

FULL SCALE ARENA  
ISO TEST REPORT

**Rendered to:**

Solar Gard®

**MODEL DESIGNATION:** Solar Gard® Panorama® Safety & Security Films

**PRODUCT TYPE:** Safety and Security Films

This report contains in its entirety:

**Cover Page:** 1 page  
**Report Body:** 10 pages  
**Appendix A:** 11 pages  
**Appendix B:** 2 pages  
**Appendix C:** 9 pages  
**Appendix D:** 4 pages  
**Revision Log:** 1 page

<b>Test Report No.:</b>	B8765.03-801-12
<b>Test Date:</b>	10/13/10
<b>Report Date:</b>	03/02/11
<b>Test Report Retention End Date:</b>	03/02/15



Solar Gard®  
Solar Gard® Panorama® Safety & Security Films

**1.0 MANUFACTURER'S IDENTIFICATION**

- 1.1 Name of Applicant: Saint-Gobain Performance Plastics  
4540 Viewridge Avenue  
San Diego, CA 92123  
Voice: 800.359.8468
- 1.2 Contact Person: Miguel Detres (ext 1025)  
Nick Routh (ext 1033)

**2.0 SCOPE OF WORK**

- 2.1 Introduction  
Solar Gard retained Architectural Testing, Inc. (ATI) to conduct a full scale arena blast test on their Solar Gard Panorama window film per the requirements of ISO 16933:2007.

**3.0 PRODUCT IDENTIFICATION**

- 3.1 Product Type: Safety & Security Film
- 3.2 Model Designation: Solar Gard Panorama
- 3.3 Performance Class: 124 ft Standoff: exceeds 7.25 psi - 36 psi-msec  
(37.79 m Standoff: exceeds 50 kPa – 250 kPa-msec)
- 3.4 Overall Size: Specimens 9-16: 36-1/2" (w) x 44-3/4 (h)  
(927.1 mm (w) x 1137 mm (h))
- 3.5 Location: Lynn County, Texas
- 3.6 Elevation: 3126 ft. (952.8 m)
- 3.7 Test Date: 10/13/2010
- 3.8 Test Time: 2:21 p.m.
- 3.9 Ambient Temperature: 80° F (26.67° C)
- 3.10 Relative Humidity: 19%
- 3.11 Weather Condition Clear.
- 3.12 Configuration: Fixed
- 3.13 Drawing: This test report is incomplete if not accompanied by Solar Gard drawing labeled "Test Specimen Drawings" (sheets 1 through 10) bearing the digital stamp of Architectural Testing, Inc.
- 3.14 Sample Source: Specimens provided by Solar Gard.

**4.0 EXPLOSIVE CHARGE**

- 4.1 Charge Type: ANFO(Ammonium Nitrate Fuel Oil)
- 4.2 Charge Weight: 400 lbs (181.43 kg)
- 4.3 Standoff Distance: 124 feet (37.79 m)

## 5.0 BLAST REACTION CHAMBER

The blast reaction chamber construction consists of wide flange steel beams, steel tubes, and steel skin that enclose the chambers. ATI also placed four (4) foot (1219 mm) wide wing walls on the blast reaction chamber top and sides to reduce clearing effects on the reflecting surface. The overall dimensions of the blast reaction chamber are twenty-eight (28) feet (8534 mm) wide, sixteen (16) feet (4876 mm) tall, and ten (10) feet (3048 mm) deep. The blast reaction chamber encloses a volume that houses witness panels and structural members. The sealed surfaces of the blast reaction chamber prevent air blast pressure from wrapping around the test specimen so that the blast pressure loads only one side of the test specimen.

## 6.0 PRODUCT DESCRIPTION

### 6.1 Frame Construction

The frame was fabricated using the aluminum extrusions defined in Table 1.

Table 1: Aluminum Extrusion Details

Description	Part #	Overall Cross-Section	Alloy/Temper
Head	FG-3103	4.500" x 2.000" x 0.060" (114.3 mm x 50.80 mm x 1.524 mm)	6063-T5
Jamb	FG-3100	4.500" x 2.000" x 0.060" (114.3 mm x 50.80 mm x 1.524 mm)	
Sill	FG-3161	4.500" x 2.000" x 0.060" (114.3 mm x 50.80 mm x 1.524 mm)	
Glass Stop	FG-3144	1.500" x 1.500" x 0.060" (38.10 mm x 38.10 mm x 1.524 mm)	

#### 6.1.1 Corner Construction

The vertical members ran through, while the horizontal members were square cut, butted and mechanically fastened to each vertical member using two (2) FS-8 #14 x 1" Assembly screws.

#### 6.1.2 Dual Pane Frame (Specimens 9-16)

The Head (Part #FG-3103) and Jamb (Part #FG-3100) were used. The Glass Stop (Part #FG-3144) was snap fit to the Sill (Part #FG-3161).

### 6.2 Glazing Details

#### 6.2.1 Glazing Materials

Glass Type III consisted of 1" (25.40 mm) (nominal) insulated glass comprised of the following components:

- 1/4" (6.350 mm) annealed glass
- 1/2" (12.70 mm) air space
- 1/4" (6.350 mm) annealed glass

Glass Type IV consisted of 1" (25.40 mm) (nominal) insulated glass comprised of the following components:

- 1/4" (6.350 mm) tempered glass
- 1/2" (12.70 mm) air space
- 1/4" (6.350 mm) tempered glass
- 

#### 6.2.2 Safety Film

Each specimen used the safety film defined in Table 2.

Table 2: Safety Film Details

Specimen #	Film Type
9-16	Solar Gard Panorama 8 mil

6.2.3 Glazing Method

The glass lites used in the test specimens were glazed using the following (typical) procedures:

6.2.3.1 Exterior Side

Continuous strips of Gasket (Part #FG-1113) were used.

6.2.3.2 Interior Side

A continuous 3/4" x 3/4" (19.05 mm x 19.05 mm) bead of GE SCS2000 SilPruf\* silicone sealant & adhesive to adhere the film to the window frame was used.

6.2.4 Daylight Opening and Glass Bite

Table 3 provides the daylight opening and glass bite for each lite used in this test specimen.

Table 3: Daylight Opening and Glass Bite Details

Specimen #	Qty.	Glazing Material Type	Daylight Opening	Glass Bite
9-12	4	III	32-1/2" (w) x 40-3/4" (h) (825.5 mm (w) x 1035 mm (h))	3/8" (9.525 mm)
13-16		IV		

6.3 Sealants Used

Table 4 provides details of each sealant used in each test specimen.

Table 4: Sealant Details

Location	Sealant Description
Perimeter Sealant	None used
Frame Joint Sealant	None Used
Glazing Sealant	GE SCS2000 SilPruf* silicone sealant & adhesive

## 7.0 PRODUCT INSTALLATION

7.1 Table 5 provides details of the product installation into the steel opening.

Table 5: Product Installation Details

Specimen #	Location	Fastener Schedule	Fastener Description
9-16	Perimeter	2" (50.80 mm) from ends and 10" (254.0 mm) on center thereafter	Two (2) 1-3/4" x 1-3/4" (44.45 mm x 44.45 mm) angles were welded together using two (2) 1/4" (6.350 mm) fillet welds and used to sandwich the frame on either side. The exterior angles were mechanically fastened to the steel opening using one (1) 9/16" x 2" (14.29 mm x 50.8 mm) HH Gr. 5 Bolt and the interior angles were welded to the steel opening using two (2) 1/4" (6.350 mm) fillet welds.
9-16	Perimeter	12" (304.8 mm) from the Top and Bottom	2" (50.80 mm) clips on the verticals of the angle mechanically fastened to the exterior and interior using one (1) 9/16" x 2" (14.29 mm x 50.8 mm) HH Gr. 5 Bolt



