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APPROVAL REPORT

SAFETY SHIELD 800 LCL-800-XSR
WINDOW FILM FOR USE AS A RETROFIT
HURRICANE GLAZING PROTECTION SYSTEM

Prepared for:

MADICO INC.
64 INDUSTRIAL PARKWAY
WOBURN, MA 01801

Project ID: 3037005
Class: 4350
Date of Approval: SEPTEMBER 16, 2009
Authorized by:

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I INTRODUCTION

1.1 Madico Inc. submitted their Safety Shield 800 (internally referred to as LCL-800-XSR by Madico) window film for use as a retrofit Hurricane Glazing Protection System to determine if it meets the Approval requirements of the **Standard** listed below as a Windstorm Resistant Fenestration. This program examined the film using a wet glaze system that utilized a structural adhesive.

1.2 The examination included testing for static wind pressure resistance, impact resistance from windborne debris, cyclic wind pressure resistance testing and simulated hail resistance tests.

1.3 This Report may be reproduced only in its entirety and without modification.

1.4 **Standard:**

Title	Class / Document Name	Date of Issue
Windstorm Resistant Fenestrations	4350	September 2006

1.5 The tests, in addition to an initial, in-plant Facilities and Procedures Audit (F&PA) inspection of the quality controls in place at the manufacturing facilities that produce the components used in this system were conducted under Project ID 3031654. The audits indicate that the manufacturer has a satisfactory quality control system in place to ensure continued production of material equivalent to the material that was used in the test program.

1.6 **Listing:** This system will be listed in the Approval Guide as follows:

Safety Shield 800 LCL-800-XSR Window Film for use as a Hurricane Glazing Protection System for retrofit installations. Designed for exterior openings on the face or corners of buildings that require small missile impact resistance [Wind Zone HM – SM (FL)] where design pressures are not expected to exceed (inward acting) +40 psf (1.9 kPa) or (outward acting) -56 psf (2.7 kPa). Max opening size is 35.7 ft² (3.3 m²) with the width of the opening not exceeding 5 ft 4-1/4 in (1.6 m) and the height of the opening not exceeding 6 ft 8 in (2.1 m). These units may suffer permanent deformation or physical damage after small missile impact or after being subjected to wind pressures depending upon the severity of the high wind event. Also Approved for Severe Hail Resistance.

Retrofit installation: The system consists of an existing aluminum window frame secured to the building structure with minimum #10 screws appropriate for the substrate. The window frames shall be examined to ensure that they are properly anchored to the building structure. The frames shall only be secured to structural steel, concrete or minimum 2 x 8 wood studs (hollow masonry units and steel studs are not allowed). Additional fasteners shall be installed such the the resulting fastener spacing is a maximum of 4 in. (100 mm) from each corner and a maximum 24 in (600 mm) oc in the head, sill and both jambs. The max design pressures for retrofit use shall not be greater than those shown above and as certified by a registered professional engineer for the max positive and negative pressures that the existing frame unit and its securement to the building can withstand. The 8 mil [0.008 in. (0.20 mm)] thick clear polyester security window film, LCL-800-XSR, supplied in rolls up to 72 in. (1.8 m) in width, is adhered to nominal 1/4 in. (6 mm) thick annealed glass in accordance with the manufacturer's written installation instructions. Gaskets are cut back and the window frame prepped as described in the installation instructions. The film is applied in the normal daylight fashion being cut such that it is between 0.0625 to 0.125 in (1.6 to 3.2 mm) from the edge of the window frame. It is secured around the entire perimeter to the frame using Dow Corning 995 Silicone Structural Sealant in a triangular bevel with each leg overlapping the film or frame by a minimum of 3/8 in (9.6 mm).

II PRODUCT DESCRIPTION

2.1 The Safety Shield 800 LCL-800-XSR Window Film Hurricane Glazing Protection System consists of the following components:

2.1.1 The security window film is an 8 mil [0.008 in. (0.20 mm)] thick clear polyester film. It is identified as LCL-800-XSR and is manufactured by Madico, Inc. The film is available in multiple roll widths up to and including 72 in. (1.8 m). It is applied to clean bladed glass with a squeegee and fastened to the perimeter of the window frames using a structural silicone adhesive.

2.1.2 The glazing material is not supplied by this manufacturer. For the wet glaze system using the structural adhesive, it shall be nominal 0.25 in. (6 mm) thick, or thicker, clear annealed glass.

