

*D*ow Corning® Silicone Sealants for Impact-Resistant Window Systems



One dark night in 1999, burglars broke through the windows of a national retail chain store in Stuart, Florida, triggering the store alarm. Before police officers arrived, the burglars grabbed \$35,000 worth of jewelry and disappeared.

Store managers responded quickly to this “smash-and-grab” incident. They had the broken windows replaced and reinforced with more than 1,000 square feet of protective window film anchored to the window frames with a Dow Corning® brand silicone sealant.

Just days later, someone used a heavy metal object to smash the glass on the store’s front door. But the shattered glass remained adhered to the security film, the silicone sealant absorbed the blows, and the would-be burglar left empty-handed. Police found the broken window still firmly attached to the window frame.



AV04959 – Photo Credit: MSC Specialty Films

Impact-resistant window systems

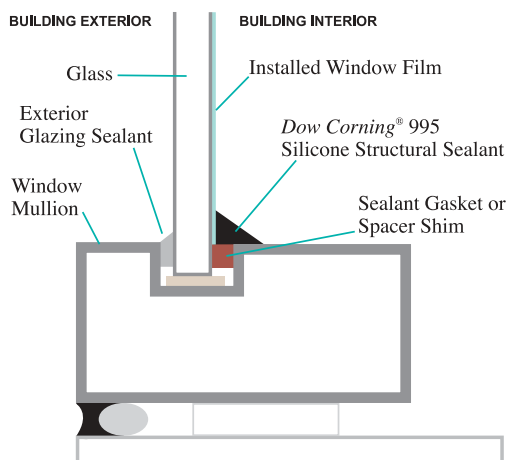
Window technology has improved dramatically in the past two decades. Today, laminated glass window systems provide remarkable impact resistance and increased occupant protection. Laminated systems generally feature a tough interlayer, such as polyvinyl butyral (PVB), or a strong, transparent plastic film. The edges of the glass are sealed to the window frames, typically with a durable, but flexible, silicone glazing sealant. Factory laminated glass is preferred for new construction.

Increased impact resistance is now also available for retrofit applications. In these window film systems, a transparent, multilayered plastic film is adhered to the interior surfaces of a building’s windows. Then the edges of the film are sealed to the window frames with a silicone glazing sealant (See Figure 1.). The film does not affect the normal function of the windows, but transforms them into flexible membranes that help capture and absorb impact energy.

Whether factory laminated or on-site applied film, the result is dramatically increased protection for building owners, occupants and even passersby in the event of criminal trespass, natural forces like hurricanes, and even bomb blasts. Impact-resistant window systems reduce the potential for broken glass being blown from its frames, the leading cause of injuries in events like terrorist bombings.

Silicone sealants help provide building owners and tenants with increased security and protection.

Figure 1.



Dow Corning® silicone sealant anchors the protective window film to the window frame. A triangular glazing joint provides a sealant bite of 3/8 inch to 1/2 inch on both the window film and the framing member. This joint design has performed well in a variety of tests of high-performance window film applications designed to withstand applied forces.

The silicone anchor

Common to most of today’s new impact-resistant window systems is a high-performance silicone sealant from Dow Corning. Silicones are specified for their high tensile and tear strength; long-term flexibility; resistance to harsh weather, temperature extremes and ultraviolet light; and excellent adhesion to glass and most window frame materials.

The two most specified products are *Dow Corning® 995 Structural Silicone Sealant* and *Dow Corning® 983 Silicone Glazing and Curtainwall Adhesive/Sealant*. Originally formulated as structural glazing adhesive/sealants to adhere metal, glass and stone curtainwall panels to building exteriors, *Dow Corning 995* and *983* sealants have found application in impact-resistant window systems for new construction and for retrofit systems for existing buildings. They are selected for their ability to maintain positive adhesion while window frames bend and twist under a range of stresses.

