GLOBAL EXTERIOR SAFETY & SECURITY WINDOW FILM

8 MIL CLEAR EXTERIOR

EXTERIOR-APPLIED HEAVY-DUTY OPTICALLY CLEAR SAFETY FILM

8 MIL FILM THICKNESS | EXTERIOR APPLICATION | EN 12600 CLASS 2(B)2

Global 8 Mil Clear Exterior is a heavy-duty, optically clear 8 mil safety and security window film formulated for application to the outside surface of the glass. Its high-impact, micro-layered polyester construction holds shattered glass fragments firmly in place on impact — independently tested by TÜV Rheinland to **EN 12600 Class 2(B)2** — while leaving the appearance of the glazing virtually unchanged: 87% visible light transmittance, neutral 9% reflectance and less than 1% ultraviolet transmittance. A UV-stable, scratch-resistant hard coat protects the film against weathering and routine exterior cleaning, making it the practical choice for skylights, atriums, curtain walls and high-risk glazing where interior access to the glass is restricted.

Key Features & Benefits

- **Heavy-Duty Glass Retention** — 8 mil micro-layered polyester holds shattered glass together on impact, giving twice the thickness and break load of 4 mil film.
- **Certified Impact Performance** — Tested by TÜV Rheinland to EN 12600 (pendulum impact), classified 2(B)2 on both film and glass side.
- **Exterior Application** — Installed on the outer glass surface, ideal where scaffolding, occupancy or fixed glazing rules out interior fitting.
- **Optically Clear** — 87% visible light transmittance preserves natural daylight, views and the original look of the facade.
- **UV Protection** — Blocks more than 99% of ultraviolet radiation, protecting interiors, furnishings and merchandise from fading.
- **Weather and Abrasion Resistant** — UV-stable scratch-resistant hard coat withstands sun, rain, dust and routine exterior cleaning.

Applications

- Skylights, atrium glazing and canopies
- Curtain walls, facades and fixed glazing
- Ground-floor shopfronts, entrances and glass doors
- Banks, jewellery stores and high-value retail
- Government, educational and healthcare facilities
- Occupied buildings where interior access is restricted

Warranty

- Up to 5 years (exterior applications)
- Up to 10 years (interior applications)
- Covers bubbling, peeling, delamination, cracking and adhesive failure under normal use
- 8 mil optically clear polyester, UV-stable scratch-resistant hard coat for glass safety retention
- Applies to material supplied by Global Hi-Tech Films and installed per the application manual

Product Performance Details

OPTICAL PROPERTIES	VALUE
Thickness (mil)	8.0
Visible Light Transmittance (%)	87
Visible Light Reflectance – Ext (%)	9
Visible Light Reflectance – Int (%)	9
Ultraviolet Transmittance (%)	<1
Glare Reduction (%)	1

SOLAR & THERMAL PERFORMANCE	VALUE
Total Solar Energy Rejected (%)	18
Solar Heat Gain Coefficient	0.82
Shading Coefficient	0.94
Luminous Efficacy	1.06
U-Value (W/m^2K)	1.08
UV Rejection (%)	>99

Performance data tested to ASHRAE, ASTM, BS EN 410 and AIMCAL standards. All values as applied to 1/4 inch (6 mm) single-pane clear glass. Results are representative of actual production and may vary from batch to batch. Highlighted columns denote performance with 8 Mil Clear Exterior applied.

Product Construction

- 8 mil (approx. 200 micron) micro-layered optically clear polyester
- Pressure-sensitive adhesive system
- UV-stable, scratch-resistant hard coat
- Clear, untinted appearance — no change to glass colour

Installation & Handling

- Applied to the exterior surface of the glass
- Wet application method; clean, dust-free conditions
- Allow the film to cure fully before cleaning
- Edge sealing / attachment system where specified

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8 MIL CLEAR EXTERIOR · TECHNICAL DATA SHEET

Mechanical Properties

PROPERTY	UNIT	NOMINAL VALUE
Tensile Strength at Break (MD)	Kg/cm^2	3600
Tensile Strength at Break (MD)	PSI	51,200
Break Load (MD)	Kg/cm	38
Elongation at Break (MD)	%	260
Peel Strength (After Curing)	Grams/inch	5000
Abrasion Resistance	100 cycles, haze addition	<10%

MD = machine direction. Mechanical values are nominal and representative of actual production; they may vary from batch to batch.

Performance on Common Glass Types

PROPERTY	SINGLE PANE CLEAR 6 mm		SINGLE PANE TINTED 6 mm		DUAL PANE CLEAR 6 mm		DUAL PANE TINTED 6 mm	
	Glass	+ 8 Mil	Glass	+ 8 Mil	Glass	+ 8 Mil	Glass	+ 8 Mil
Solar Heat Gain Coefficient	0.82	0.82	0.67	0.63	0.70	0.73	0.55	0.64
Visible Light Transmitted (%)	88	87	55	54	79	77	49	47
Visible Light Reflected – Int (%)	8	9	7	7	15	14	11	12
Visible Light Reflected – Ext (%)	8	9	6	8	15	14	8	8
U-Value	1.03	1.08	1.03	1.03	0.47	0.47	0.47	0.47
UV Blocking (%)	43	>99	NA	>99	NA	>99	NA	>99
Total Solar Energy Rejected (%)	18	18	33	37	30	27	45	36
Glare Reduction (%)	NA	1	NA	4	NA	3	NA	8

Highlighted columns denote performance with 8 Mil Clear film applied. Dual pane values based on 1/4 inch (6 mm) glass both panes.

Independent Test Certification

TEST STANDARD	TEST ITEM	LABORATORY	RESULT
EN 12600:2002 — Pendulum impact test & classification for flat glass	4 mm glass + 8 mil Safety Film	TÜV Rheinland Nederland B.V. (NoBo 0336) Reports 89224672-21 / -22 / -23	**PASS — Class 2(B)2** film side & glass side

Warranty Coverage

Warranty period from date of installation:

- Up to 5 years — exterior applications
- Up to 10 years — interior applications
- Covers bubbling, blistering, delamination, cracking, crazing, peeling and edge lift
- Covers adhesive failure under normal use

Conditions and exclusions:

- Film must be supplied by Global Hi-Tech Films and installed per the application manual
- Excludes mechanical damage, misuse, abrasive cleaners, blades and unapproved solvents
- Excludes glass breakage, thermal stress fracture and pre-existing glazing defects

Care and Maintenance

- Allow the film to cure fully before the first cleaning
- Clean with a soft cloth and mild, non-abrasive soap solution
- Avoid abrasive pads, blades and strong solvents
- Rinse dust and grit off before wiping

87%	>99%	2(B)2	5 / 10 YR
VISIBLE LIGHT TRANSMITTANCE	UV RADIATION BLOCKED	EN 12600 IMPACT CLASSIFICATION	EXTERIOR / INTERIOR WARRANTY

Global 8 Mil Clear Exterior — a heavy-duty, optically clear 8 mil exterior-applied safety film: EN 12600 Class 2(B)2 glass fragment retention, >99% UV rejection and full daylight transmission, with a 5-year exterior and 10-year interior warranty.

Note

The values listed herein are nominal and provided for reference only, and may vary ± 5% under field conditions. Safety film improves glass fragment retention but does not make glazing unbreakable or bullet resistant. Exterior applications must be installed and, where specified, edge-sealed in accordance with the application manual. Before application, the user must determine the product's suitability for the intended use and assumes all associated risk and liability.

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Test Report – Products
Testrapport - Producten

Test report no.: *Testrapport nr.:*	**89224672-21**	**Order No.:** *Opdracht nr.:*	89224672 24.A160	
Client Reference No.: *Klantreferentie nr.:*	-	**Order date:** *Opdrachtdatum:*	2024-07-22	
Client: *Klant:*	Garware Hi Tech Films Limited Naigaon, P.O. Waluj, Aurangabad – 431 133, Maharashtra, India.			
Test item: *Testvoorwerp:*	4mm Glass + 8mil Safety Film			
Identification/ Type No.: *Benaming / Type nr.:*	4mm Glass + 8mil Safety Film			
Order content: *Inhoud opdracht:*	Samples for testing against EN 12600, as given in the standard			
Test specification: *Testomschrijving:*	EN 12600:2002[a] Impact test method and classification for flat glass *Laminated safety glass*			

Date of sample receipt: *Ontvangstdatum monster:*	2024-08-01
Test sample No: *Testproefstuk nr.:*	89224672-01/04
Testing period: *Testperiode:*	2024-11-26 - 2024-11-26
Place of testing: *Testlocatie:*	Arnhem, the Netherlands
Testing laboratory: *Testlaboratorium:*	TÜV Rheinland Nederland B.V. (NoBo 0336)
Test result*: *Testresultaat*:*	Pass



tested by: *getest door:*	X Ondertekend door: Salah El Bardai	**authorized by:** *geautoriseerd door:*	X Signed by: Sef Hovens
Date: 2025-01-21 *Datum:*		**Issue Date:** 2025-01-21 *Datum uitgave:*	
Position / *functie*:	Expert	**Position** / *functie*:	Expert

Others /
Andere:

Condition of the test item at delivery:
Toestand van het test voorwerp bij ontvangst: Test item complete and undamaged

* Legend:	P(ass) = passed a.m. test specification(s)	F(ail) = failed a.m. test specification(s)	N/A = not applicable	N/T = not tested
** Legenda:*	*P(ass) = voldoet aan test omschrijving*	*F(ail) = voldoet niet aan test omschrijving*	*N/A = niet van toepassing*	*N/T = niet getest*