2.1.3 The window frame shall be an extruded aluminum shape made from anodized 6063-T6 aluminum alloy. The frame is 4 in. (102 mm) deep by 1.75 in. (45 mm) high.

2.1.4 The wet glaze system incorporates a structural silicone adhesive, identified as Dow Corning 995 Silicone Structural Adhesive manufactured by Dow Corning. Existing gaskets are cut back to the edge of the window frame. The frame is cleaned and the adhesive applied around the perimeter of the frame leaving a triangular shaped bead with each leg of the triangle overlapping the frame and window by a minimum of 3/8 in. (9.6 mm). For further details, see the installation instructions in Appendix A.

2.2 Proprietary information and specifications for each of the components identified above is on file at FM Approvals.

III TESTS AND PROCEDURES

3.1 Tests were conducted as required by FM Approvals Approval Standard 4350 (September 2006), Windstorm Resistant Fenestrations.

3.2 Impact Resistant Tests

3.2.1 This test method is intended to evaluate the performance of windstorm resistant fenestration systems located in geographical areas that are subject to the impact of windborne debris (FM Zone HM). The test procedures involved small missile tests which simulate exposure to fenestration at high building elevations. The test method is based on several known test methods such as ASTM E 1996-05 and FBC TAS 201-94.

3.2.2 The missile used in this program was the small missile. The small missile impact test consists of impacting a test specimen with ten (10) steel balls with each steel ball weighing 0.07 oz (2 g) traveling at a speed of 130 ft/sec (39.6 m/s). Each sample shall be subjected to three (3) impacts at predetermined locations.

3.2.3 The Small Missile Cannon was used to deliver the small missile. The cannon consists of a 1 in. (25 mm) internal diameter pipe that is approximately 4 ft (1.2 m) in length mounted onto a support frame. Compressed air is supplied to the cannon and monitored by a pressure gauge. A remote firing device and valve are used to fire the missile.

3.2.4 A timing system, capable of measuring the speed of the missile within a tolerance of 1 ft/sec (0.3 m/s), was used. Only the speed of one (1) steel ball needs to be monitored in order to determine the velocity of the projectile.

3.2.5 The impact resistance tests were conducted on three (3) samples to determine the ability of the assembly to resist damage from flying debris.

3.2.6 When ready for testing, the air cannon is positioned such that the end of the cannon is located at an appropriate distance from the test panel such that the missiles are distributed over a maximum area of 2 ft^2 (0.2 m^2) of the test specimen. Each of three (3) test samples received a series of three (3) impacts with each impact consisting of the ten (10) ball bearings referenced above. The series of impacts were centered at the center of the test specimen, along the edge of the center of the long dimension of the test specimen and at one corner of the test specimen.

3.2.7 The small missiles impacted the surface of the test specimen with a speed of 130 ft/sec – 132 ft/sec (39.6 m/s – 40.2 m/s) which is equivalent to approximately 90 miles per hour (166.5 km/hr).

3.2.8 After each missile impact, the test specimen shall be examined to determine if any missiles have penetrated the system. No penetration or through openings are allowed as a result of the small missile impact test.

3.3 Cyclic Wind Pressure Resistance Tests

3.3.1 Cyclic Wind Pressure Resistance Tests are conducted to evaluate the ability of the system to withstand cyclic loads. During a high wind event, exterior building components are subjected to a wide range of wind forces from sustained winds and wind gusts with both blowing in multiple directions. Because the components are also exposed to flying debris, the cyclic loads are applied on test specimens that have satisfactorily met the impact requirements. This test method is based on several known test methods such as ASTM E1886 and FBC TAS-203-94.

3.3.2 All FM Approved Windstorm Resistant Fenestration systems shall have a wind load rating. The rating shall be expressed as a pair of inward and outward acting pressures (P^{inward} and $P^{outward}$) using a static pressure test and a cyclic pressure test. The FM Approved rating shall be the lowest pair of pressures (inward and outward) from the static pressure test or the cyclic pressure test. The ratings shall be given in increments of 5 lbs/ft² (0.25 kPa) based on the inward pressure. The minimum rating needed for Approval shall be 30 lbs/ft² (1.45 kPa) for the inward pressure.

3.3.3 The magnitude of the pressure on the leeward side of a building is equal or higher than the pressure on the windward side. Because of this, the outward pressure used in the test program shall be of greater magnitude than the inward pressure. The FM Approved outward pressure used in this program will be based on pressure coefficients of -1.4 based on an applied pressure (+P) on the windward side. The positive sign is used to signify the fact that P^{inward} applies forces toward the fenestration system. The negative sign is used to signify that $P^{outward}$ places forces away from the fenestration system (suction).