Easily applied and tooled, these *Dow Corning* silicone products function as trouble-free, long-lasting window glazing sealants, while remaining ready for the worst that the natural world and human nature can provide. They are the anchors to the most advanced impact-resistant window systems in the industry.

After pieces of glass fell out of a window opening in 1999 at the 45-story CNA Financial Plaza Building in Chicago, Illinois, the building owners decided to replace virtually all of the skyscraper's windows with heat-resistant glass that would resist the thermal stresses that cause occasional cracks in the old windows.

But replacing all of the windows could take as long as five years. Rather than risk another incident during this period, CNA Insurance decided to install one of the new breed of protective window film systems. After extensive testing, they chose the 3M™ Ultraflex Window System.

This “anchored film” system is comprised of 3M™ Scotchshield™ Ultra High Performance Safety & Security Film, a strong, multilayer polyester film that is adhered to the window glass, and Dow Corning® 995 Structural Silicone Sealant, a high-performance glazing sealant used to anchor the edges of the film and hold the lite in the window frame.

Dow Corning® 995 Structural Silicone Sealant used in high-rise protective window system

In the spring of 2000, two contractor teams began work at the CNA Plaza. One team removed the old sealant, leaving enough in place to hold the building's windows in place during film installation. Following them, another team thoroughly cleaned the windows and frames and applied the film.

When the film was dry, a one-inch triangular bead of Dow Corning 995 Structural Silicone Sealant was applied and tooled around the window frames, providing a 1/2-inch bite on both the film and the aluminum frames.

The CNA Plaza project was completed in September 2000, with 2,559 windows secured by the 3M Ultraflex Window System.

“We're very pleased with the results,” said Bill Phillips, chief safety officer at CNA Insurance. “The fact that names like 3M and Dow Corning stand behind the product is very reassuring.”

Over 2,500 window lites on the CNA Financial Plaza Building in Chicago, Illinois, were retrofitted with the 3M™ Ultraflex Window System, a high-performance, impact-resistant, protective window film system glazed with Dow Corning 995 Structural Silicone Sealant.



Silicones and structural glazing

Silicone structural glazing is a common new construction technique that uses silicone adhesive/sealants instead of metal fasteners to hold glass lites, stone or metal panels to the exterior of a building. Well-designed structural glazing systems safely transmit wind loads to the supporting structure, withstanding tremendous tension and compression loads from high-velocity winds.

Designers of structurally glazed buildings face considerable challenges in areas like Hong Kong, Taipei and Florida, where typhoons, tornadoes and hurricanes are a seasonal occurrence. High winds place extreme demands on silicone sealants used for structural glazing. But for decades, silicones have met the test. They offer the inherent adhesion and tear strength, flexibility and weather resistance to outperform other methods of curtainwall attachment.

Silicone structural glazing sealants and impact-resistant window systems

When an unprotected window is broken by flying debris during a hurricane, the rapidly changing interior and exterior pressures can severely load the building's walls, even causing the building to collapse. In the wake of the tremendous damage caused by Hurricane Andrew in 1992, government officials and code bodies

in South Florida reassessed the glazing used in both commercial and residential buildings.

Silicone adhesive/sealants passed the structural glazing tests. Meeting the demanding, new, impact-resistant glazing rules for windows, doors and skylights was a greater challenge.

Mimicking the fury of a hurricane, controlled tests were devised in which projectiles were shot at windows, followed by a series of severe windloads. Impact-resistant window systems, like *Dupont® SentryGlas®* composite glass, met the new standards. A laminated glass system, comprised of a single pane of glass, a PVB interlayer and an exterior layer of clear, strong polyester film, the SentryGlas composite glass broke in the projectile tests, but remained adhered to its flexible diaphragm. More importantly, the shattered glass remained attached to its window opening, due to the *Dow Corning* silicone structural glazing sealants used.