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Dit testrapport heeft alleen betrekking op het voorgenoemde test voorwerp. Zonder toestemming van het testcentrum mag dit testrapport niet in delen worden vermenigvuldigd. Dit keuringsrapport geeft geen recht op het dragen van enig keurmerk.
V05

Test report no.: 89224672-21
Testrapport nr.:

Remarks
Opmerkingen

1	The equipment used during the specified testing period was calibrated according to our test laboratory calibration program. The equipment fulfils the requirements included in the relevant standards. The traceability of the test equipment used is ensured by compliance with the regulations of our management system. Detailed information regarding test conditions, equipment and measurement uncertainty is available in the test laboratory and could be provided on request. For the influence of the measuring uncertainties on the results, reference is made to the validation of the respective methods. *De apparatuur welke tijdens de gespecificeerde testperiode is gebruikt, is gekalibreerd volgens ons kalibratieprogramma. De apparatuur voldoet aan de eisen welke zijn opgenomen in de relevante normen. De traceerbaarheid van de gebruikte testapparatuurs is gewaarborgd door naleving van de voorschriften in ons kwaliteitsmanagementsysteem. Gedetailleerde informatie over testomstandigheden, apparatuur en meetonzekerheid is beschikbaar in het testlaboratorium en kan op verzoek worden verstrekt. Voor de invloed van de meetonzekerheden op de resultaten wordt verwezen naar de validatie van de respectievelijke methode c.q. verrichting*
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3	Test clauses with remark of * are subcontracted to qualified subcontractors and descripted under the respective test clause in the report. Tests clauses marked with [a] are performed under ISO 17025 accreditation. Deviations of testing specification(s), test locations or customer requirements are listed in specific test clause in the report. This report is only to be read is a whole. No opinions or interpretation are included in this report. This test report consists of multiple pages and is only to be read is a whole. The number of pages can be seen in the header on the top right of each page, the report ends when the last page is reached. TÜV Rheinland Nederland B.V. is solely responsible for the content. *Test onderdelen welke met * zijn gemarkeerd zijn uitbesteed aan gekwalificeerde onderaannemers en zijn beschreven in het respectievelijke test onderdeel van dit rapport. Test onderdelen welke met [a] zijn gemarkeerd zijn onder ISO 17025 accreditatie uitgevoerd. Afwijkingen van testspecificatie(s), testlocaties of klant eisen zijn vermeld in het van toepassing zijnde onderdeel in het rapport. Het rapport dient als geheel te worden gelezen. Er zijn geen opinies en interpretaties opgenomen binnen het rapport. Dit rapport bestaat uit meerdere pagina's en dient al geheel gelezen te worden. Het aantal pagina's is rechtsboven in de koptekst van dit rapport vermeld en eindigt wanneer de laatste pagina is bereikt. TÜV Rheinland Nederland is als enige verantwoordelijk voor de inhoud van het rapport.*
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Test report no.: 89224672-21
Testrapport nr.:

Product description
Product omschrijving

1	**Product details:** *Product details:*	Name of the manufacturer : Garware Hi Tech Films Limited Address of the manufacturer : Naigaon, P.O. Waluj, Aurangabad – 431 133, Maharashtra, India. Production plant of the samples : - Line ID where the samples are made : - Production date : - Sampling date : - The product was marked as : 4 mm Glass + 8mil Safety Film Kind of glass : Clear float glass Nominal thickness : 4.1 mm Composition : 4 mm float + 8mil Safety Film Intermediate layer, name, type : 8 mil Safety Film
2	**Other:** *Andere:*	Test sample(s), as well sample information, description, product details and intended usage was provided by customer.
3	**Test sample obtaining:** *Selectie van het proefstuk:*	☒ Sending by customer ☐ Sampling by TÜV Rheinland Group ☐ others:

Product description
Product omschrijving

Picture 1. Sample 2 After impact	Picture 2. Sample 3 After impact
	

Test method
Test methode

EN 12600:2002[a]	**Impact test method and classification for flat glass**	
Scope:	EN 12600 specifies a pendulum impact test method for single flat glass for use in buildings. The test is intended to classify flat glass products in three principal classes by performance under impact and by mode of breakage. The standard does not specify requirements for applications, nor does it specify requirements for durability.	
Test requirements of clause 4 :	When tested by the method given in clause 5 of the standard, each test piece shall either not break or shall break as defined in one of the following ways : a) Numerous cracks appear, but no shear or opening is allowed within the test piece through which a 76mm diameter sphere can pass when a maximum force of 25 N is applied. Additionally, if particles are detached from the test piece up to 3 minutes after impact, they shall - in total – weigh no more than a mass equivalent to 10.000 mm² of the original test piece. The largest single particle shall weigh less than the mass equivalent to 4.400 mm² of the original test piece; b) Disintegration occurs and the 10 largest crack-free particles collected within 3 minutes after impact and weighed, all together, within 5 minutes of impact shall weigh no more than the mass equivalent to 6.500 mm² of the original test piece. The particles shall be selected only from the portion of the original test piece exposed in the test frame. Only the exposed area of any particle retained in the test frame shall be taken into account in determining the mass equivalent.	Applicable clause : (a) ☒ (b) ☐
Test method:	The test temperature shall be (20 ± 5) °C. **Clause 5.** Each test piece shall comprise a single pane of glass product and be representative of the normal production of the type of product submitted for test. Results obtained with test pieces of dimensions (876 ± 2) x (1938 ± 2) mm are valid for classification purposes of the glass product, whatever the service dimensions. The test shall be carried out at each drop height on four pieces of identical structure and the same nominal thickness. In case of symmetrical samples, the classification obtained can be used for both sides of the product. For asymmetrical samples, the classification obtained, are intended solely for installation in situations where the risk of impact is from one side only. Inspect the test piece after impact and note whether ; - It remains unbroken; or - It broke in accordance with either the requirements a) or b) of clause 4; or - It broke and failed to conform to the requirements of clause 4. If any of the initial four test pieces fails to conform to the requirements of clause 4, the procedure is terminated. If all four test pieces either do not break or else break according to the criteria given in clause 4, and it is required to test the material to a higher impact level, increase the drop height to the next impact level. Repeat the test on four more samples of the same material (If the material remained unbroken, the same sample(s) may be used.)	

Test method
Test methode

	Impact levels	
	Classification	Drop height (mm)
	3	190
	2	450
	1	1200
Measuring uncertainty:	Caused by the destructive nature of the test and pass/fail result no measurement uncertainty can be determined. Based on the validation of the test procedure, measurement set-up and the associated parts (test frame / drop height, etc.) there is a presumption of conformity established which is approved with ISO 17025 accreditation.	
Sphere penetration test :	The probe assembly shall consist of a sphere of diameter (76 ± 1) mm connected to an arm with a device for measuring when a maximum force of 25 N has been applied. The probe assembly shall be held horizontal. It shall then be pushed in any opening formed in the test piece. The weakest point of resistance shall be selected. A horizontal force shall be applied until : - A maximum force of 25 N has been achieved without penetration by the sphere. The test piece shall be deemed to have passed the test; or - The maximum diameter of the sphere has passed through the plan of the test piece without a force of 25 N being achieved. The test piece shall be deemed to have failed the test.	
Classification :	**General** Glazing conforming to this European standard is classified as follows : - Its performance under the impact test; - The drop height at which breakage occurred; - The drop height at which the product passed in accordance with a) of clause 4; - The drop height at which the product passed in accordance with b) of clause 4; - The mode of breakage of the material if it remains unbroken after the impact test.	
	Drop height class Glazing shall be classified as follows : - Class 3: material that conforms the requirements of clause 4 when tested by the method given in clause 5 at a drop height of 190 mm; - Class 2: material that conforms the requirements of clause 4 when tested by the method given in clause 5 at a drop height of 190 mm and 450 mm; - Class 1: material that conforms the requirements of clause 4 when tested by the method given in clause 5 at a drop height of 190 mm 450 mm and 1200 mm.	

Test method
Test methode

Mode of breakage

If all test pieces remain unbroken at the drop height appropriate to its intended drop height class, the mode of breakage shall be determined as per Annex C of this standard. The mode of breakage shall be described as follows :

- Type A : numerous cracks appear forming separate fragments with sharp edges, some of which are large (typical of annealed glass);
- Type B : numerous cracks appear, but the fragments hold together and do not separate (typical of laminated glass);
- Type C : disintegration occurs, leading to a large number of small particles that are relatively harmless (typical of toughened glass).

Performance classification

The performance classification of a glass product shall be given as follows :

α (β) ϕ , where

- α : is the highest drop height class at which the product either did not break or broke in accordance with a) or b) of clause 4;
- β : is the mode of breakage;
- ϕ : is the highest drop height class at which the product either did not break or when broke, broke in accordance with a) clause.

When a glass product breaks at a drop height of 190 mm and the breakage is not in accordance with a) of clause 4 then the value of ϕ quoted shall be zero.