3.3.4 A cyclic load was applied to each of three (3) test specimens that were impacted by the small missile. In addition, as required by Approval Standard 4350, a 4th sample was subjected to the Cyclic Wind Pressure Resistance Test. This 4th test specimen was not required to be impacted by the small missile. During the Cyclic Wind Pressure Resistance Tests, air is regulated and exhausted by valves controlled by pressure transducers. The loading schedule is shown in Table 3.3.4. The positive pressure direction is towards the interior of the assembly. The negative pressure direction is towards the exterior of the assembly. Each load cycle had a duration of 1 to 3 seconds.

Table 3.3.4

Loading Sequence	Pressure Range	Number of Cycles	Pressure Direction	Outward Pressure Values Multiplied by a Ratio of -1.4
1	0.2P – 0.5P	3500	Positive	NA
2	0.0P – 0.6P	300	Positive	NA
3	0.5P – 0.8P	600	Positive	NA
4	0.3P – 1.0P	100	Positive	NA
5	0.3P – 1.0P	50	Negative	-0.4P/ -1.4P
6	0.5P – 0.8P	1050	Negative	-0.7P/ -1.1P
7	0.0P – 0.6P	50	Negative	0.0P/ -0.8P
8	0.2P – 0.5P	3350	Negative	-0.3P/ -0.7P

3.3.5 Between load sequences and after the final load sequence, the test specimen was examined for the presence of separation between any components, cracks or through openings.

3.3.6 The assemblies shall not exhibit any cracks longer than 5 in. (125 mm) through which air can pass or wider than 1/16 in. (1.6 mm).

3.3.7 The pressure used in this test program for the wet glaze system was +40 psf (1.9 kPa) (inward acting) and -56 psf (2.7 kPa) (outward acting). The window in each of the test samples had a clear opening size of 64-1/4 in. (1.63 m) wide and 80 in. (2.03 m) in height.

3.4 Static Wind Pressure Test

3.4.1 A Static Wind Pressure Test was conducted to measure the wind resistance performance of the assembly. The objective of the test is to provide a realistic method of evaluating the static wind pressure resistance of an installed assembly and the individual components when applied within the installed assembly.

3.4.2 Refer to Paragraph 3.3.2, 3.3.3 and 3.3.7 for an explanation of the pressures used in this program.

3.4.3 Air shall be supplied until the loading reaches +0.5P. The pressure was held at this level for a period of 60 seconds. Upon holding the pressure at +0.5P for 60 seconds, the pressure difference was released. The sample was allowed a recovery period of not less than one (1) minute or more than two (2) minutes.

3.4.4 After the recovery period, air shall be supplied until the loading reaches +1.0P. The pressure was held at this level for a period of 60 seconds. Upon holding the pressure at +1.0P for 60 seconds, the pressure difference was released. The sample was allowed a recovery period of not less than one (1) minute or more than two (2) minutes.

3.4.5 After the recovery period, air was supplied until the loading reached -0.7P [0.5P x (-1.4)]. The pressure was held at this level for a period of 60 seconds. Upon holding the pressure at -0.7P for 60 seconds, the pressure difference was released. The sample was allowed a recovery period of not less than one (1) minute or more than two (2) minutes.

3.4.6 After the recovery period, air was supplied until the loading reached -1.4P [1.0P x (-1.4)]. The pressure was held at this level for a period of 60 seconds. Upon holding the pressure at -1.4P for 60 seconds, the pressure difference was released and the sample examined for separation from the supporting members, permanent deformation, cracking or fracturing of any component or failing to resist the applied load.

3.4.7 The pressure used in this test program for the wet glaze system was +40 psf (1.9 kPa) (inward acting) and -56 psf (2.7 kPa) (outward acting).

3.5 Simulated Hail Resistance Test Using Freezer Ice Balls

3.5.1 This test method is intended to evaluate the performance of windstorm resistant fenestration systems when subjected to the impact of simulated hail. Two ratings are available – Severe (S) and Moderate (M). The Severe Hail rating consists of a nominal 1.75 in. (44 mm) diameter ice ball having a kinetic energy of 14.9 ft-lbs (20.3 J). The Moderate Hail rating consists of a nominal 1.5 in. (38 mm) diameter ice ball having a kinetic energy of 7.8 ft-lbs (10.4 J). The impact speeds are 101.8 ft/sec (31.0 m/sec) and 92.5 ft/sec (28.2 m/sec), respectively.