Today, glazed windows, doors and skylights in newly constructed government and commercial buildings in Dade County, Florida, and other hurricane zones must meet higher levels of impact resistance. *Dow Corning® 995 Structural Silicone Sealant* and *Dow Corning 983 Silicone Glazing and Curtainwall Adhesive/Sealant* are both approved for these demanding applications. The same properties that make them reliable choices for structural glazing projects – outstanding adhesion and tear strength, flexibility and weather resistance – make them the sealants of choice for impact-resistant protective window systems.

S Sealants equal to the elements

About 75 percent of Hong Kong's skyscrapers are structurally glazed, and Dow Corning silicone structural glazing sealants are used in virtually all of them. At risk of seasonal typhoons, Hong Kong's skyline must withstand high winds, monsoon rains and extreme temperatures that have yet to challenge the strength and reliability of its buildings' structural glazing systems.



From Dow Corning

Dow Corning® 995 Structural Silicone Sealant is a one-part, neutral-cure adhesive that cures to tough elastomeric rubber. It offers excellent, unprimed adhesion to most common building substrates, such as glass, reflective glass, anodized aluminum, granite and paints, including most fluoropolymer-based paints. It has a long shelf life and is available with a 20-year limited structural adhesion warranty in approved applications.

Dow Corning 983 Silicone Glazing and Curtainwall Adhesive/Sealant is a two-part silicone formulation that cures to a high-modulus elastomeric rubber. It offers excellent, unprimed adhesion to glass, reflective coatings, metals and paints; a long shelf life; easy tooling; and adjustable cure rates up to 40 minutes. It is also available with a 20-year limited structural adhesion warranty in approved applications.

In 1992, Hurricane Andrew caused dozens of deaths and billions of dollars of damage in south Florida. Engineering studies of the destruction showed that when windows blew out of an otherwise sturdy structure, the building's collapse could rapidly follow. South Florida building codes were dramatically strengthened in response.

One solution approved for use was impact-resistant, laminated glass window systems that are sealed, or anchored, to the window frame with a Dow Corning silicone glazing sealant. The interlayers resist punctures by flying debris, and the glass remains attached to the film even after breaking. The broken lite remains firmly attached to the window frame because the silicone sealant maintains adhesion and

Dow Corning 983 Curtainwall Adhesive is designed for shop-glazing of new windows for use in new construction or building renovation projects. *Dow Corning* 995 Sealant can be used in both shop-glazing and on site.

Both *Dow Corning* 995 Sealant and *Dow Corning* 983 Curtainwall Adhesive have been used successfully in window systems designed to pass hurricane and impact glazing requirements. *Dow Corning* 995 Sealant has been tested successfully with various film manufacturers and is Sealant, Waterproofing and Restoration Institute (SWRI) validated at $\pm 50\%$ extension/compression. Contact Dow Corning for more information on test approvals and rated systems.



allows the frame to bend and twist under extremely high wind loads.

No construction technique is completely safe from the worst that nature can deliver, but silicone sealants offer today's advanced impact-resistant window systems the strength and flexibility to dramatically increase personal safety and minimize damage in the future.



AV05085 – NOAA-National Weather Service- National Hurricane Center.

The remnants of a Levitz Furniture warehouse showroom located along U.S. 1, west of the community of Whispering Pines.

TYPICAL PROPERTIES

Specification Writers: Please contact your local Dow Corning sales office or your Global Dow Corning Connection before writing specifications on these products.

	<i>Dow Corning</i> 983 Silicone Glazing and Curtainwall Adhesive/Sealant	<i>Dow Corning</i> 995 Structural Silicone Adhesive
Color	Black, Gray	Black, Gray, White
Tensile Adhesion Strength, psi	120	150
Ultimate Elongation, percent	219 ¹	525 ¹
Durometer Hardness, Shore A	43 ²	40 ¹
Tear Strength, Die B, ppi	56 ²	49 ¹
Movement Capability, percent	± 12	$\pm 50^3$

¹ As cured after 7 days at 25°C (77°F), 50% RH.

² As cured after 7 days at room temperature.

³ As cured after 21 days at 25°C (77°F), 50% RH.