## **8.0 INSTRUMENTATION**

- 8.1 Data Acquisition System  
ATI used a high speed data acquisition system with a system record time of one-hundred thousand (100,000) samples per second.
- 8.2 Reflected Pressure Transducers  
ATI placed four (4) reflected pressure transducers on the single span blast reaction chambers to measure the reflected blast pressure time histories acting on the surface of the mock-up. The reflected pressure transducer locations are given in Figures 1.
- 8.3 Internal Pressure Transducer  
ATI used one (1) pressure transducer to measure the internal incident air blast pressure time history in each of the single span chambers.
- 8.4 Free Field Pressure Transducers  
ATI used one (1) free field pressure transducer to measure the free field incident air blast pressure time histories. ATI placed this transducer further than 25 feet (7.620 m) from any of the blast reaction chambers at a standoff distance of 124 feet (37.79 m).
- 8.5 High Speed Cameras  
ATI used digital high speed cameras to record system response under air blast pressure. One (1) camera filmed the exterior of the mock-up and one (1) camera filmed the interior of each of the mock-ups during air blast pressure loading.
- 8.6 Witness Panels  
ATI used witness panels defined in ISO 16933:2007 Section 6.6. The witness panel makeup consisted of two layers of material. The outer layer consisted of one-half (1/2) inch (12.70 mm) thick rigid foam plastic thermal insulation board composed of polyisocyanurate foam bonded to a durable white-matte non-glare aluminum facer and a reflective reinforced aluminum facer with a density of two (2) pounds per cubic foot (32.03 kilograms per cubic meter). The inside layer consisted of one (1) inch extruded polystyrene insulation with a density of 1.8 pounds per cubic foot (28.83 kilograms per cubic meter).

## **9.0 BLAST PRESSURE DATA AT 124 FEET STANDOFF**

- 9.1 Reflected Pressure Transducer Location  
Figure 1 shows the locations of the reflected pressure transducers on the two (2) single span reaction chambers.

### CHAMBER 3

### CHAMBER 4

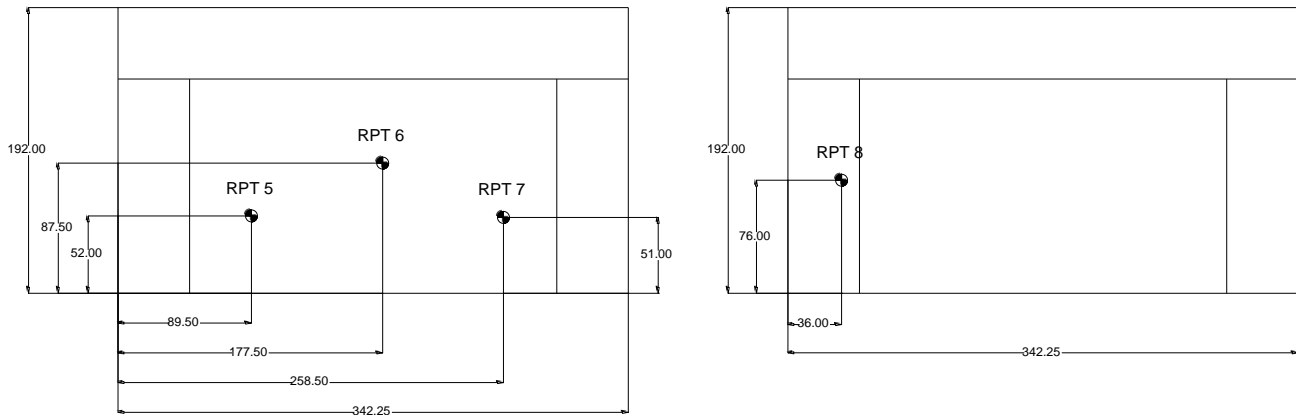


Figure 1: Reflected Pressure Transducer Locations

#### 9.2 Reflected Air Blast Pressure Results

Table 6 summarizes the reflected blast pressure and positive phase impulse for each pressure transducer location. Figures 2 through 5 provide the reflected air blast pressure (red) and impulse (blue) time histories graphically.

Table 6: Reflected Air Blast Pressure Results

Air Blast Parameter	RPT 5	RPT 6	RPT 7	RPT 8	Average
Peak Pressure, psi (kPa)	8.893 (61.32)	7.720 (53.23)	8.895 (61.33)	8.165 (56.30)	8.529 (58.81)
Positive Phase Impulse, psi-msec (kPa-msec)	36.15 (249.2)	38.81 (267.6)	36.59 (252.3)	37.52 (258.7)	36.79 <sup>1</sup> (253.7 <sup>1</sup> )
Positive Phase Duration (msec)	10.86	13.04	11.31	9.613	11.21

<sup>1</sup>Average is based off ConWep output with clearing effects taken into account.

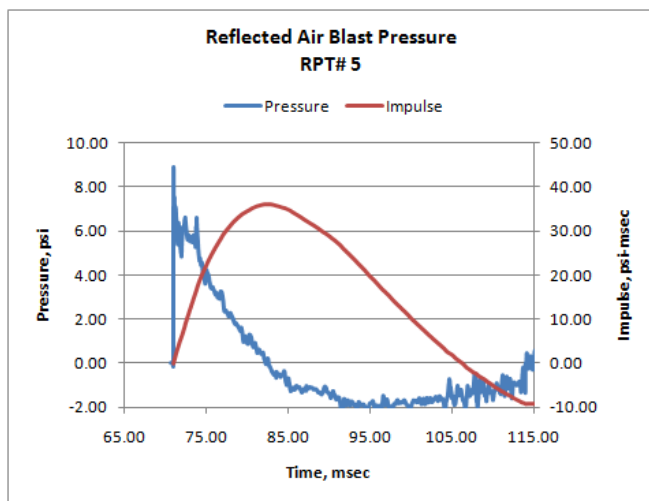


Figure 2: Reflected Air Blast Pressure (RPT #5)

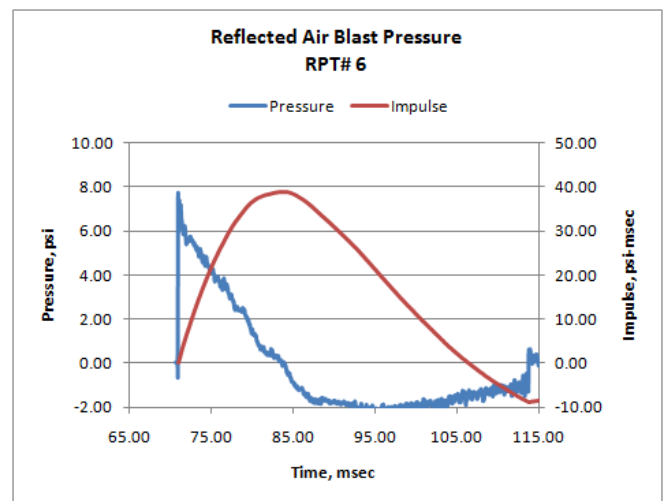


Figure 3: Reflected Air Blast Pressure (RPT #6)

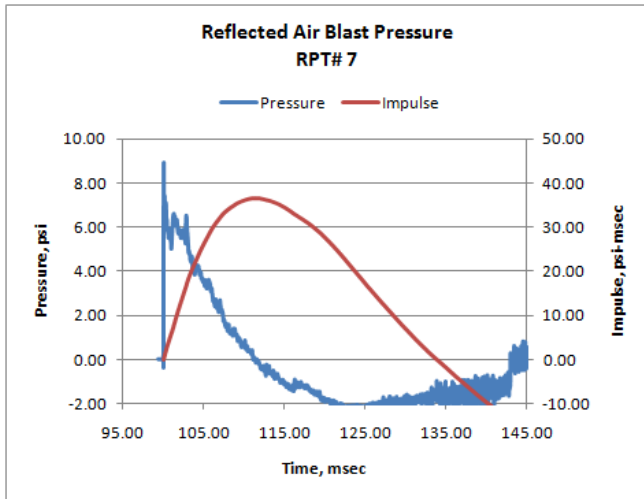


Figure 4: Reflected Air Blast Pressure (RPT #7)