3.5.2 The test uses a launching device capable of propelling ice balls at the speeds necessary to develop the intended kinetic energy. Aiming accuracy of the launcher must be sufficient to assure that the ice balls strike the test specimen at the specified impact areas.

3.5.3 A velocity measuring device is used to monitor the speed of the ice balls. It shall be accurate within ±1 ft/sec (±0.3 m/sec).

3.5.4 The test specimen shall be the maximum size for which Approval is desired and shall be representative of the samples being considered for Approval. The test specimen shall be placed over ½ in. (13 mm) thick plywood if necessary.

3.5.5 The test specimen was conditioned at 40°F ±5°F (4°C ±3°C) for a period of not less than 48 hours immediately prior to the test.

3.5.6 The ice balls were molded using distilled water by placing them in a freezer for a minimum of 48 hours at a controlled temperature of -7°F ±7°F (-22°C ±4°C) until they were frozen solid. Acceptable ice balls shall be free of cracks and air bubbles.

3.5.7 The ice balls used in this program were the 1.75 in (45 mm) diameter ice balls. The mass of the ice ball was 0.0928 lbs (42.1 g) ±10%. The speed of each ice ball was approximately 101.8 ft/sec (31 m/sec).

3.5.8 The test specimen was positioned vertically so that the trajectory of the ice ball is perpendicular (90° ±5°) to the test specimen at impact.

3.5.9 The test specimen was impacted a total of ten (10) times over three (3) general areas. The test specimen was impacted four (4) times within a 12 in. (300 mm) diameter circle located at the center of the specimen, three (3) times along the top edge of the specimen within six (6) in. (150 mm) of the edge of the specimen and three (3) times along one (1) side edge of the specimen within six (6) in. (150 mm) of the edge of the specimen. Each missile was fired separately.

3.5.10 The specimen shall be considered to meet the test criteria if there is no sign of cracking or splitting after being impacted as described above.

IV TEST SAMPLES

4.1 Wet Glaze System

4.1.1 All test samples had a clear daylight opening of 5 ft 4-1/4 in. (1.63 m) in width and 6 ft 8 in. (2.03 m) in height. The window frame was fabricated from extruded aluminum shape made from anodized 6063-T6 aluminum alloy. The frame was 4 in. (100 mm) deep by 1.75 in. (45 mm) high. The frame was designed to provide a 7/16 in (11 mm) glass bite. The corners of the frame were squared and butt jointed. The glazing consisted of a nominal 0.25 in. (6 mm) annealed glass. The frame surface was cleaned where the structural adhesive would eventually be applied. This was done to improve the adhesion. Prior to applying the window film, the gasketing on the interior side of the window was cut back to the edge of the window frame.

4.2 The 0.008 in. (0.20 mm) thick Safety Shield 800 LCL-800-XSR was then applied to the interior surface of the window. Existing gaskets are cut back to the edge of the window frame. The frame is cleaned and the Dow Corning 995 Silicone Structural Sealant was applied around the perimeter of the frame leaving a triangular shaped bead with each leg of the triangle overlapping the frame and window by a minimum of 3/8 in. (9.6 mm). For further details, see the installation instructions in Appendix A.

4.3 The samples were installed within a wooden frame consisting of nominal 2 x 8 southern yellow pine boards. The window frame was fastened to the wooden test frame using #10 x 3 flat head Phillips wood screws. The fasteners were located 4 in. (100 mm) from each corner in both directions and 24 in. (600 mm) on center around the perimeter.

V RESULTS

5.1 Impact Resistance Tests

5.1.1 Each of three (3) test samples received a series of three (3) impacts with each impact consisting of ten (10) ball bearings each weighing 0.07 oz. (2 grams). The speed of each missile was 130 ft/sec – 132 ft/sec (39.6 m/s – 40.2 m/s) which is equivalent to approximately 90 miles per hour (166.5 km/hr).

5.1.2 The series of impacts for each sample were located at the center of the test specimen, along the edge of the center of the long dimension of the test specimen and at one corner of the test specimen.

5.1.3 In each case, the impact of the steel balls cracked the glass however there was no penetration or development of any through openings as required by the test acceptance criteria.