On a single day in 1998, terrorist truck bombs struck U.S. embassies in Nairobi, Kenya, and Dar Es Salaam, Tanzania. Flying glass caused the majority of the injuries suffered in the embassy buildings and those surrounding them. As a result, governments worldwide began looking for strategies to fortify new and existing government buildings.

Silicone structural glazing came under close scrutiny. Buildings with reflective glass skins were initially viewed as vulnerable, but testing proved these perceptions wrong. (See photo below.)

Today, many building projects require blast resistance to be included in the architect's specifications, and silicone adhesive/sealants are being specified for bomb-blast resistance. Recent structurally glazed construction projects, specified with a blast-resistant element provided by Dow Corning, include a new Parliamentary building and the Harbour Exchange and Bishopsgate buildings in the United Kingdom, the L.G. Kangnam Tower in Seoul, South Korea, and the Lloyd D. George Federal Courthouse in Las Vegas, Nevada.



AV05086 - Photo courtesy of U.S. State Department

When a truck bomb was exploded outside the U.S. Embassy in Nairobi, Kenya, the blast blew out virtually all of the windows in nearby buildings. While severely damaged, the embassy building had impact-resistant laminated glass windows and better withstood the terrorist attack.

Silicones and blast protection



AV05123 - Photo courtesy of Grendon Design Agency



AV05124 - Photo courtesy of Grendon Design Agency

In controlled bomb-blast application testing conducted by Dow Corning, 12 kilos of TNT were exploded 6.5 meters away from a 12 x 12-meter glass curtainwall panel structurally glazed on all four sides with a Dow Corning silicone structural glazing adhesive/sealant. While the glass broke during the explosion, the facade stayed largely in place, thanks to the strength and flexibility of the sealant.



AV05084 - Photo courtesy of U.S. State Department

The new Lloyd D. George Federal Courthouse in Las Vegas, Nevada, is a silicone structural glazing project designed to offer increased protection to building occupants in the event of a nearby bomb blast.



AV09864

Flying glass from broken windows in a bomb-blasted building like this one can cause serious injuries.

Impact-resistant window systems meet bomb-blast requirements

Following the embassy bombings, the U.S. State Department embarked on a program to rapidly increase security and occupant protection at other government facilities around the world. Dow Corning's experience with structural glazing and the performance of advanced protective window systems in hurricane-force testing paved the way for retrofitting numerous government buildings with impact-resistant window systems using *Dow Corning* silicone sealants.

While no system can completely protect people from a direct bomb blast, keeping broken windows in their frames goes a long way to ensuring that building occupants will not be injured by flying glass. Dow Corning leads the way.



AV09866

The 1990s were alarming times around the world.

At U.S. Army barracks in Saudi Arabia, American embassies in Dar Es Salaam, Tanzania, and Nairobi, Kenya, and at the Alfred P. Murrah Federal Building in Oklahoma City, Oklahoma, terrorist bombs killed hundreds of people and wounded hundreds more. The plots were similar and remarkably simple. Drive an explosives-laden vehicle close to the building and set it off. Depending upon the distance to the target, it was often flying glass that caused most of the injuries and deaths.

In response, governments and organizations around the world quietly took action to safeguard their buildings and their people. Advanced, impact-resistant laminated glass and window film systems, using Dow Corning silicone glazing sealants, quickly became one of the most common security improvement projects.

Dozens of buildings around the world now offer their occupants increased protection. Proven effective, impact-resistant window systems and Dow Corning silicone sealants lessen the risk of a dangerous world.

For more information or the name of the Dow Corning sales representative or product distributor in your area, call 1-800-322-8723 or 1-989-496-6000. (In Canada, call 1-800-268-5350.) Dow Corning has sales offices, manufacturing sites, as well as science and technology laboratories around the globe. Telephone numbers of locations near you are available on the World Wide Web at www.dowcorning.com, or by calling one of our primary locations listed below.

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