers and distributors in more than 60 countries via 18 company-owned offices, Saint-Gobain window film is sold under the Solar Gard®, Panorama®, Quantum® and Solar Gard Armorcoat® brands.

Disclaimer

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