Test results
Test resultaten

Expression of test results				
Performance under impact test	**Composition (from the attack side) : 4mm Glass + 8mil Safety Film**			
	Sample number			
	89224672 #1	89224672 #2	89224672 #3	89224672 #4
Asymmetrical yes/no	Yes			
Attack face?	Glass side			
Dimensions	876 x 1938 mm			
Nominal thickness	4.1 mm			
Tyre pressure (0,35 ± 0,02) MPa ? yes/no	yes			
In case of applied films, film clamped in frame ? yes/no	n.a.			
Behaviour at each drop height	- did the test piece broke or not - if broken, the mode of breakage - was it broken in accordance with clause 4, a) or b)			
Class 2 (drop height 450mm)	No Breakage	Breakage, A / **B** / C Clause a)	Breakage, A / **B** / C Clause a)	No Breakage

Based on EN 12600:2002 [a], Clause 6

Glazing conforming to this European Standard is classified by the performance of four consecutive samples under impact.

Trade name	**: 4mm Glass + 8mil Safety Film**	Pass ☒
Composition	**: 4mm Glass + 8mil Safety Film**	Fail ☐
Classification EN 12600	**: 2 (B) 2 Glass side**	Not applicable ☐

Remarks

The test results exclusively relate to the tested objects.

When and if changes are made in production method and/or equipment, assessment according to this standard shall be reconsidered and re-tests shall be performed when the changes can lead to different specifications of the glass. The decision and responsibility lies at the manufacturer.

If no reference of the product description was supplied by the manufacturer, than that document shall be added to this test report by the manufacturer. It was to the manufacturer's responsibility that the samples delivered for initial type test are representative to the production and deviations from perfection were included in the delivered test samples.

- End of report -

Test Report – Products
Testrapport - Producten

Test report no.: *Testrapport nr.:*	**89224672-22**	**Order No.:** *Opdracht nr.:*	89224672 24.A160	
Client Reference No.: *Klantreferentie nr.:*	-	**Order date:** *Opdrachtdatum:*	2024-07-22	
Client: *Klant:*	Garware Hi Tech Films Limited Naigaon, P.O. Waluj, Aurangabad – 431 133, Maharashtra, India.			
Test item: *Testvoorwerp:*	4mm Glass + 8mil Safety Film			
Identification/ Type No.: *Benaming / Type nr.:*	4mm Glass + 8mil Safety Film			
Order content: *Inhoud opdracht:*	Samples for testing against EN 12600, as given in the standard			
Test specification: *Testomschrijving:*	EN 12600:2002[a] Impact test method and classification for flat glass *Laminated safety glass*			

Date of sample receipt: *Ontvangstdatum monster:*	2024-08-01
Test sample No: *Testproefstuk nr.:*	89224672-01/04
Testing period: *Testperiode:*	2024-11-26 - 2024-11-26
Place of testing: *Testlocatie:*	Arnhem, the Netherlands
Testing laboratory: *Testlaboratorium:*	TÜV Rheinland Nederland B.V. (NoBo 0336)
Test result*: *Testresultaat*:*	Pass



tested by: *getest door:* **Date:** 2025-01-21 *Datum:*	X Ondertekend door: Salah El Bardai	**authorized by:** *geautoriseerd door:* **Issue Date:** 2025-01-21 *Datum uitgave:*	X Signed by: Sef Hovens
Position / *functie*:	Expert	**Position** / *functie*:	Expert

Others /
Andere:

Condition of the test item at delivery:
Toestand van het test voorwerp bij ontvangst: Test item complete and undamaged

* Legend:	P(ass) = passed a.m. test specification(s)	F(ail) = failed a.m. test specification(s)	N/A = not applicable	N/T = not tested
** Legenda:*	*P(ass) = voldoet aan test omschrijving*	*F(ail) = voldoet niet aan test omschrijving*	*N/A = niet van toepassing*	*N/T = niet getest*

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V05

Test report no.: 89224672-22
Testrapport nr.:

Remarks
Opmerkingen

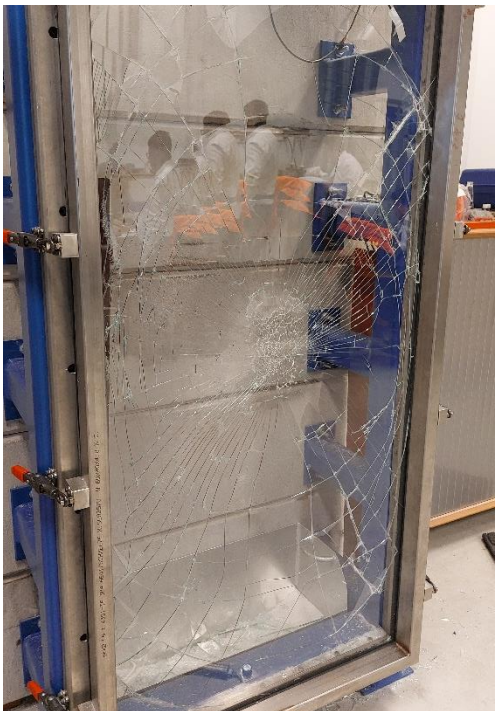
1	The equipment used during the specified testing period was calibrated according to our test laboratory calibration program. The equipment fulfils the requirements included in the relevant standards. The traceability of the test equipment used is ensured by compliance with the regulations of our management system. Detailed information regarding test conditions, equipment and measurement uncertainty is available in the test laboratory and could be provided on request. For the influence of the measuring uncertainties on the results, reference is made to the validation of the respective methods. *De apparatuur welke tijdens de gespecificeerde testperiode is gebruikt, is gekalibreerd volgens ons kalibratieprogramma. De apparatuur voldoet aan de eisen welke zijn opgenomen in de relevante normen. De traceerbaarheid van de gebruikte testapparatuurs is gewaarborgd door naleving van de voorschriften in ons kwaliteitsmanagementsysteem. Gedetailleerde informatie over testomstandigheden, apparatuur en meetonzekerheid is beschikbaar in het testlaboratorium en kan op verzoek worden verstrekt. Voor de invloed van de meetonzekerheden op de resultaten wordt verwezen naar de validatie van de respectievelijke methode c.q. verrichting*
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3	Test clauses with remark of * are subcontracted to qualified subcontractors and descripted under the respective test clause in the report. Tests clauses marked with [a] are performed under ISO 17025 accreditation. Deviations of testing specification(s), test locations or customer requirements are listed in specific test clause in the report. This report is only to be read is a whole. No opinions or interpretation are included in this report. This test report consists of multiple pages and is only to be read is a whole. The number of pages can be seen in the header on the top right of each page, the report ends when the last page is reached. TÜV Rheinland Nederland B.V. is solely responsible for the content. *Test onderdelen welke met * zijn gemarkeerd zijn uitbesteed aan gekwalificeerde onderaannemers en zijn beschreven in het respectievelijke test onderdeel van dit rapport. Test onderdelen welke met [a] zijn gemarkeerd zijn onder ISO 17025 accreditatie uitgevoerd. Afwijkingen van testspecificatie(s), testlocaties of klant eisen zijn vermeld in het van toepassing zijnde onderdeel in het rapport. Het rapport dient als geheel te worden gelezen. Er zijn geen opinies en interpretaties opgenomen binnen het rapport. Dit rapport bestaat uit meerdere pagina's en dient al geheel gelezen te worden. Het aantal pagina's is rechtsboven in de koptekst van dit rapport vermeld en eindigt wanneer de laatste pagina is bereikt. TÜV Rheinland Nederland is als enige verantwoordelijk voor de inhoud van het rapport.*
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Test report no.: 89224672-22
Testrapport nr.:

Product description
Product omschrijving

1	**Product details:** *Product details:*	Name of the manufacturer : Garware Hi Tech Films Limited Address of the manufacturer : Naigaon, P.O. Waluj, Aurangabad – 431 133, Maharashtra, India. Production plant of the samples : - Line ID where the samples are made : - Production date : - Sampling date : - The product was marked as : 4 mm Glass + 8mil Safety Film Kind of glass : Clear float glass Nominal thickness : 4 mm Composition : 4 mm float + 8mil Safety Film Intermediate layer, name, type : 8 mil Safety Film
2	**Other:** *Andere:*	Test sample(s), as well sample information, description, product details and intended usage was provided by customer.
3	**Test sample obtaining:** *Selectie van het proefstuk:*	☒ Sending by customer ☐ Sampling by TÜV Rheinland Group ☐ others:

Product description
Product omschrijving

Picture 1. Sample 1 After impact	Picture 2. Sample 2 After impact
	
Picture 1. Sample 3 After impact	**Picture 2. Sample 4 After impact**
	

Test method
Test methode

EN 12600:2002[a]	**Impact test method and classification for flat glass**	
Scope:	EN 12600 specifies a pendulum impact test method for single flat glass for use in buildings. The test is intended to classify flat glass products in three principal classes by performance under impact and by mode of breakage. The standard does not specify requirements for applications, nor does it specify requirements for durability.	
Test requirements of clause 4 :	When tested by the method given in clause 5 of the standard, each test piece shall either not break or shall break as defined in one of the following ways : a) Numerous cracks appear, but no shear or opening is allowed within the test piece through which a 76mm diameter sphere can pass when a maximum force of 25 N is applied. Additionally, if particles are detached from the test piece up to 3 minutes after impact, they shall - in total – weigh no more than a mass equivalent to 10.000 mm² of the original test piece. The largest single particle shall weigh less than the mass equivalent to 4.400 mm² of the original test piece; b) Disintegration occurs and the 10 largest crack-free particles collected within 3 minutes after impact and weighed, all together, within 5 minutes of impact shall weigh no more than the mass equivalent to 6.500 mm² of the original test piece. The particles shall be selected only from the portion of the original test piece exposed in the test frame. Only the exposed area of any particle retained in the test frame shall be taken into account in determining the mass equivalent.	Applicable clause : (a) ☒ (b) ☐
Test method:	The test temperature shall be (20 ± 5) °C. **Clause 5.** Each test piece shall comprise a single pane of glass product and be representative of the normal production of the type of product submitted for test. Results obtained with test pieces of dimensions (876 ± 2) x (1938 ± 2) mm are valid for classification purposes of the glass product, whatever the service dimensions. The test shall be carried out at each drop height on four pieces of identical structure and the same nominal thickness. In case of symmetrical samples, the classification obtained can be used for both sides of the product. For asymmetrical samples, the classification obtained, are intended solely for installation in situations where the risk of impact is from one side only. Inspect the test piece after impact and note whether ; - It remains unbroken; or - It broke in accordance with either the requirements a) or b) of clause 4; or - It broke and failed to conform to the requirements of clause 4. If any of the initial four test pieces fails to conform to the requirements of clause 4, the procedure is terminated. If all four test pieces either do not break or else break according to the criteria given in clause 4, and it is required to test the material to a higher impact level, increase the drop height to the next impact level. Repeat the test on four more samples of the same material (If the material remained unbroken, the same sample(s) may be used.)	