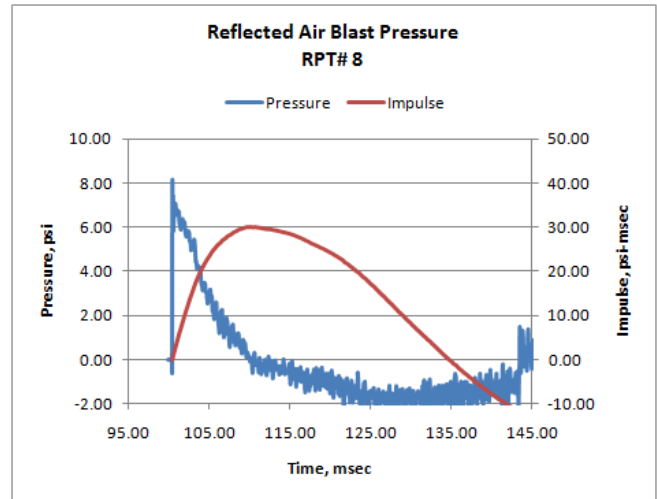


Figure 5: Reflected Air Blast Pressure (RPT #8)

9.3 Free Field Incident Air Blast Pressure Results

Table 7 provides the results obtained from the free field pressure transducers, and Figure 6 provides the free field incident air blast pressure time histories.

Table 7: Free Field Air Blast Pressure Results

Blast Parameter	FF 1
Peak Air Blast Pressure, psi (kPa)	4.210 (29.03)
Peak Positive Phase Impulse, psi-msec (kPa-msec)	20.91 (144.2)

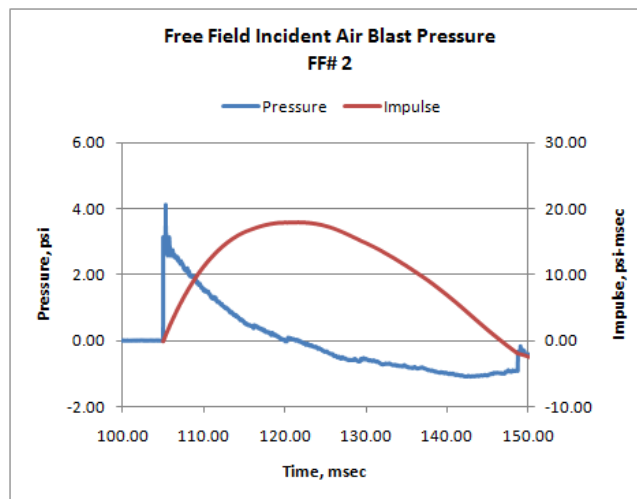


Figure 6: Free Field Incident Air Blast Pressure Time Histories

9.4 Internal Incident Air Blast Pressure Results

ATI measured a maximum internal air blast pressure of approximately 0.481 psi (3.316 kPa) inside the air chamber during air blast pressure loading. Figure 7 provides a graph of the internal air blast pressure time history.

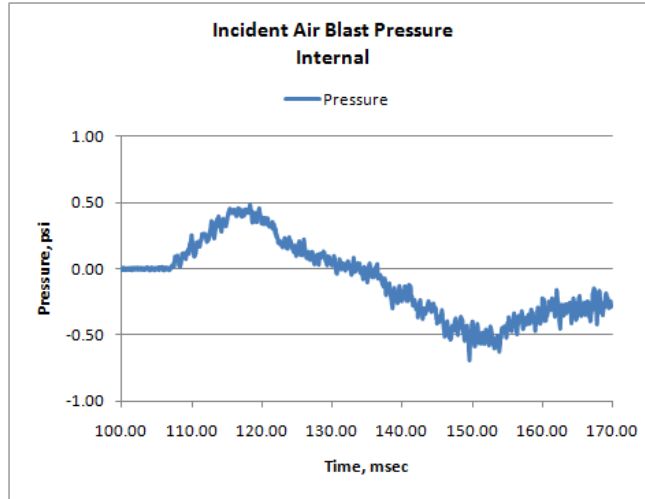


Figure 7: Internal Incident Air Blast Pressure Time History

## 10.0 TEST RESULTS

### 10.1 Chamber 3

#### 10.1.1 Glazing Response

All four (4) of the specimens' outboard and inboard lites fractured during air blast pressure loading. Specimen 11's inboard film tore producing four (4) qualifying fragments with a sum united dimension of 6.903 in. (175.3 mm). One (1) fragment impact was observed 5.250 in (133.3 mm) above the floor in the vertical witness panel. Specimen 12's inboard film tore producing two (2) qualifying fragments with a sum united dimension of 2.542 in (64.57 mm). Table 8 provides a summary of the glazing response during air blast pressure loading. Table 9 provides the calculation method to determine the sum united dimension of the fragments.

Table 8: Glazing Response Summary

Specimen #	Temp. °F (°C)	Fracture Status		Comments
		Inboard	Outboard	
9	71.50 (21.94)	Yes	Yes	No tears or pullout observed.
10	72.00 (22.22)	Yes	Yes	No tears or pullout observed.
11	70.00 (21.11)	Yes	Yes	7.000 in (177.8 mm) tear observed, no pullout
12	72.50 (22.50)	Yes	Yes	5.500 in (140.0 mm) tear observed, no pullout



Table 9: United Fragment Dimensions and Total

Specimen #	Fragment	Length in, (mm)	Width in, (mm)	Height in, (mm)	Subtotal in, (mm)	Fragment Sum in, (mm)
11	1	1.043 (26.49)	0.898 (22.81)	0.218 (5.580)	2.159 (54.88)	6.903 (175.3)
	2	1.277 (32.43)	0.667 (16.94)	0.221 (5.613)	2.165 (54.98)	
	3	0.965 (24.51)	0.267 (6.782)	0.217 (5.518)	1.449 (36.81)	
	4	0.591 (15.01)	0.321 (8.153)	0.218 (5.537)	1.130 (28.70)	
12	1	0.880 (22.35)	0.110 (2.794)	0.224 (5.689)	1.214 (30.84)	2.542 (64.57)
	2	0.784 (19.91)	0.328 (8.331)	0.216 (5.486)	1.328 (33.73)	

10.1.2 Frame Response

No visible damage occurred at the head, sill or jambs during air blast pressure loading.

10.1.3 Clip Response

No visible damage occurred at the internal or external jamb clips during air blast pressure loading.

10.2 Chamber 4

10.2.1 Glazing Response

Specimen 13, 15, and 16 inboard and outboard lites did not fracture during air blast pressure loading. Specimen 14's inboard and outboard lites yielded during air blast pressure loading. The film showed no signs of tearing and retained the glazing within the frame. Zero (0) perforations or fragment indents were observed anywhere in the vertical witness panel. Table 10 provides a summary of the glazing response during air blast pressure loading.

Table 10: Glazing Response Summary

Specimen #	Temp.	Fracture Status		Comments
	°F (°C)	Inboard	Outboard	
13	73.50 (23.05)	No	No	No tears or pullout observed.
14	73.50 (23.05)	Yes	Yes	No tears or pullout observed.
15	73.00 (22.78)	No	No	No tears or pullout observed.
16	72.50 (22.50)	No	No	No tears or pullout observed.

10.2.2 Frame Response

No visible damage occurred at the head, sill or jambs during air blast pressure loading.

10.2.3 Clip Response

No visible damage occurred at the internal or external jamb clips during air blast pressure loading.



**11.0 HAZARD RATING**

11.1 ISO 16933

11.1.1 Dual Pane Annealed 8 mil Film Wet Glazed

The system performed consistent with a "Hazard rating C"; therefore, the classification code for the glazing is EXV33(C). The exterior lites and interior lites of all the specimens yielded during the air blast pressure loading. Specimen 11 and 12's interior film tore in the upper right corner allowing fragments to enter the space between 1 and 3 meters from the interior face of the specimen.