5.2 Cyclic Wind Pressure Resistance Tests

5.2.1 Each of the three (3) test samples impacted by the simulated wind borne debris was subjected to a cyclical wind pressure test as described in Paragraph 3.3. The cyclic tests were conducted after the samples had been subjected to the small missile impact test. In addition, a 4th sample which had not been impacted by simulated windborne debris was subjected to a cycle test as required by the test standard.

5.2.2 The tests were conducted using a positive pressure, P, of 40 lbs/ft^2 (1.9 kPa) and a negative pressure, -1.4 P, of 56 lbs/ft^2 (2.7 kPa). A positive pressure shall be considered to be acting inward (towards a building) and a negative pressure shall be considered to be acting outward (away from a building).

5.2.3 None of the samples exhibited any cracks longer than 5 in. (125 mm) through which air can pass or any cracks greater than 1/16 in. (1.6 mm) in width.

5.2.4 The sample that was not impacted by the small missile did not shatter or develop any cracks or through openings.

5.3 Static Wind Pressure Test

5.3.1 A static wind pressure test was conducted on one (1) of the samples in accordance with Paragraph 3.4.

5.3.2 The design loads were +40 psf (1.9 kPa) and -56 psf (2.7 kPa). The positive (inward) pressure levels tested were +20 psf and +40 psf (+1.0 and +1.9 kPa). The negative (outward) pressure levels tested were -28 lbs/ft² and -56 lbs/ft² (-1.4 and -2.7 kPa).

5.3.3 The sample met all criteria as required by the test standard.

5.4 Simulated Hail Resistance Test Using Freezer Ice Balls

5.4.1 A sample was subjected to the Simulated Hail Resistance Test Using Freezer Ice Balls for Severe (S) Hail. There was no sign of cracking or splitting after being impacted as described in Paragraph 3.5.

VI MARKINGS

6.1 Each package or wrapper of the Safety Shield 800 LCL-800-XSR Window Film System manufactured by Madico shall contain the manufacturer's name, product trade name, the Approval mark of FM Approvals and the ratings attained in this program (Wind Zone HM – SM (FL) and Severe Hail Resistance)..

6.2 Labels denoting Approval shall be attached only to products fabricated in accordance with this report.

6.3 Labels denoting Approval shall be applied by the manufacturer only within, and on the premises of, manufacturing locations that are under the FM Approvals Facilities and Procedures Audit Program.

VII MANUFACTURER'S RESPONSIBILITIES

7.1 To assure compliance with installation procedures in the field, the manufacturer shall supply to the installer such necessary instructions or assistance as required to produce the desired performance achieved in the tests.

7.2 FM Approval is based upon the fabrication of hurricane glazing protections systems in accordance with this Approval Report, satisfactory field experience and continued use of acceptable quality control procedures as determined by Facilities and Procedures Audits.

7.3 The manufacturer shall be responsible for the continuous high quality of all assemblies and components and shall notify FM Approvals of intended changes in any component listed in this report.

7.4 All requests for changes shall be made and agreed to in writing utilizing FM Approvals Form 797, "Approved Product-Revision Report", prior to fabrication and/or distribution for sale.

7.5 The manufacturer shall establish and adhere to sufficient quality controls to ensure that labels denoting Approval shall only be applied to products conforming to the requirements set forth in this report.

VIII FACILITIES AND PROCEDURES AUDITS

8.1 Facilities and Procedures Audits of the Elizabethtown, KY and Woburn, MA facilities that produce the components used in this system have indicated that each facility has the necessary equipment, facilities, personnel and quality controls to fabricate the hurricane glazing protection system listed in this report.

8.2 Periodic, unannounced Facilities and Procedures Audits will be conducted to determine that the quality and uniformity of the component parts being used in the fabrication of the hurricane glazing protection systems are being maintained and that they are providing a level of quality equivalent to that originally Approved.

8.3 Approval recognition is contingent upon satisfactory results of the follow-up Facilities and Procedures Audits.

8.3.1 Unsatisfactory results of Facilities and Procedures Audits may result in additional Facilities and Procedures Audits as deemed necessary by FM Approvals or forfeiture of Approval recognition.

IX DOCUMENTATION

The following documents describe the hurricane glazing protection system referenced in this report. A copy is kept on file at FM Approvals and at the manufacturing facility.