Test method
Test methode

	Impact levels	
	Classification	Drop height (mm)
	3	190
	2	450
	1	1200
Measuring uncertainty:	Caused by the destructive nature of the test and pass/fail result no measurement uncertainty can be determined. Based on the validation of the test procedure, measurement set-up and the associated parts (test frame / drop height, etc.) there is a presumption of conformity established which is approved with ISO 17025 accreditation.	
Sphere penetration test :	The probe assembly shall consist of a sphere of diameter (76 ± 1) mm connected to an arm with a device for measuring when a maximum force of 25 N has been applied. The probe assembly shall be held horizontal. It shall then be pushed in any opening formed in the test piece. The weakest point of resistance shall be selected. A horizontal force shall be applied until : - A maximum force of 25 N has been achieved without penetration by the sphere. The test piece shall be deemed to have passed the test; or - The maximum diameter of the sphere has passed through the plan of the test piece without a force of 25 N being achieved. The test piece shall be deemed to have failed the test.	
Classification :	**General** Glazing conforming to this European standard is classified as follows : - Its performance under the impact test; - The drop height at which breakage occurred; - The drop height at which the product passed in accordance with a) of clause 4; - The drop height at which the product passed in accordance with b) of clause 4; - The mode of breakage of the material if it remains unbroken after the impact test.	
	Drop height class Glazing shall be classified as follows : - Class 3: material that conforms the requirements of clause 4 when tested by the method given in clause 5 at a drop height of 190 mm; - Class 2: material that conforms the requirements of clause 4 when tested by the method given in clause 5 at a drop height of 190 mm and 450 mm; - Class 1: material that conforms the requirements of clause 4 when tested by the method given in clause 5 at a drop height of 190 mm 450 mm and 1200 mm.	

Test method
Test methode

Mode of breakage

If all test pieces remain unbroken at the drop height appropriate to its intended drop height class, the mode of breakage shall be determined as per Annex C of this standard. The mode of breakage shall be described as follows :

- Type A : numerous cracks appear forming separate fragments with sharp edges, some of which are large (typical of annealed glass);
- Type B : numerous cracks appear, but the fragments hold together and do not separate (typical of laminated glass);
- Type C : disintegration occurs, leading to a large number of small particles that are relatively harmless (typical of toughened glass).

Performance classification

The performance classification of a glass product shall be given as follows :

α (β) ϕ , where

- α : is the highest drop height class at which the product either did not break or broke in accordance with a) or b) of clause 4;
- β : is the mode of breakage;
- ϕ : is the highest drop height class at which the product either did not break or when broke, broke in accordance with a) clause.

When a glass product breaks at a drop height of 190 mm and the breakage is not in accordance with a) of clause 4 then the value of ϕ quoted shall be zero.

Test results
Test resultaten

Expression of test results				
Performance under impact test	**Composition (from the attack side) : 8mil Safety + Film4mm Glass**			
	Sample number			
	89224672 #1	89224672 #2	89224672 #3	89224672 #4
Asymmetrical yes/no	Yes			
Attack face?	Foil side			
Dimensions	876 x 1938 mm			
Nominal thickness	4 mm			
Tyre pressure (0,35 ± 0,02) MPa ? yes/no	yes			
In case of applied films, film clamped in frame ? yes/no	n.a.			
Behaviour at each drop height	- did the test piece broke or not - if broken, the mode of breakage - was it broken in accordance with clause 4, a) or b)			
Class 2 (drop height 450mm)	Breakage, A / **B** / C Clause a)	Breakage, A / **B** / C Clause a)	Breakage, A / **B** / C Clause a)	Breakage, A / **B** / C Clause a)

	Based on EN 12600:2002 [a], Clause 6	
	Glazing conforming to this European Standard is classified by the performance of four consecutive samples under impact.	
	Trade name : 4mm Glass + 8mil Safety Film **Composition : 8mil Safety + Film 4mm Glass** **Classification EN 12600 : 2 (B) 2 Foil side**	Pass ☒ Fail ☐ Not applicable ☐
Remarks	**The test results exclusively relate to the tested objects.**	
	When and if changes are made in production method and/or equipment, assessment according to this standard shall be reconsidered and re-tests shall be performed when the changes can lead to different specifications of the glass. The decision and responsibility lies at the manufacturer.	
	If no reference of the product description was supplied by the manufacturer, than that document shall be added to this test report by the manufacturer. It was to the manufacturer's responsibility that the samples delivered for initial type test are representative to the production and deviations from perfection were included in the delivered test samples.	

- End of report -

Test Report – Products
Testrapport - Producten

Test report no.: *Testrapport nr.:*	**89224672-23**	**Order No.:** *Opdracht nr.:*	89224672 24.A160	
Client Reference No.: *Klantreferentie nr.:*	-	**Order date:** *Opdrachtdatum:*	2024-07-22	
Client: *Klant:*	Garware Hi Tech Films Limited Naigaon, P.O. Waluj, Aurangabad – 431 133, Maharashtra, India.			
Test item: *Testvoorwerp:*	4mm Glass + 8mil Solar Safety Film			
Identification/ Type No.: *Benaming / Type nr.:*	4mm Glass + 8mil Solar Safety Film			
Order content: *Inhoud opdracht:*	Samples for testing against EN 12600, as given in the standard			
Test specification: *Testomschrijving:*	EN 12600:2002[a] Impact test method and classification for flat glass *Laminated safety glass*			

Date of sample receipt: *Ontvangstdatum monster:*	2024-08-01
Test sample No: *Testproefstuk nr.:*	89224672-01/04
Testing period: *Testperiode:*	2024-11-26 - 2024-11-26
Place of testing: *Testlocatie:*	Arnhem, the Netherlands
Testing laboratory: *Testlaboratorium:*	TÜV Rheinland Nederland B.V. (NoBo 0336)
Test result*: *Testresultaat*:*	Pass



tested by: *getest door:*	X Ondertekend door: Salah El Bardai	**authorized by:** *geautoriseerd door:*	X Signed by: Sef Hovens
Date: 2025-01-21 *Datum:*		**Issue Date:** 2025-01-21 *Datum uitgave:*	
Position / *functie*:	Expert	**Position** / *functie*:	Expert

Others /
Andere:

Condition of the test item at delivery:
Toestand van het test voorwerp bij ontvangst: Test item complete and undamaged

* Legend:	P(ass) = passed a.m. test specification(s)	F(ail) = failed a.m. test specification(s)	N/A = not applicable	N/T = not tested
** Legenda:*	*P(ass) = voldoet aan test omschrijving*	*F(ail) = voldoet niet aan test omschrijving*	*N/A = niet van toepassing*	*N/T = niet getest*

This test report only relates to the a. m. test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any test mark.
Dit testrapport heeft alleen betrekking op het voorgenoemde test voorwerp. Zonder toestemming van het testcentrum mag dit testrapport niet in delen worden vermenigvuldigd. Dit keuringsrapport geeft geen recht op het dragen van enig keurmerk.
VU5

Test report no.: 89224672-23
Testrapport nr.:

Remarks
Opmerkingen

1	The equipment used during the specified testing period was calibrated according to our test laboratory calibration program. The equipment fulfils the requirements included in the relevant standards. The traceability of the test equipment used is ensured by compliance with the regulations of our management system. Detailed information regarding test conditions, equipment and measurement uncertainty is available in the test laboratory and could be provided on request. For the influence of the measuring uncertainties on the results, reference is made to the validation of the respective methods. *De apparatuur welke tijdens de gespecificeerde testperiode is gebruikt, is gekalibreerd volgens ons kalibratieprogramma. De apparatuur voldoet aan de eisen welke zijn opgenomen in de relevante normen. De traceerbaarheid van de gebruikte testapparatuurs is gewaarborgd door naleving van de voorschriften in ons kwaliteitsmanagementsysteem. Gedetailleerde informatie over testomstandigheden, apparatuur en meetonzekerheid is beschikbaar in het testlaboratorium en kan op verzoek worden verstrekt. Voor de invloed van de meetonzekerheden op de resultaten wordt verwezen naar de validatie van de respectievelijke methode c.q. verrichting*
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3	Test clauses with remark of * are subcontracted to qualified subcontractors and descripted under the respective test clause in the report. Tests clauses marked with [a] are performed under ISO 17025 accreditation. Deviations of testing specification(s), test locations or customer requirements are listed in specific test clause in the report. This report is only to be read is a whole. No opinions or interpretation are included in this report. This test report consists of multiple pages and is only to be read is a whole. The number of pages can be seen in the header on the top right of each page, the report ends when the last page is reached. TÜV Rheinland Nederland B.V. is solely responsible for the content. *Test onderdelen welke met * zijn gemarkeerd zijn uitbesteed aan gekwalificeerde onderaannemers en zijn beschreven in het respectievelijke test onderdeel van dit rapport. Test onderdelen welke met [a] zijn gemarkeerd zijn onder ISO 17025 accreditatie uitgevoerd. Afwijkingen van testspecificatie(s), testlocaties of klant eisen zijn vermeld in het van toepassing zijnde onderdeel in het rapport. Het rapport dient als geheel te worden gelezen. Er zijn geen opinies en interpretaties opgenomen binnen het rapport. Dit rapport bestaat uit meerdere pagina's en dient al geheel gelezen te worden. Het aantal pagina's is rechtsboven in de koptekst van dit rapport vermeld en eindigt wanneer de laatste pagina is bereikt. TÜV Rheinland Nederland is als enige verantwoordelijk voor de inhoud van het rapport.*
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Test report no.: 89224672-23
Testrapport nr.:

Product description
Product omschrijving

1	**Product details:** *Product details:*	Name of the manufacturer : Garware Hi Tech Films Limited Address of the manufacturer : Naigaon, P.O. Waluj, Aurangabad – 431 133, Maharashtra, India. Production plant of the samples : - Line ID where the samples are made : - Production date : - Sampling date : - The product was marked as : 4 mm Glass + 8mil Solar Safety Film Kind of glass : Clear float glass Nominal thickness : 4.1 mm Composition : 4 mm float + 8mil Solar Safety Film Intermediate layer, name, type : 8 mil Solar Safety Film
2	**Other:** *Andere:*	Test sample(s), as well sample information, description, product details and intended usage was provided by customer.
3	**Test sample obtaining:** *Selectie van het proefstuk:*	☒ Sending by customer ☐ Sampling by TÜV Rheinland Group ☐ others:

Product description
Product omschrijving

Picture 1. Sample 1 After impact	Picture 2. Sample 2 After impact
	
Picture 3. Sample 3 After impact	**Picture 4. Sample 4 After impact**
	

Test method
Test methode

EN 12600:2002[a]	**Impact test method and classification for flat glass**	
Scope:	EN 12600 specifies a pendulum impact test method for single flat glass for use in buildings. The test is intended to classify flat glass products in three principal classes by performance under impact and by mode of breakage. The standard does not specify requirements for applications, nor does it specify requirements for durability.	
Test requirements of clause 4 :	When tested by the method given in clause 5 of the standard, each test piece shall either not break or shall break as defined in one of the following ways : a) Numerous cracks appear, but no shear or opening is allowed within the test piece through which a 76mm diameter sphere can pass when a maximum force of 25 N is applied. Additionally, if particles are detached from the test piece up to 3 minutes after impact, they shall - in total – weigh no more than a mass equivalent to 10.000 mm² of the original test piece. The largest single particle shall weigh less than the mass equivalent to 4.400 mm² of the original test piece; b) Disintegration occurs and the 10 largest crack-free particles collected within 3 minutes after impact and weighed, all together, within 5 minutes of impact shall weigh no more than the mass equivalent to 6.500 mm² of the original test piece. The particles shall be selected only from the portion of the original test piece exposed in the test frame. Only the exposed area of any particle retained in the test frame shall be taken into account in determining the mass equivalent.	Applicable clause : (a) ☒ (b) ☐
Test method:	The test temperature shall be (20 ± 5) °C. **Clause 5.** Each test piece shall comprise a single pane of glass product and be representative of the normal production of the type of product submitted for test. Results obtained with test pieces of dimensions (876 ± 2) x (1938 ± 2) mm are valid for classification purposes of the glass product, whatever the service dimensions. The test shall be carried out at each drop height on four pieces of identical structure and the same nominal thickness. In case of symmetrical samples, the classification obtained can be used for both sides of the product. For asymmetrical samples, the classification obtained, are intended solely for installation in situations where the risk of impact is from one side only. Inspect the test piece after impact and note whether ; - It remains unbroken; or - It broke in accordance with either the requirements a) or b) of clause 4; or - It broke and failed to conform to the requirements of clause 4. If any of the initial four test pieces fails to conform to the requirements of clause 4, the procedure is terminated. If all four test pieces either do not break or else break according to the criteria given in clause 4, and it is required to test the material to a higher impact level, increase the drop height to the next impact level. Repeat the test on four more samples of the same material (If the material remained unbroken, the same sample(s) may be used.)	

Test method
Test methode

	Impact levels	
	Classification	Drop height (mm)
	3	190
	2	450
	1	1200

Measuring uncertainty:	Caused by the destructive nature of the test and pass/fail result no measurement uncertainty can be determined. Based on the validation of the test procedure, measurement set-up and the associated parts (test frame / drop height, etc.) there is a presumption of conformity established which is approved with ISO 17025 accreditation.
Sphere penetration test :	The probe assembly shall consist of a sphere of diameter (76 ± 1) mm connected to an arm with a device for measuring when a maximum force of 25 N has been applied. The probe assembly shall be held horizontal. It shall then be pushed in any opening formed in the test piece. The weakest point of resistance shall be selected. A horizontal force shall be applied until : - A maximum force of 25 N has been achieved without penetration by the sphere. The test piece shall be deemed to have passed the test; or - The maximum diameter of the sphere has passed through the plan of the test piece without a force of 25 N being achieved. The test piece shall be deemed to have failed the test.
Classification :	**General** Glazing conforming to this European standard is classified as follows : - Its performance under the impact test; - The drop height at which breakage occurred; - The drop height at which the product passed in accordance with a) of clause 4; - The drop height at which the product passed in accordance with b) of clause 4; - The mode of breakage of the material if it remains unbroken after the impact test.
	Drop height class Glazing shall be classified as follows : - Class 3: material that conforms the requirements of clause 4 when tested by the method given in clause 5 at a drop height of 190 mm; - Class 2: material that conforms the requirements of clause 4 when tested by the method given in clause 5 at a drop height of 190 mm and 450 mm; - Class 1: material that conforms the requirements of clause 4 when tested by the method given in clause 5 at a drop height of 190 mm 450 mm and 1200 mm.

Test method
Test methode

Mode of breakage

If all test pieces remain unbroken at the drop height appropriate to its intended drop height class, the mode of breakage shall be determined as per Annex C of this standard. The mode of breakage shall be described as follows :

- Type A : numerous cracks appear forming separate fragments with sharp edges, some of which are large (typical of annealed glass);
- Type B : numerous cracks appear, but the fragments hold together and do not separate (typical of laminated glass);
- Type C : disintegration occurs, leading to a large number of small particles that are relatively harmless (typical of toughened glass).

Performance classification

The performance classification of a glass product shall be given as follows :

α (β) ϕ , where

- α : is the highest drop height class at which the product either did not break or broke in accordance with a) or b) of clause 4;
- β : is the mode of breakage;
- ϕ : is the highest drop height class at which the product either did not break or when broke, broke in accordance with a) clause.

When a glass product breaks at a drop height of 190 mm and the breakage is not in accordance with a) of clause 4 then the value of ϕ quoted shall be zero.

Test results
Test resultaten

Expression of test results				
Performance under impact test	**Composition (from the attack side) : 4mm Glass + 8mil Solar Safety Film**			
	Sample number			
	89224672 #1	89224672 #2	89224672 #3	89224672 #4
Asymmetrical yes/no	Yes			
Attack face?	Glass side			
Dimensions	876 x 1938 mm			
Nominal thickness	4.1 mm			
Tyre pressure (0,35 ± 0,02) MPa ? yes/no	yes			
In case of applied films, film clamped in frame ? yes/no	n.a.			
Behaviour at each drop height	- did the test piece broke or not - if broken, the mode of breakage - was it broken in accordance with clause 4, a) or b)			
Class 2 (drop height 450mm)	No Breakage	Breakage, A / **B** / C Clause a)	Breakage, A / **B** / C Clause a)	Breakage, A / **B** / C Clause a)

Based on EN 12600:2002 [a], Clause 6

Glazing conforming to this European Standard is classified by the performance of four consecutive samples under impact.

Trade name	**: 4mm Glass + 8mil Solar Safety Film**	Pass ☒
Composition	**: 4mm Glass + 8mil Solar Safety Film**	Fail ☐
Classification EN 12600	**: 2 (B) 2 Glass side**	Not applicable ☐

Remarks

The test results exclusively relate to the tested objects.

When and if changes are made in production method and/or equipment, assessment according to this standard shall be reconsidered and re-tests shall be performed when the changes can lead to different specifications of the glass. The decision and responsibility lies at the manufacturer.