11.1.2 Dual Pane Tempered 8 mil Film Wet Glazed

The system performed consistent with a "Hazard rating B"; therefore, the classification code for the glazing is EXV33(B). The exterior and interior lites of Specimen 14 fractured during air blast pressure loading. The glazing was fully retained in the test frames. No breach and no material were lost from the interior surface of the specimen during air blast pressure loading.

**12.0 CERTIFICATION AND DISCLAIMER STATEMENT**

All tests performed on these test specimens were conducted in accordance with the specifications of the applicable codes, standards and test methods listed below by ATI.ATI does not have, nor does it intend to acquire or will it acquire, a financial interest in any company manufacturing or distributing products tested at ATI.ATI is not owned, operated or controlled by any company manufacturing or distributing products it tests. This report is only intended for the use of the entity named in Section 1.0 of this report. Detailed assembly drawings showing wall thickness of all members, corner construction and hardware applications are on file and have been compared to the test specimens submitted. ATI will service this report for the entire test record retention period. Test records that are retained such as detailed drawings, datasheets, representative samples of test specimens, or other pertinent project documentation will be retained by ATI for the entire test record retention period.

All results obtained apply only to the specimens tested and they do indicate compliance with the performance requirements of the test methods and specifications listed in the following section.

If test specimens contain glazing, no conclusions of any kind regarding the adequacy or inadequacy of the glass in any glazed test specimens can be made. This report does not constitute certification of this product nor an opinion or endorsement by this laboratory. It is the exclusive property of the client so named herein and relates only to the specimens tested. This report may not be reproduced, except in full, without the written approval of ATI.

**13.0 APPLICABLE CODES, STANDARDS, AND TEST METHODS**

**ISO 16933:2007:** *Glass in building – Explosion-resistant security glazing – Test and classification for arena air-blast loading.*

**14.0 WITNESSES (ALL OR PARTIAL)**

Vinu J. Abraham, P.E.	SE Region Vice President	Architectural Testing, Inc.
Daniel Simmons, E.I.T.	Project Manager	Architectural Testing, Inc.
Bart Masters	Technician	Architectural Testing, Inc.
Jay Ignazinski	Technician	Architectural Testing, Inc.
Miguel Detres	Technical Service Representative	Solar Gard®



**15.0 APPENDICES**

This test report is incomplete if not accompanied by the following Appendices.

Appendix A: Test Specimen Drawings..... 11 Pages  
Appendix B: Test Setup ..... 2 Pages  
Appendix C: Photographic Record ..... 9 Pages  
Appendix D: GE SCS2000 SilPruf\* Specifications ..... 4 Pages  
Revision Log ..... 1 Page

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Daniel Simmons, E.I.T.  
Project Manager

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Vinu J. Abraham, P.E.  
FL Reg. #53820  
Vice President – Southeast Region

**APPENDIX A:**  
**"Test Specimen Drawings"**  
**10 SHEETS**



WINDOW FILMS • PHOTOVOLTAICS • CUSTOM COATINGS

**Test Specimen Drawings- ISO 16933  
Solar Gard® Panorama® Safety & Security Films**

- a. Glazing materials
  - i. Type III - Insulated glass unit made up of two sheets of 1/4" (6.35 mm) annealed glass separated by a 1/2" (12.7 mm) air space.
    - 1. Daylight opening of 32 1/2" by 40 3/4" (825.5 mm by 1035 mm)
    - 2. Windows within Chamber 3
  - ii. Type IV - Insulated glass unit made up of two sheets of 1/4" (6.35 mm) tempered glass separated by a 1/2" (12.7 mm) air space.
    - 1. Daylight opening of 32 1/2" by 40 3/4" (825.5 mm by 1035 mm)
    - 2. Windows within Chamber 4
- b. Safety & Security Film - The following type of safety & security film was tested.
  - i. Solar Gard® Panorama® 8mil
- c. Frame assembly – Specimens were prepared using clear anodized aluminum. The following parts list was used to fabricate the units. The details of these parts are defined in Section I.

Description	Manufactured Part #	Overall Dimensions	Material
Insulated Glass Unit Series 3000			
Head	FG-3103	4 1/2" x 2" x 0.060" (114.3 mm x 50.8 mm x 1.524 mm)	6063 T5 Aluminum
Jamb	FG-3100	4 1/2" x 2" x 0.060" (114.3 mm x 50.8 mm x 1.524 mm)	
Sill	FG-3161	4 1/2" x 2" x 0.060" (114.3 mm x 50.8 mm x 1.524 mm)	
Glass Stop	FG-3144	1 1/2" x 1 1/2" x 0.060" (38.1 mm x 38.1 mm x 1.524 mm)	
Fastener	FS-8 #14	1" (25.4 mm)	

- d. Corner assembly – Frames were all square cut and assembled using fastener FS-8 #14 (1" (25.4 mm)).
- e. Glass bite – Each window unit had a glass bite of 3/8" (9.53 mm).
- f. Exterior glazing method – The following glazing material was used to glaze the exterior portion of the glass.




Architectural Testing, Inc  
Test sample complies with details shown herein. Any deviations are noted in the test report or drawings.

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Description	Manufactured Part #	
Gasket (vinyl filler)	FG-1133	

- g. Interior glazing method – Solar Gard attached the Solar Gard Panorama film with GE SCS2000 SilPruf\* structural sealant. The wet glaze attachment consisted of a 3/4" bead on the interior side of the glazing to adhere the film to the window frame as shown in Section II. Specifications for the GE SCS2000 SilPruf\* can be reviewed in Appendix D.
- h. Test buck installation method – Architectural Testing Inc. installed the window frames into the test bucks using 1-3/4" x 1-3/4" (44.45 mm x 44.45 mm) angles sandwiching the specimens with 2" (50.8 mm) clips on the verticals of the angle 12" (304.8 mm) from the top and bottom. The details of this installation are in Section III.

Exterior mounting - The exterior angles were mechanically fastened to the steel opening using one (1) 9/16" x 2" (14.29 mm x 50.8 mm) HH Gr. 5 Bolt. Hardware spacing: 2" (50.8 mm) from the end and 10" (254 mm) on center thereafter. 2" (50.8 mm) clips were mechanically fastened on the verticals of the angle 12" (304.8 mm) from the top and bottom were installed using (1) 9/16" x 2" (14.29 mm x 50.8 mm) HH Gr. 5 Bolt

Interior mounting - The interior angles were welded to the steel opening using two (2) 1/4" (6.35 mm) fillet welds. 2" (50.8 mm) clips were mechanically fastened on the verticals of the angle 12" from the top and bottom were installed using (1) 9/16" x 2" (14.29 mm x 50.8 mm) HH Gr. 5 Bolt

Fastener Schedule	Fastener Description
2" (50.8 mm) from ends and 10" (254 mm) on center thereafter	Two (2) 1-3/4" x 1-3/4" (44.45 mm x 44.45 mm) angles were welded together using two (2) 1/4" (6.35 mm) fillet welds and used to sandwich the frame on either side. The exterior angles were mechanically fastened to the steel opening using one (1) 9/16" x 2" (14.29 mm x 50.8 mm) HH Gr. 5 Bolt and the interior angles were welded to the steel opening using two (2) 1/4" (6.35 mm) fillet welds– Details in Section III
12" (304.8 mm) from the Top and Bottom	2" (50.8 mm) clips on the verticals of the angle – Details in Section III



Architectural Testing, Inc  
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Saint-Gobain Performance Plastics