Document	Issue or Revision	Description
FM Approvals Facilities and Procedures Audit Manual	December 11, 2008	Follow-up audit manual for window film.
FM Approvals Facilities and Procedures Audit Manual	January 26, 2009	Follow-up audit manual for silicone structural adhesive.
Wet Glaze Attachment System	August 2009	Installation instructions

X CONCLUSIONS

10.1 Madico, Inc. Safety Shield 800 LCL-800-XSR Window Film, as described in this report, meets Approval requirements as a retrofit Windstorm Resistant Fenestration for fixed window systems when installed as described below:

10.1.1 Opening size and glazing

Maximum clear opening size:	35.7 ft² (3.3 m²) with the width of the opening not exceeding 5 ft 4-1/4 in (1.6 m) and the height of the opening not exceeding 6 ft 8 in (2.1 m).
Glazing:	Nominal 0.25 in (6 mm) thick clear and annealed glass.

10.1.2 Security Film: 8 mil [0.008 in. (0.20 mm)] thick clear polyester film identified as Safety Shield 800 LCL-800-XSR Window Film by Madico, Inc. The film is available in multiple roll widths up to and including 72 in. (1.8 m).

10.1.3 Structural Adhesive: A bead of Dow Corning 995 Silicone Structural Sealant is applied as a triangular shaped bevel having legs a minimum of 3/8 in. (9.6 mm) long. Prior to the application of the adhesive, the portion of the frame that will be in contact with the adhesive shall be cleaned in accordance with the manufacturer's written installation instructions.

10.1.4 Additional Requirements: The window frame shall be fastened only to structural steel, concrete or minimum 2 x 8 wood studs (hollow masonry units and steel studs are not allowed). The fasteners shall be placed a maximum of 4 in. (100 mm) from each corner and a maximum 24 in (600 mm) oc in the head, sill and both jambs.

10.2 The window frame used in this test program was fabricated from an extruded aluminum shape made from anodized 6063-T6 aluminum alloy. The frame was 4 in. (100 mm) deep by 1.75 in. (45 mm) high.

10.2.1 The frame used in this program was considered to be representative of window frames that are thought to be in use. The system examined in this program can be retrofitted onto other window frames if specific details are satisfied as described below.

10.2.2 Prior to retrofit installation of the system examined in this report, an assessment of the existing window frame and its securement shall be conducted.

10.2.3 The larger of three (3) individual units or 5% of all existing units expected to receive the retrofit on any single building shall be physically examined to determine the adequacy of the method used to secure the existing window frames to the building.

10.2.4 If necessary, additional fasteners shall be installed such that all sides of the existing frame are secured with minimum #10 screws spaced no further than 4 in. (100 mm) in both directions at each corner and 24 in. (600 mm) on center along the head, sill and jambs.

10.2.5 The design pressure that the existing window frames shall be determined and certified by a registered professional engineer for the maximum positive and negative pressures the existing frame and it's securement to the building can withstand.

10.3 The appropriate type and length of fasteners are to be used for securement for the type of structural member encountered such that the resulting embedment shall be the minimum needed to develop the full strength of the fastener.

10.4 The Safety Shield 800 LCL-800-XSR Window Film shall be installed on the interior surface of windows located on the exterior face or corners of buildings where small missile impact resistance is required and where design pressures are not expected to exceed + 40 lbs/ft² (1.9 kPa) [inward acting] or – 56 lbs/ft² (-2.7 kPa) [outward acting]. The system has met the requirements for FM Wind Zone HM – SM (FL) as defined in Approval Standard 4350. The Safety Shield 800 LCL-800-XSR Window Film is Approved for locations that require a Severe (S) Hail Resistance.

10.4.1 For guidelines on determining the anticipated pressure levels and hail resistance requirements for specific locations, see FM Global Loss Prevention Data Sheet 1-28, "Wind Design" and 1-34, "Hail Damage".

10.4.2 The pressure values determined using FM Global Loss Prevention Data Sheet 1-28, "Wind Design" might not be the same pressures obtained using the guidelines of other jurisdictions. The end user should verify the limit of the corresponding pressure values obtained using other methods.

10.5 The windstorm resistant fenestration system examined in this report meets the Approval requirements and, as such, is eligible to bear a permanent, serialized label signifying Approval by FM Approvals.

10.6 Since a duly signed Master Agreement is on file for this customer, Approval is effective as of the date of this report.

10.7 This test program was conducted in accordance with FM Approvals Standard 4350, Windstorm Resistant Fenestrations. The test methods used in this program are identical to FBC TAS 201-94 and TAS 203-94.