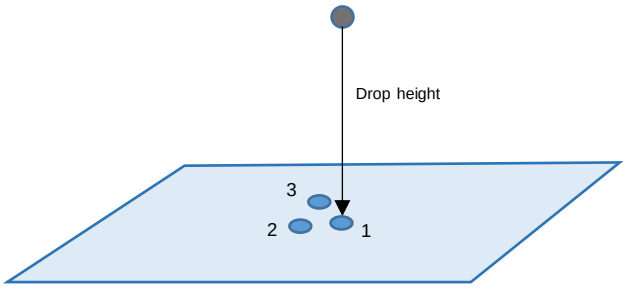
If no reference of the product description was supplied by the manufacturer, than that document shall be added to this test report by the manufacturer. It was to the manufacturer's responsibility that the samples delivered for initial type test are representative to the production and deviations from perfection were included in the delivered test samples.

- End of report -

Test Report – Products
Testrapport - Producten

Test report no.: *Testrapport nr.:*	**89224672-30**	**Order No.:** *Opdracht nr.:*	89224672 24.A160	
Client Reference No.: *Klantreferentie nr.:*	-	**Order date:** *Opdrachtdatum:*	2024-07-22	
Client: *Klant:*	Garware Hi Tech Films Limited Naigaon, P.O. Waluj, Aurangabad – 431 133, Maharashtra, India.			
Test item: *Testvoorwerp:*	4mm Glass+ 8mil Solar Safety Film			
Identification/ Type No.: *Benaming / Type nr.:*	4mm Glass+ 8mil Solar Safety Film			
Order content: *Inhoud opdracht:*	Classification testing hard body impact			
Test specification: *Testomschrijving:*	EN 356:1999 Glass in building - Security glazing [a] Testing and classification of resistance against manual attack *Resistance to hard body impact*			

Date of sample receipt: *Ontvangstdatum monster:*	2024-08-01
Test sample No: *Testproefstuk nr.:*	4 pieces
Testing period: *Testperiode:*	2024-11-26 - 2024-11-26
Place of testing: *Testlocatie:*	Arnhem, the Netherlands
Testing laboratory: *Testlaboratorium:*	TÜV Rheinland Nederland NoBo 0336
Test result*: *Testresultaat*:*	Pass



tested by: *getest door:*	X Salah Ondertekend door: Salah El Bardai	**authorized by:** *geautoriseerd door:*	X Signed by: Sef Hovens
Date: 2025-01-21 *Datum:*		**Issue Date:** 2025-01-21 *Datum uitgave:*	
Position / *functie*:	Expert	**Position** / *functie*:	Expert

Others / *Andere*: Category of resistance: P1A
Code designation: EN 356 P1A

Condition of the test item at delivery: *Toestand van het test voorwerp bij ontvangst:* Test item complete and undamaged

* Legend:	P(ass) = passed a.m. test specification(s)	F(ail) = failed a.m. test specification(s)	N/A = not applicable	N/T = not tested
* *Legenda:*	*P(ass) = voldoet aan test omschrijving*	*F(ail) = voldoet niet aan test omschrijving*	*N/A = niet van toepassing*	*N/T = niet getest*

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Dit testrapport heeft alleen betrekking op het voorgenoemde test voorwerp. Zonder toestemming van het testcentrum mag dit testrapport niet in delen worden vermenigvuldigd. Dit keuringsrapport geeft geen recht op het dragen van enig keurmerk.
V05

Test report no.: 89224672-30
Testrapport nr.:

Remarks
Opmerkingen

1	The equipment used during the specified testing period was calibrated according to our test laboratory calibration program. The equipment fulfils the requirements included in the relevant standards. The traceability of the test equipment used is ensured by compliance with the regulations of our management system.The decision rule for statements of conformity in this test report is based on the "Zero Guard Band Rule" and "Simple Acceptance" in accordance to and ILAC-G8:09/2019 and IEC Guide 115:2021, unless otherwise specified in the applied standard mentioned on Page 1 of this report or requested by the customer. This means that measurement uncertainty is not taken in account. *De apparatuur die tijdens de gespecificeerde testperiode is gebruikt, is gekalibreerd volgens ons testlaboratoriumkalibratieprogramma. De apparatuur voldoet aan de eisen die zijn opgenomen in de relevante normen. De traceerbaarheid van de gebruikte testapparatuur wordt gewaarborgd door naleving van de voorschriften van ons managementsysteem. De beslisregel voor conformiteitsverklaringen in dit testrapport is gebaseerd op de "Zero Guard Band Rule" en "Simple Acceptance" in overeenstemming met en ILAC -G8:09/2019 en IEC Guide 115:2021, tenzij anders aangegeven in de toegepaste norm vermeld op pagina 1 van dit rapport of aangevraagd door de klant. Dit betekent dat er geen rekening wordt gehouden met de meetonzekerheid.*
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Clause *Deel*	**Product description** *Productomschrijving*

1	**Product details:** *Product details:*	Name of the manufacturer : Garware Hi Tech Films Limited Address of the manufacturer : Naigaon, P.O. Waluj, Aurangabad – 431 133, Maharashtra, India. Production plant of the samples : - Line ID where the samples are made : - Production date : - Sampling date : - The product was marked as : 4 mm Glass + 8mil Solar Safety Film Kind of glass : Clear float glass Nominal thickness : 4.1 mm Composition : 4 mm float + 8mil Solar Safety Film
2	**Other:** *Andere:*	Test sample(s), as well sample information, description, product details and intended usage was provided by customer.
3	**Test sample obtaining:** *Selectie van het proefstuk:*	☒ Sending by customer ☐ Sampling by TÜV Rheinland Group ☐ Others:
4	**Number of test items** Aantal proefstukken	4
5	**Picture of sample**	

Picture 1.



Picture 2.



Clause Deel	**Requirements – Tests** *Vereisten - Tests*

6	**Scope**	EN 356 specifies requirements and test methods for security glazing designed to resist actions of force by delaying access of objects and/or persons to a protected space for a short period of time. The standard classifies security glazing products into categories of resistance to actions of force.			
7	**Requirement**	**Resistance to hard body impact** The security glazing product shall be classified in that particular category of resistance if all three test pieces prevent penetration by the impacting body when tested by the method described in clause 8 of the standard.			
8	**Classification**	Category of resistance	Drop height (mm)	Total number of strikes	Code designation for category of resistance
		P1A	1500 ± 50	3 in a triangle	EN 356 P1A
		P2A	3000 ± 50	3 in a triangle	EN 356 P2A
		P3A	6000 ± 50	3 in a triangle	EN 356 P3A
		P4A	9000 ± 50	3 in a triangle	EN 356 P4A
		P5A	9000 ± 50	3 times 3 in a triangle	EN 356 P5A
9	**Test method**	**Clause 8 EN356. Test method for drop test:** The test piece shall be placed horizontally into the clamping frame of the test piece support apparatus and fixed in accordance with the requirements of clause 6.1.3. of this standard. The drop height (measured from the bottom of the impactor to the surface of the test piece) shall be adjusted according to table 1 for the category of resistance tested. For categories P1A, P2A, P3A and P4A, the impactor (a steel ball of 4,11 ±0,06 kg) shall be dropped on to each test piece three times from the same height, in such a way that the impacted positions form the pattern of an equilateral triangle with a side length of (130 ± 20) mm around the geometric centre of the test piece, with one side of the triangle parallel to a short side of the specimen. The impact position opposite to this side of the triangle shall be hit first. For category P5A, the above procedure shall be repeated a total of three times on each test piece, giving nine impacts, three on each point of the triangle. Loose fragments shall be removed from the test piece after each impact. The test temperature shall be (23 ± 2) °C.			
10	**Measurement uncertainty**	Caused by the destructive nature of the test and pass/fail result no measurement uncertainty can be determined. Based on the validation of the test procedure, measurement set-up and the associated parts (steel ball / drop height, etc.) there is a presumption of conformity established which is approved with ISO 17025 accreditation.			

Clause Deel	**Requirements – Tests** *Vereisten - Tests*

11 Resistance to Hard Body Impact

Composition (from the attack side)	**4 mm Glass + 8mil Solar Safety Film**
Asymmetrical yes/no	Yes
Attack face?	As marked by the manufacturer - Glass side
Dimensions [mm]	900 x 1100
Nominal thickness [mm]	4.1
Clamping < (140 ± 20) N/mm^2 ? yes/no	Yes
Drop height [mm]	1500
Number of strikes	3 in a triangle

Test piece	Position	1	2	3
Repetition 1	1	No Breakage	Breakage, no penetration	No Breakage
	2	Breakage, no penetration	Breakage, no penetration	No Breakage
	3	Breakage, no penetration	Breakage, no penetration	Breakage, no penetration
Test result		Pass	Pass	Pass
Penetration within 5 seconds since the time of impact ? yes/no		No	No	No
Slippage of test piece > 5mm ? yes/no		No	No	No

12 Classification based on test results EN 356:1999, Clause 10.1 Drop test

The security glazing product is classified in that category of resistance corresponding to the applied drop height and number of impacts, provided that all three test pieces have resisted penetration by the impactor.