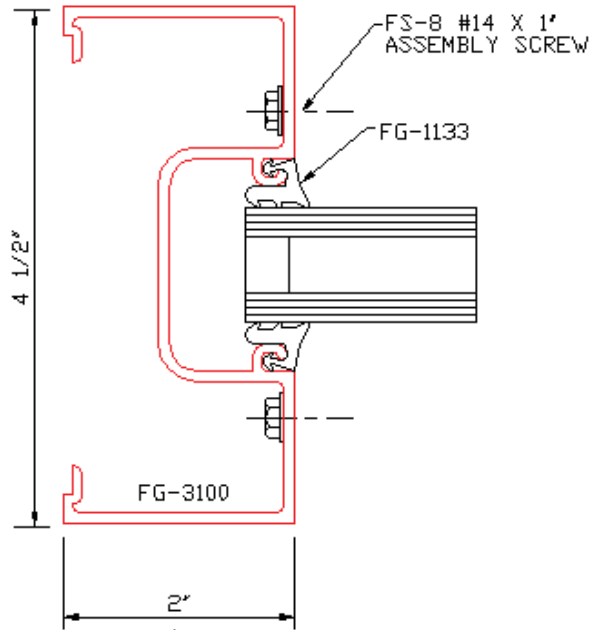
4540 Viewridge Avenue • San Diego • California 92123 USA • Tel: +1 858 576 0200 • Fax: +1 858 571 3605 • www.solargard.com

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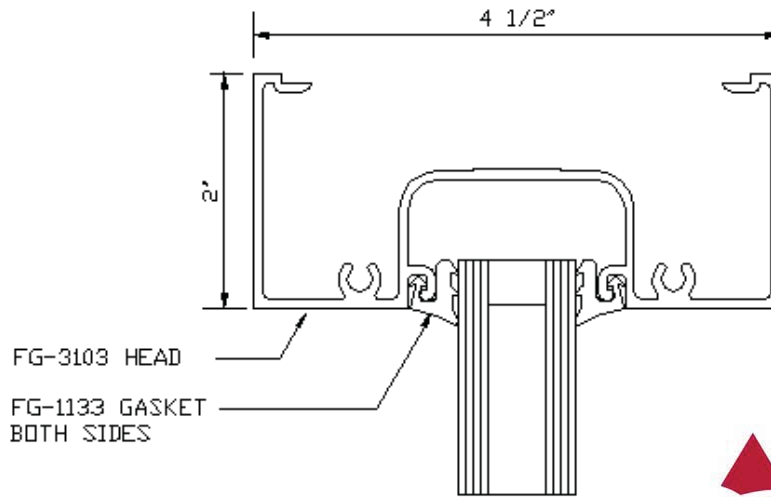
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**SECTION I**

- a. Dual pane frame detail
  - i. Jamb detail



- ii. Head detail

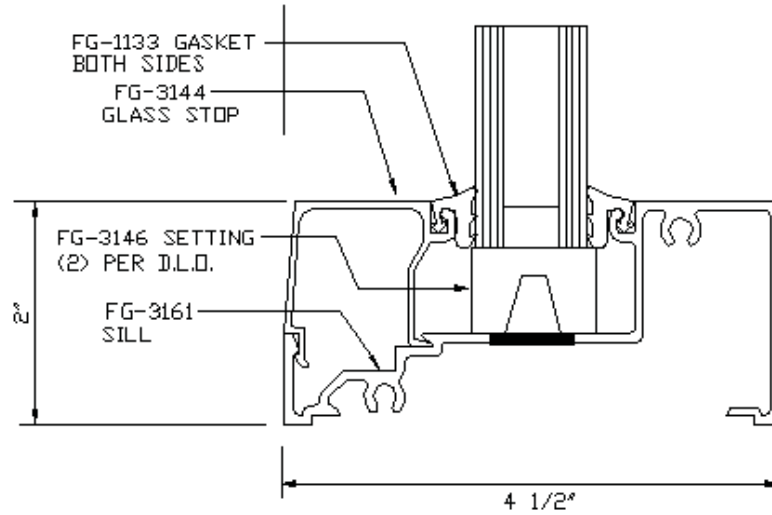


Architectural Testing, Inc  
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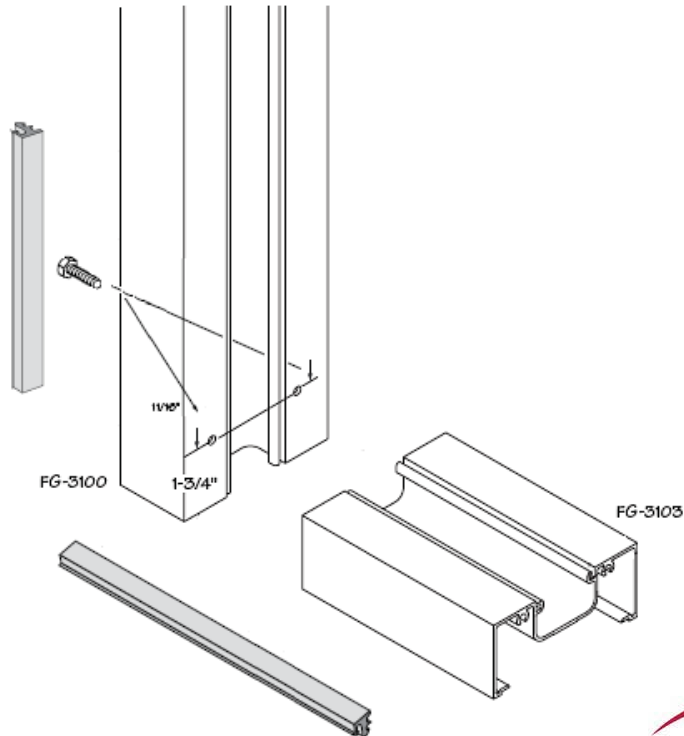
Report #: B8765.03-801-12

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iii. Sill detail



iv. Assembly



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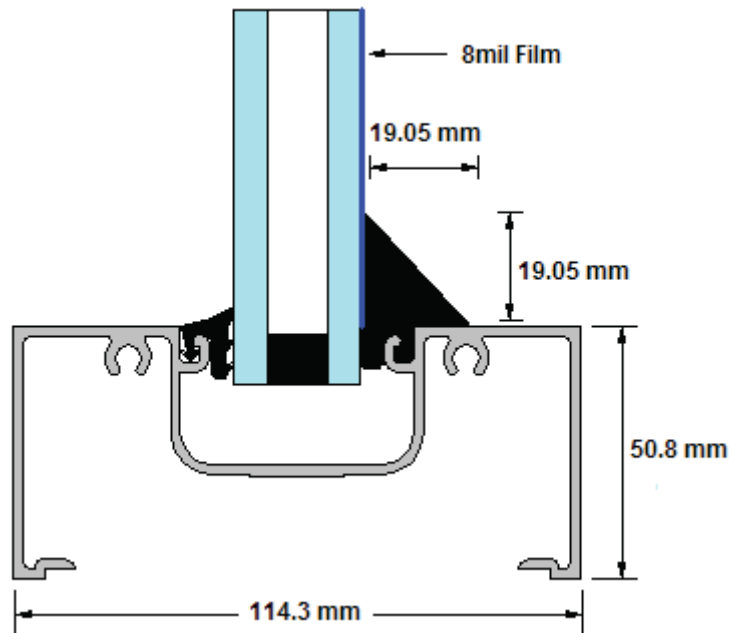




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**SECTION II**

- a. Wet glaze installation detail
  - i. 8mil (200 micron) Film on Dual Pane Glass