PROJECT DATA RECORD: **3037005**

ORIGINAL DATA RECORD: **3031654**

ATTACHMENTS: **Appendix A** **Wet Glaze Attachment System (5 pages)**

EXAMINATION AND REPORT BY:

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Appendix A
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Safety Shield 800 with Wet Glaze Attachment System for Windstorm Applications

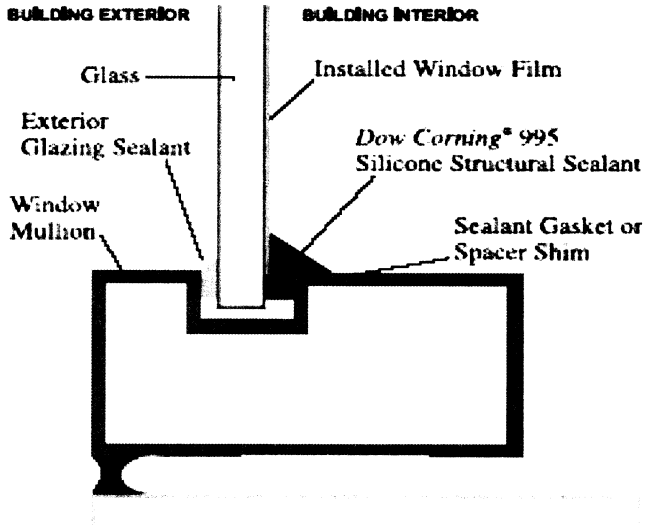
Converting windows from a hazard to a defensive asset requires that (1) the glass is held together even when broken and (2) the window lite remains attached to the frame. Window systems developed to meet these requirements are comprised of a tough, transparent polyester film adhered to the window glass and, Madico recommends *Dow Corning*® 995 Silicone Structural Adhesive, used as a glazing sealant to anchor the edges of the film and to hold the lite in the supporting frame. These systems have proven effective when evaluated for blast, wind load, or impact resistance.

Each of the hazards noted above has slightly different needs and requirements. Any system proposed must be evaluated for specific requirements and must be used only as tested. For example, a system that can withstand a 4-psi bomb blast may not be acceptable for a hurricane application or one with a 10-psi blast requirement. Performance depends upon the flexibility and strength of the entire system, including the film, sealant and frame. Therefore, the glazing sealant joint must be designed with a thorough understanding of the flexibility and strength of the whole window film system.

The sealant attachment systems that are economically viable in retrofit applications are built around a triangular joint connecting the film to the supporting framing member. To achieve acceptable performance, a very high-performance sealant must be used. The following information documents some of the key parameters that have proven critical for proper sealant application in high performance protective glazing systems and provides examples of application issues that could affect system performance.

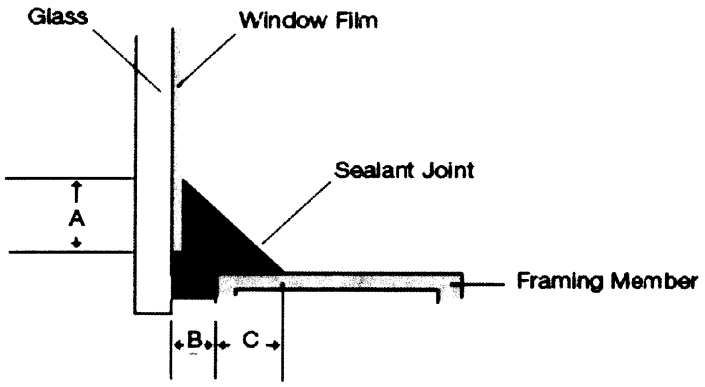
Figure 1. Application utilizing a triangular bead of *Dow Corning*® 995 Silicone Structural Adhesive

Figure 1.



Looking specifically at the sealant joint geometry, several areas are important to consider and control. *Figure 2* illustrates a triangular sealant joint.

Figure 2. The triangular joint is the most common, acceptable joint design



The sealant bite onto the attached film.

To ensure sealant adhesion and ultimate performance, a minimum sealant bite of **3/8** inch is required for any sealant cap bead. Many high performance applications designed to withstand an applied force are built around a sealant bite of 3/8 for wind load applications to 1/2 inch for blast that has proven to perform well in a wide variety of tests.