Security glazing product with (trade)name: 4 mm Glass + 8mil Solar Safety Film **Composition: 4 mm Glass + 8mil Solar Safety Film** **Category of resistance: P1A** **Code of designation: P1A**	Pass ☒ Fail ☐ Not applicable ☐

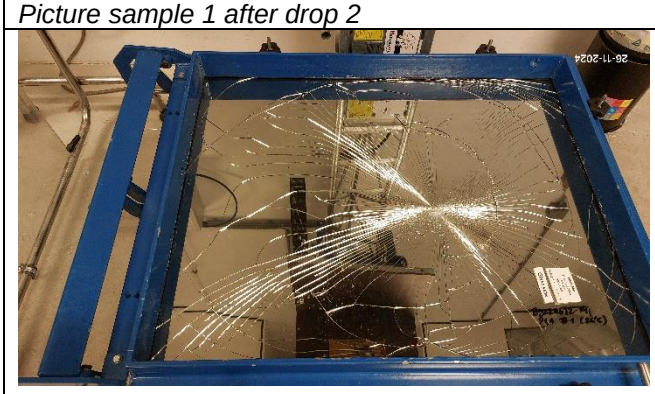
13 Remarks

When and if changes are made in production method and/or equipment, assessment according to this standard shall be reconsidered and re-tests shall be performed when the changes can lead to different specifications of the glass. The decision and responsibility lies at the manufacturer.

If no reference of the product description was supplied by the manufacturer, than that document shall be added to this test report by the manufacturer. It was to the manufacturer's responsibility that the samples delivered for initial type test are representative to the production and deviations from perfection were included in the delivered test samples.

Photo documentation
Foto documentatie

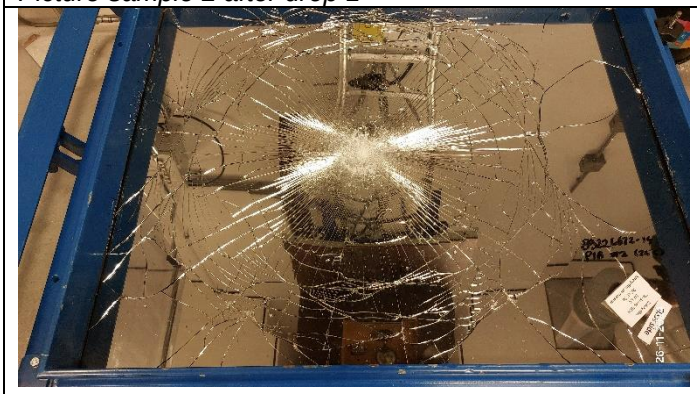
Picture sample 1 after drop 2



Picture sample 1 after drop 3



Picture sample 2 after drop 1



Picture sample 2 after drop 2



Picture sample 2 after drop 3



Picture sample 3 after drop 3



TEST REPORT

ADVANTICA

Garware Polyester Limited

Explosion Range Testing
ComBlast 2005 Part 1
March 17th 2005



ComBlast2005

GDA & DGA

An Advantica Ltd., Grendon Design Agency Ltd. and David Goode & Associates group project.

Document prepared by: Simon Trundle
Trials Manager
ComBlast 2005-1

Test Report Ref: GDA/71-1701s

Date: 18/05/2005

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1. Introduction

This test report records the results of a range test conducted on glass protection systems supplied by Garware Polyester Limited as part of the ComBlast 2005 Explosion Range Trials.

The Comblast trials were established to allow commercial companies to undertake explosion testing of their products alongside the formal Home Office annual range trails. The commercial trials element of the Comblast tests is managed by a partnership comprising of Advantica Limited [test site provider and shot firing], D. J. Goode & Associates [design of test structures] and Grendon Design Agency [GDA] [Commercial Trials Management].

The Garware Polyester explosion range test was undertaken on the afternoon of the 17th March 2005 at the Advantica Technology test site at Spadeadam, Cumbria, England, under the supervision of Simon Trundle, Managing Director of Grendon Design Agency. A total of three separate test specimens were provided for explosion testing as detailed within this test report.

The individual test specimens were prepared by Anglian Windows Limited on behalf of Garware and installed in the test cubicle by Advantica Technology Limited at the Spadeadam test range in Cumbria, United Kingdom.

Method Of Mounting Glass In Test Frames

The 6mm annealed float glass lite used for all test specimens was mounted into the test frames using compression gaskets. The glass rebate edge cover was approximately 10mm.

Limitation Of Test Performance

Only one sample of each type of product was tested and therefore is not considered a valid certification of performance under the ISO or ASTM standards where a minimum of three identical test specimens must achieve the same result.

These test results also relate only to the materials and the configurations tested and no alterations to the material manufacturer, composition or assembly method can be accepted unless further testing is undertaken.

1.1 Test specimen L1



Test specimen window frame:	1590mm x 1190mm wide.
Style:	Fixed lite non-opening
Clear glass area:	1480mm x 1080m.
Glass:	6mm annealed float held with compression gaskets
Window film manufacturer:	Garware Polyester
Window film type:	175 micron/7mil two-ply safety film.
Window film brand name:	Garsafe, Glassafe, Garware Sun Control and Global Window Film.
Date of test;	17th March 2005
Edge protection system:	A metal film anchoring system was applied to the internal perimeter of the filmed glass to anchor the filmed lite to the aluminium frame. The system was identified as the Bomb Gard Edge Retention System manufactured by View Plus Window Film Products Inc, Canada, supplied and fitted by Garware Polyester Limited/Anglian Technical Windows Ltd, UK.
Mounting of test specimen:	Total 10 x M10 mild steel bolts into test cubicle.

1.2 Test specimen C2



Test specimen window frame:	1590mm x 1190mm wide.
Style:	Fixed lite non-opening
Clear glass area:	1480mm x 1080m.
Glass:	6mm annealed float held with compression gaskets
Window film manufacturer:	Garware Polyester
Window film type:	175 micron/7mil single-ply safety film.
Window film brand name:	Garsafe, Glassafe, Garware Sun Control and Global Window Film.
Date of test;	17th March 2005
Edge protection system:	A metal film anchoring system was applied to the internal perimeter of the filmed glass to anchor the filmed lite to the aluminium frame. The system was identified as the Bomb Gard Edge Retention System manufactured by View Plus Window Film Products Inc, Canada, supplied and fitted by Garware Polyester Limited/Anglian Technical Windows Ltd, UK.
Mounting of test specimen:	Total 10 x M10 mild steel bolts into test cubicle.

1.3 Test specimen R3



Test specimen window frame:	1590mm x 1190mm wide.
Style:	Fixed lite non-opening
Clear glass area:	1480mm x 1080m.
Glass:	6mm annealed float held with compression gaskets
Window film manufacturer:	Garware Polyester
Window film type:	200 micron/8mil two-ply safety film.
Window film brand name:	Garsafe, Glassafe, Garware Sun Control and Global Window Film.
Date of test;	17th March 2005
Edge protection system:	A metal film anchoring system was applied to the internal perimeter of the filmed glass to anchor the filmed lite to the aluminium frame. The system was identified as the Bomb Gard Edge Retention System manufactured by View Plus Window Film Products Inc, Canada, supplied and fitted by Garware Polyester Limited/Anglian Technical Windows Ltd, UK.
Mounting of test specimen:	Total 10 x M10 mild steel bolts into test cubicle.

2. High Explosive Testing

The following text describes in general terms the forces applied to a test specimen in an explosion.

Detonation of a high order explosive produces a shock in air, which takes the form of a rapidly expanding pressure wave in the surrounding atmosphere. The blast wave expands outwards until it meets an object in its path i.e. the test cubicle.

The expanding blast pressure wave is arrested in its travel and in this instance 'reflects' against the front surface of the test cubicle. This expanding pressure wave is referred to as the positive phase or reflected pressure load.

A negative phase effect is experienced immediately following the rapid overpressure load generated by the expanding pressure wave. The negative phase [suction] is created when the detonation of the high explosive and rapid outward movement of the blast wave creates a vacuum at the seat of the explosion, which is rapidly filled by the surrounding atmosphere being drawn back into the evacuated space. This rapid return of air to fill the void created at the centre of the blast causes a reverse flow in the surrounding atmosphere, which causes drag or suction on the face of the test specimen. The negative phase can sometimes coincide with the elastic response of the test specimen and thereby further increase the rebound effect.

2.1 Details Of The Explosive Charges

Tests were conducted using a nitro-methane based explosive liquid contained within a cylindrical container set at a height of 800mm above the surface of the concrete test pad. Pre-testing of the nitro-methane based explosive was undertaken by Advantica to determine the net equivalency to TNT.



The nitro-methane charge size used in these tests was selected as a direct equivalent to 100kg TNT High Explosives. The explosive charge was supported on polystyrene packing to ensure that no fragments would be ejected from the charge support.

P1: Explosive charge

2.2 Blast Pressure And Impulse Loading

The test range of 31 metres from 100kg TNT was chosen on the basis that a daylight application of 200 micron 2-ply anti-shatter window film should have left the window opening and landed inside the structure within the Low Hazard zone. All three test specimens were set in a test cubicle at the same range in order to determine the value of the different film types with common anchoring under the same blast loading.

Table 1 summarises the average values using the Conwep [Conventional Weapons Effects Program] analytical program developed by the US Government and in use with the UK PSDB and Home Office.

Table 1: Blast Pressure And Impulse Loading – Predicted by ConWep

100kg TNT charge Shot number and range	Side-On Pressure		Reflected Impulse		Equivalent Reflected Pressure On face of Test Specimen	
	P_{so} kPa	P_{so} Psi	kPa-msec	Psi-msec	P_r kPa	P_r Psi
Shot No 1 @ 31metres	29	4.26	376	55	57	8.37

The above table shows the predicted pressure and impulse loading calculated using the United States Conventional Weapons Effects Program [CONWEP] after inputting the surface area of the test cubicle and wing walls and calculating the average reflected pressure and impulse. The CONWEP software is know to over predict the impulse values as it does not take account of clearing [pressure wave rapidly rolling over the top of a small target] and therefore blast gauges were mounted within the test arena to record the following side on and reflected pressures and impulses.