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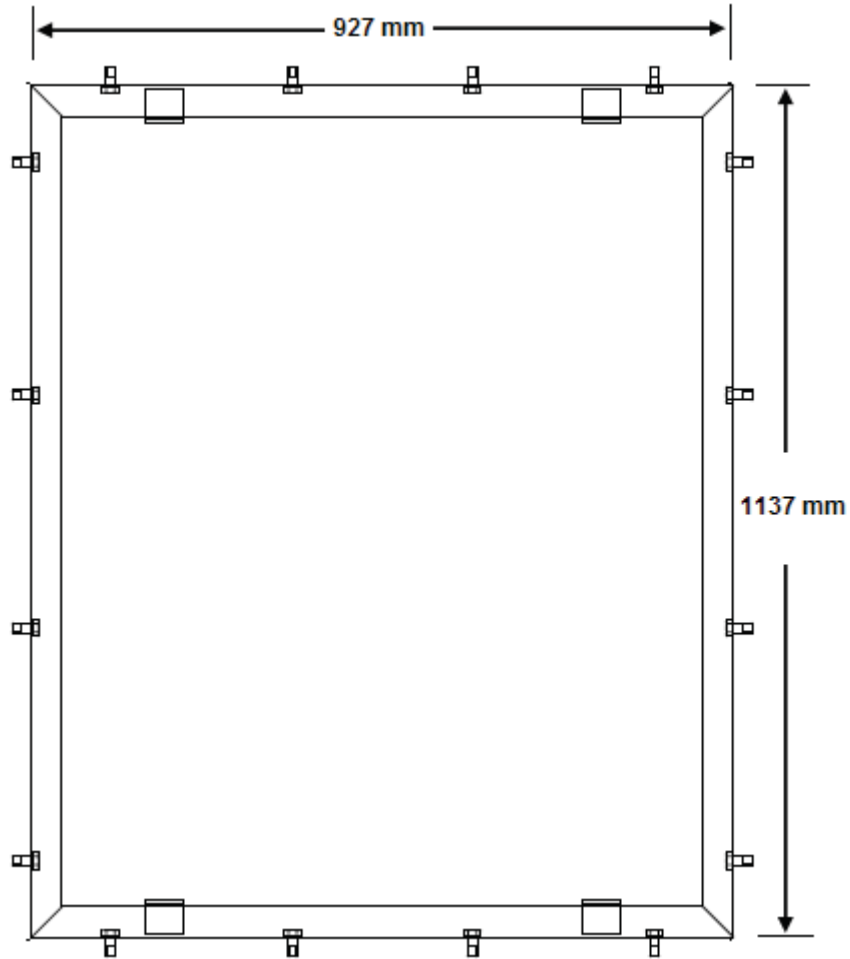


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**SECTION III**

a. Test Buck & Frame Installation Detail

i. Chamber 3 & 4



Architectural Testing, Inc  
Test sample complies with details shown herein. Any deviations are noted in the test report or drawings.

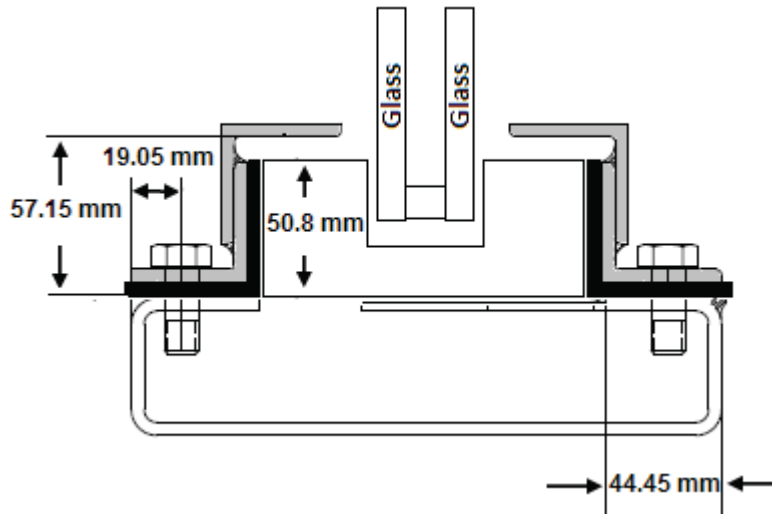
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ii. Chamber III & IV Bracket Detail



Architectural Testing, Inc  
Test sample complies with  
details shown herein. Any  
deviations are noted in the  
test report or drawings.

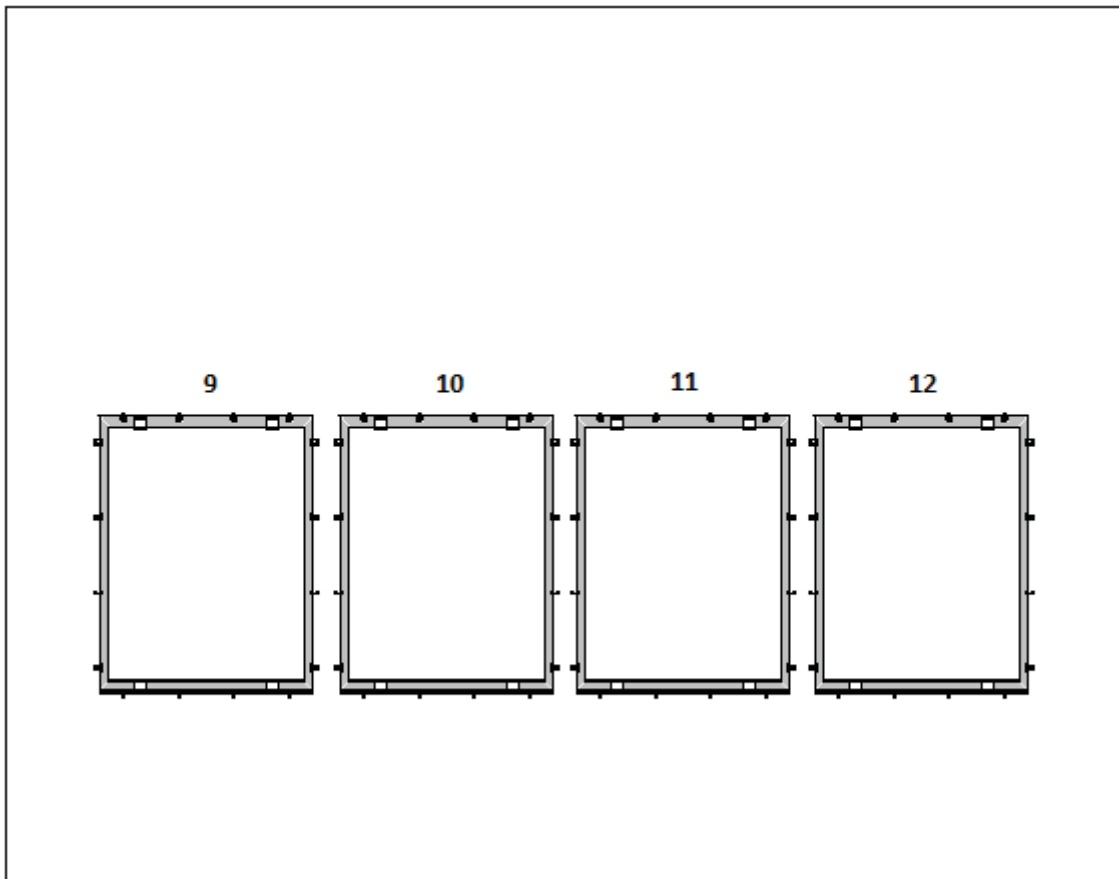


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a. Chamber drawings

i. Chamber 3

Window	Glazing Type	Assembled Unit Size	Film Type	Attachment Type
Chamber 3	9	IGU Annealed-Type III 36 1/2" x 44 3/4" (927 mm x 1137 mm)	Solar Gard Panorama 8mil	Wet Glazed
	10	IGU Annealed-Type III 36 1/2" x 44 3/4" (927 mm x 1137 mm)	Solar Gard Panorama 8mil	Wet Glazed
	11	IGU Annealed-Type III 36 1/2" x 44 3/4" (927 mm x 1137 mm)	Solar Gard Panorama 8mil	Wet Glazed
	12	IGU Annealed-Type III 36 1/2" x 44 3/4" (927 mm x 1137 mm)	Solar Gard Panorama 8mil	Wet Glazed