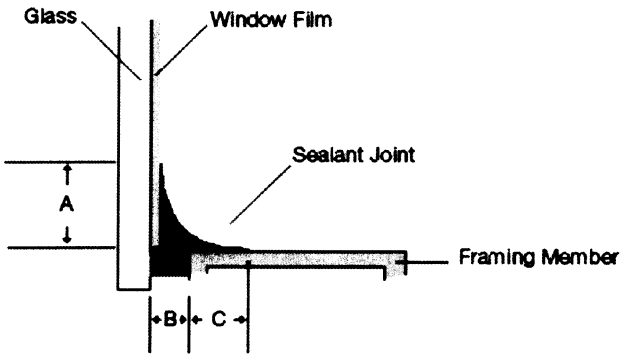
Because the requirements for any application are specific to that application, it is critical to ensure that the installation is exactly as tested by Madico..

The above application of Dow 995 wet glaze attachment combined with SafetyShield 800 installed on a minimum of ¼" glass is Rated for FM Approvals Wind Zone HM - SM (FL) and Severe Hail Resistance
Max wind pressure is (inward) 40 psf and (outward) -56 psf.

Potential areas of concern

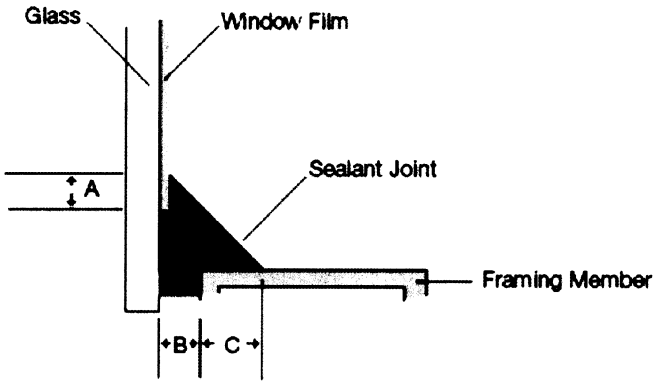
There are several areas of concern related to the way a triangular joint could be applied that can result in reduced performance. **These practices should be avoided.**

Figure 4. Concave joint surface **(Unacceptable)**



In this joint, the sealant is tooled to produce a concave surface that would affect the strength and performance of the joint. The greater the joint concavity, the weaker the joint.

Figure 5. Film too short of edge of daylight opening **(Unacceptable)**



In this illustration, the window film is left too far back from the edge of the daylight opening. The sealant contact with the film is much less than required for the system design, and joint performance will be reduced accordingly.

Figure 6. Silicone structural adhesive applied over an existing internal gasket without any cutback, resulting in a reduction of sealant bond to the framing member **(Unacceptable)**
In this example, the sealant adhesion onto the frame (dimension C) is inadequate for the bond required for an acceptable sealant joint. If the sealant bonds to the gasket, the bond is actually to a thin flap of rubber that is not designed to carry a load. As a result, the joint performance will be greatly reduced.

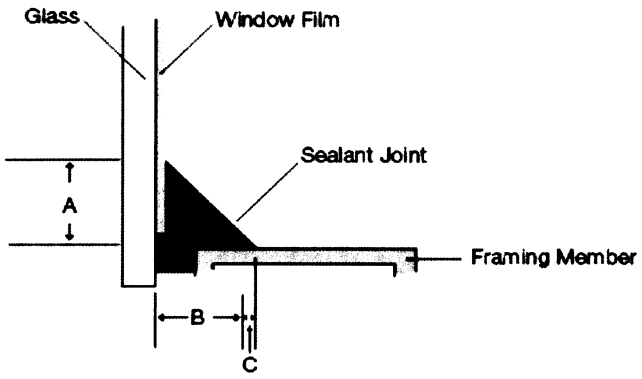
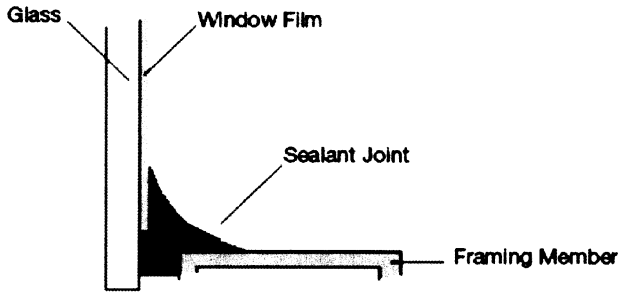


Figure 7. Do not seal directly to a gasket, and do not tool concave **(Unacceptable)**



In this application, the sealant contacts only an existing gasket and not the framing member. This is clearly unacceptable because (1) sealants often do not adhere to gasket material and (2) the gasket may not be designed to support a load.

Proper installation of the wet glaze bead will insure that the SafetyShield Safety System will perform as tested.