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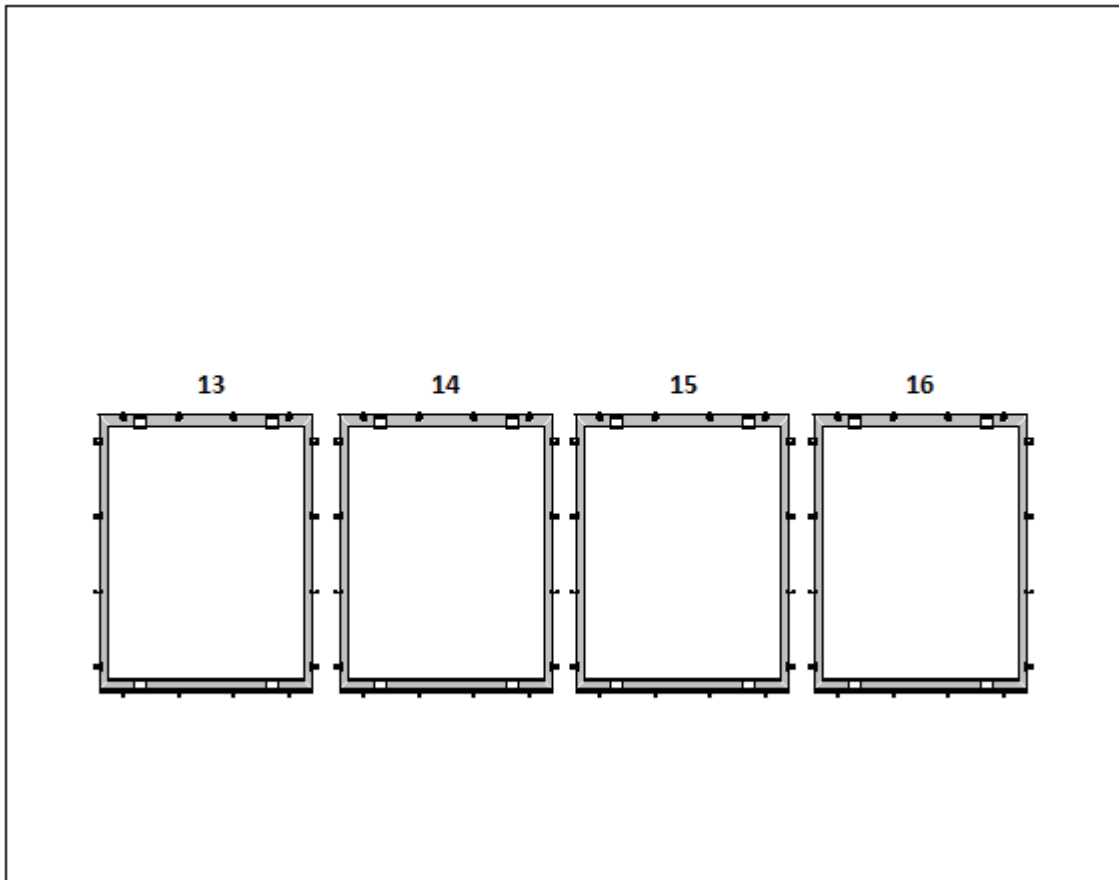
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ii. Chamber 4

Window	Glazing Type	Assembled Unit Size	Film Type	Attachment Type	
Chamber 4	13	IGU Tempered-Type IV	36 1/2" x 44 3/4" (927 mm x 1137 mm)	Solar Gard Panorama 8mil	Wet Glazed
	14	IGU Tempered-Type IV	36 1/2" x 44 3/4" (927 mm x 1137 mm)	Solar Gard Panorama 8mil	Wet Glazed
	15	IGU Tempered-Type IV	36 1/2" x 44 3/4" (927 mm x 1137 mm)	Solar Gard Panorama 8mil	Wet Glazed
	16	IGU Tempered-Type IV	36 1/2" x 44 3/4" (927 mm x 1137 mm)	Solar Gard Panorama 8mil	Wet Glazed



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## APPENDIX B: TEST SETUP



Figure B.1: Range Setup



Figure B.2: Free-Field Pressure Transducers  
124 ft Standoff



Figure B.3: Pre-Blast Specimen Setup  
Chamber 3



Figure B.4: Pre-Blast Specimen Setup  
Chamber 4

**APPENDIX C:  
PHOTOGRAPHIC RECORD**





Figure C.1: Specimen 9  
Pre-Blast Condition



Figure C.2: Specimen 10  
Pre-Blast Condition



Figure C.3: Specimen 11  
Pre-Blast Condition



Figure C.4: Specimen 12  
Pre-Blast Condition



Figure C.5: Glazing Fragment  
Chamber 3



Figure C.6: Glazing Fragment  
Chamber 3



Figure C.7: Glazing Fragment  
Chamber 3



Figure C.8: Glazing Fragment  
Chamber 3



Figure C.9: Glazing Fragment  
Chamber 3



Figure C.10: Glazing Fragment  
Chamber 3



Figure C.11: Specimen 9 External  
Post-Blast Condition



Figure C.12: Specimen 10 External  
Post-Blast Condition



Figure C.13: Specimen 11 External Post-Blast Condition



Figure C.14: Specimen 12 External Post-Blast Condition



Figure C.15: Specimen 9 Internal Post-Blast Condition



Figure C.16: Specimen 10 Internal Post-Blast Condition



Figure C.17: Specimen 11 Internal  
Post-Blast Condition



Figure C.18: Specimen 12 Internal  
Post-Blast Condition



Figure C.19: Chamber 4  
Pre-Blast Condition



Figure C.20: Specimen 13  
Pre-Blast Condition



Figure C.21: Specimen 14  
Pre-Blast Condition



Figure C.22: Specimen 15  
Pre-Blast Condition



Figure C.22: Specimen 16  
Pre-Blast Condition



Figure C.23: Specimen 13 External Post-Blast Condition



Figure C.24: Specimen 14 External Post-Blast Condition



Figure C.25: Specimen 15 External Post-Blast Condition



Figure C.26: Specimen 16 External Post-Blast Condition



Figure C.27: Specimen 13 Internal Post-Blast Condition



Figure C.28: Specimen 14 Internal Post-Blast Condition



Figure C.29: Specimen 15 Internal Post-Blast Condition



Figure C.30: Specimen 16 Internal Post-Blast Condition



**APPENDIX D:**  
**GE SCS2000 SilPruf\* Specifications**



**MOMENTIVE**  
performance materials

# SilPruf\* SCS2000

## silicone sealant & adhesive

### Product Description

SilPruf SCS2000 sealant & adhesive is a dual-purpose silicone and is a candidate for use in both weathersealing and structural glazing applications. SilPruf SCS2000 sealant & adhesive is a one-component, medium-modulus, neutral cure silicone useful on a wide variety of materials in new or remedial applications. SilPruf SCS2000 sealant & adhesive is supplied as a paste and upon cure produces a durable, formed-in-place silicone rubber joint sealant.

### Typical Performance Properties

- **Silicone Durability** - cured silicone rubber exhibits excellent long term resistance to natural weathering, including: ultraviolet radiation, high and low temperatures and rain and snow, with negligible change in elasticity.
- **Proven Track Record** - Improving global construction projects since 1974; SilPruf SCS2000 sealant & adhesive demonstrates superior sealing performance and long-lasting weatherability in a variety of applications.
- **Adhesion** - primerless adhesion to many substrates and finishes. May be considered a candidate for use with numerous construction-related materials, including: glass, polycarbonate, vinyl, numerous plastics, treated and untreated wood, fluoropolymer and powder coated paints, conversion-coated and anodized aluminum, EIFS, brick, terra-cotta, ceramic and porcelain materials, concrete and natural stones. Some finishes or substrates may require a primer.
- **±50% Movement Capacity** - can accommodate 50% movement in both extension and compression and has excellent recovery after cycling.
- **High Performance Properties** - SilPruf's combination of high tensile strength, high tear strength and the capacity to absorb high deformations (elongation) make this product an outstanding candidate for protective glazing designs and seismic applications.
- **Stable Consistency (uncured state)** - supplied as a lightweight paste, the consistency of which remains relatively unchanged over a wide temperature range. The paste is able to be easily gunned and tooled under hot and cold conditions.

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We are helping customers solve product, process, and performance problems; our silanes, fluids, elastomers, sealants, resins, adhesives, urethane additives, and other specialty products are delivering innovation in everything from car engines to biomedical

devices. From helping to develop safer tires and keeping electronics cooler, to improving the feel of lipstick and ensuring the reliability of adhesives, our technologies and enabling solutions are at the frontline of innovation.



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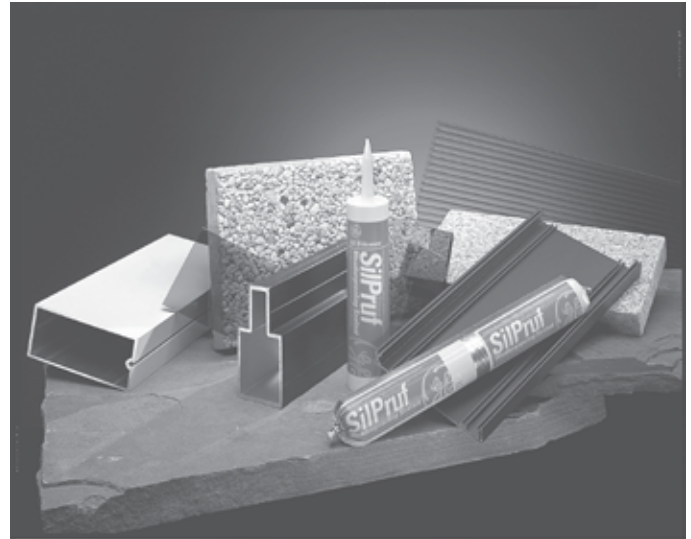
# SilPruf\* SCS2000 silicone sealant & adhesive

## Typical Performance Properties (continued)

- **Thermal Stability (cured state)** - once cured, the material remains elastic over a range of -55°F (-48°C) to 300°F (149°C) and up to 400°F (204°C) under intermittent short-term exposure.
- **Extended Work Life** - designed to allow the user sufficient time for placement and tooling.
- **Low Sag or Slump** - useful for application to horizontal, vertical or overhead surfaces.
- **Low VOC** - significantly lower than the requirements of the U.S. Green Building Council's Leadership in Energy and Environmental Design (L.E.E.D.) program.
- **Product Versatility** - full adhesive and chemical compatibility with GE sealants' silicone elastomeric coating (SilShield\* SEC2400) and silicone pre-cured weatherstrip (UltraSpan\* US1100).
- Compatible with these GE sealants insulating glass products: IGS3703, IGS3713-D1, IGS3729, IGS3723, IGS3733, IGS3743.
- Compatible with these GE sealants weatherproofing product lines: SCS2700, SCS9000, SCS2800, US1100, SEC2400.
- Compatible with these GE sealants structural products SSG4000, SSG4000AC, SSG4800J, SSG4400.
- Neutral cure byproduct with low odor.

## Basic Uses

- SilPruf SCS2000 sealant & adhesive is useful as a weather-proofing material when sealing between dissimilar or similar materials in either new or remedial glazing and sealing applications.
- SilPruf SCS2000 sealant & adhesive is useful as a weather-proofing sealant at window perimeters and punched openings.
- SilPruf SCS2000 sealant & adhesive is useful as a structural glazing adhesive (project review required).
- SilPruf SCS2000 sealant & adhesive has been successfully tested in protective glazing designs and may be considered a candidate for such applications.
- SilPruf SCS2000 sealant & adhesive is useful as an adhesive in panel stiffener applications.
- SilPruf SCS2000 sealant & adhesive is useful for adhering GE UltraSpan US1100 pre-cured silicone weatherstrip product line.



## Packaging

SilPruf SCS2000 sealant & adhesive is available in 10.1 fl. oz. (299 ml) plastic caulking cartridges, 20 fl. oz. (591.5 mL) foil sausage packs, 2 gallon plastic pails (2 gals. / 7.6 L) and 5 gallon plastic pails (5 gals. / 18.9 L). Plastic cartridges are packaged as 24 units in cardboard boxes and are dispensed using a single component hand or air-pressured caulking gun. Cartridges and pails are designed for convenience in shipping and are easily handled by warehouse workers and mechanics on scaffolds and staging. Sausage packs are designed to reduce volume of used containers compared to conventional sealant cartridges, thereby reducing solid waste. The use of sausage packs also boosts productivity by cutting typical reloading time in half.

## Colors

SilPruf SCS2000 sealant & adhesive is available in 8 standard colors, 6 special colors, and can be custom colored.

Grade	Color
SCS2002.....	White
SCS2003.....	Black
SCS2004 .....	Limestone
SCS2008.....	Light Grey
SCS2009 .....	Aluminum Grey
SCS2010.....	Dark Grey
SCS2020.....	Precast White
SCS2097 .....	Bronze
SCS2040 .....	Earth Tone
SCS2041 .....	Red Brick
SCS2046 .....	Champagne
SCS2006 .....	Antique Pink
SCS2100.0322 .....	Blue Spruce
SCS2100.0148 .....	Sandy Beige

## SilPruf\* SCS2000 silicone sealant & adhesive

### Specifications

Typical property values of SilPruf SCS2000 sealant & adhesive as supplied and cured are set forth in the tables below. Typical product data values should not be used as specifications. Assistance with specifications is available by contacting Momentive Performance Materials<sup>1</sup> at 1-800-255-8886.

### Typical Properties – Supplied

Property	Value <sup>(1)</sup>	Test Method
Consistency	Paste	
Polymer	100% silicone	
VOC	20 g/l	WPSTM C1454
Work Life (tooling time)	20-30 minutes	
Tack Free Time	3-4 hours (@ 72°F, 50% RH)	ASTM C679
Sag/Slump	0.1" max.	ASTM D2202

### Typical Properties – Cured

Property	Value <sup>(1)</sup>	Test Method
Hardness, Durometer (Type A Indentor)	24	ASTM D2240
Ultimate Tensile Strength	341 psi (2.35 MPa)	ASTM D412
Ultimate Elongation	715%	ASTM D412
Tensile at 50% Elongation	47.0 psi (0.32 MPa)	ASTM C1184
Tensile at 100% Elongation	73.2 psi (0.50 MPa)	ASTM C1184
Ultimate Tensile Strength	140.5 psi (0.97 MPa)	ASTM C1135
Ultimate Elongation	353%	ASTM C1135
Tear Strength; die B	76.8 ppi	ASTM D624
Shear Strength (@ 1/4" thickness)	121.4 psi (0.84 Mpa)	ASTM C961
Peel Strength (average) (21-day cure @ 75°F (21°C) 50% RH)	56.6 pli	ASTM C794
Joint Movement Capability	±50%	ASTM C719
Service Temperature Range (after cure)	-55°F to +250°F (-48°C to 121°C)	
Fire Endurance	2 hours (with backer)	UL723, ASTM E814
Weathering and U.V. Resistance	Excellent	GE 20 yr. study
Cure Time (1/4" or 6 mm deep section) @ 75°F (24°C) 50% RH	3-4 days	
Full Cure (most common bead sizes)	10-14 days	

(1) Average value. Actual value may vary.

## Revision Log

Rev. #	Date	Page(s)	Section #	Revision(s)
0	3/2/2011	N/A	N/A	Original Report Issued.
1	3/28/2012	Cover, 1, and 10	1.0, 2.0, 3.0 and 14.0	Changed all occurrences of "Bekaert Specialty Films, LLC" to "Solar Gard <sup>®</sup> ". Changed Applicant to Saint-Grobain Performance Plastics.