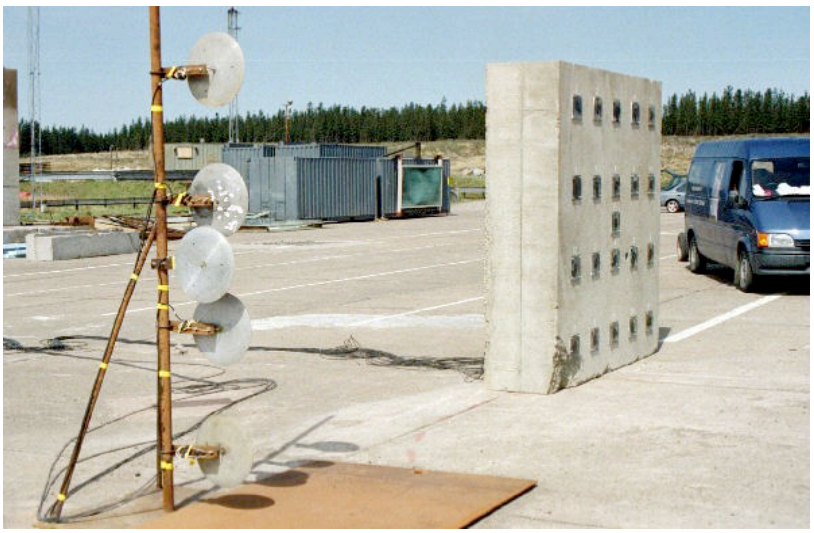
Table 2: Blast Pressure And Impulse Loading – Measured On Range

100kg TNT charge Shot number and range	Measured Side-On Pressure		Reflected Impulse		Equivalent Uniform Reflected Pressure On face of Test Specimen	
	P_{so} kPa	P_{so} Psi	kPa-msec	Psi-msec	P_r kPa	P_r Psi
Shot No 1 @ 31metres	30	4.41	307	45.13	58	8.52

Table two includes the average values measured over four gauges e.g. 2 gauges in the gauge block test wall measuring reflected pressure and impulse and 2 side-on gauges standing in the free field measuring the side on pressure as the blast wave passed by.



P2: Free field gauges



P3: Gauge block

Photos show free field gauges [P1] for measuring side-on incident pressure and the gauge block [P2] used for measuring reflected pressure on face of test specimen.

Summary Of Blast Load

The test specimens received a reflected pressure on the impact face of 58 kPa [8.52 psi] and a reflected impulse loading of 327 kPa-millisecond [48.07 psi-millisecond].

3. Classification Of Performance

The following text and graphic are extracts taken from sections 4 and 7.4 of the new ISO Arena Test Standard draft of October 2003. It is expected that this blast test standard will be adopted internationally in 2006 and is therefore used to classify the results of these tests.

A hazard rating is applied to glazing based on its performance under the blast conditions chosen for the test. The rating is specific to those blast conditions. The hazard rating of the glazing or glazing system shall be according to the rating criteria definitions provided below and further demonstrated in the Figure.

Table 1: ISO Method Of Classification

Hazard Rating	Description	Definition [summary]
A	No Break	The glazing is observed not to fracture and there is no visible damage to the glazing system
B	No Hazard	The glazing is observed to fracture but is fully retained in the facility test frame or glazing system frame with no breach and no material is lost from the interior surface
C	Minimal Hazard	The glazing is observed to fracture and the total length of tears in the glazing plus the total length of pullout from the edge of the frame is less than 20 percent of the glazing sight perimeter. Also, *(. . permissible dust and fragments . .etc)*
D	Very Low Hazard	The glazing is observed to fracture and is located within 1m of the original location. Also, *(. . permissible dust and fragments . .etc)*
E	Low Hazard	The glazing is observed to fracture but glazing fragments fall between 1 m of the interior face of the specimen and 0.5 m or less above the floor of a vertical witness panel located 3 m from the interior face of the specimen. Also, *(. . permissible dust and fragments and indents. .etc)*
F	High Hazard	Glazing is observed to fracture and there are more than 10 perforations in the area of a vertical witness panel located 3 m from the interior face of the specimen and higher than 0.5 m above the floor or there are one or more perforations in the same witness panel area with fragment penetration through the first layer and into the second layer of the witness panel.

The results of the test classification are expressed in the following graphic which is reproduced in larger scale in Annex A.

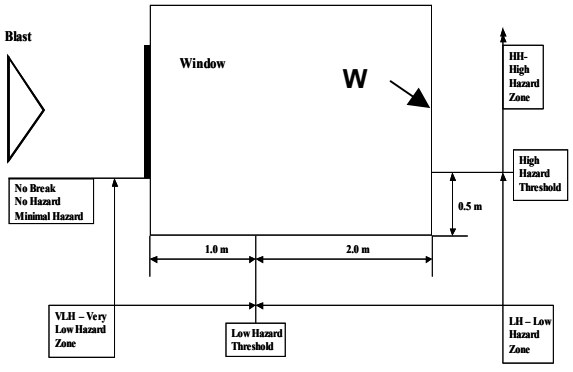


Figure 1: ISO standard hazard zones.

Table 2: GSA Method Of Classification

The following table summarises the performance criteria adopted by the US GSA.

Performance Condition	Description	Glass Fragments		Hazard Level	Protection Level
		Exterior to structure	Interior to structure		
1	Glass not cracked, fully survived and/or fully retained by frame and no glass fragments either inside or outside structure.	None	None	NA	Very High
2	Glass may be cracked but is retained by the frame.	Yes	No significant fragments. Dusting or very small fragments near sill or on floor acceptable.	Very Low	Very High
3a	Glass failed and not fully retained in frame.	Yes	Yes - land on floor no more than 40 inches from window	Low	High
3b	Glass failed and not fully retained in frame.	Yes	Yes - land on floor no more than 10 ft from window.	Low	High
4	Glass failed and not fully retained in frame.	Yes	Yes - Land on floor more than 10 ft from window and impact a vertical surface located not more than 10 ft behind the window no higher than 2 ft above floor level.	Medium	Medium
5	Glass fails catastrophically.	Yes	Yes - land on floor more than 10 ft from window and impact a vertical surface not more than 10 ft behind window above a height of 2 ft.	High	Low

Note: In the USA, Category C facilities require protection from window fragments up to a blast load with a peak pressure of 4psi and an impulse of 28 psi-ms. A performance condition (Damage Level) 4 is permitted for Category C. A graphical depiction of the performance conditions contained in the criteria is shown in Figure 1. A description of the performance conditions and hazard levels are outlined in Table 3.

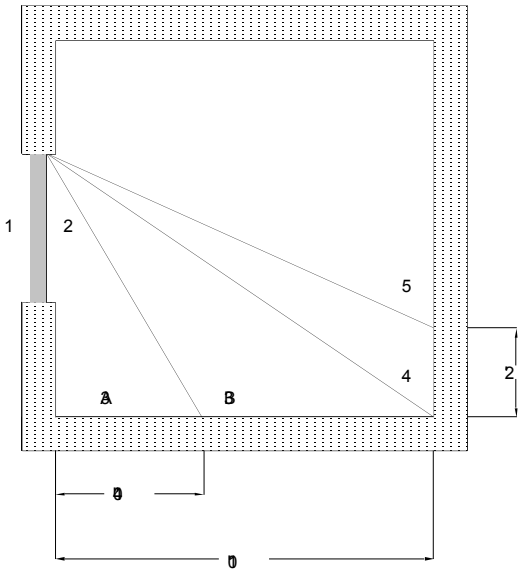


Figure 2: GSA Performance Zones

The United Kingdom Home Office has undertaken explosion testing of glazing materials on an annual basis since 1980 under the EDICTS test program. The EDICTS test program was

undertaken to develop a better understanding of the performance of different glass types, under blast load. The data extracted from the EDICTS research program has lead to it being possible to judge the hazard threshold for unprotected common forms of glass such as annealed float and to identify the benefits that can be gained by retrofitting the annealed glass with window safety film or by replacing the annealed glass with laminated or toughened safety glass.

For the purpose of these current trials we have adopted the EDICTS hazard classification system in the absence of any formal UK or CEN test standards for blast resistance.

The UK EDICTS test criteria relates to the classification of hazard for glazing systems in post break condition and is based on the following performance criteria:

B/S[(1)] 'Break Safely' is where the glass cracks but remains within the window frame. If it is toughened or plain glass [annealed] it may crack and fall outside or into the test cubicle but with no projection of the fragments beyond a 1000mm distance internally. If it is laminated or filmed glass it should remain securely in place. [(1)]B/S has recently being re-designated as 'Minimal Hazard' to overcome the confusion which can arise from a material being designated 'break safe' that evidently has disintegrated under blast load with clear evidence of glass fragments within the test structure.

L **'**Low Hazard' is where fragments or the entire pane of glass falls into the test cubicle to land on the floor without striking the rear wall which is set 3m away from the window opening. This implies that the fragments or pane of glass would be travelling at low velocity and thus proves less injurious to persons within a property affected by blast.

H 'High Hazard' is when the glass fragments/pane or any part of the test specimen strikes the rear wall of a 3metre deep test cubicle at 0.5m above the floor.

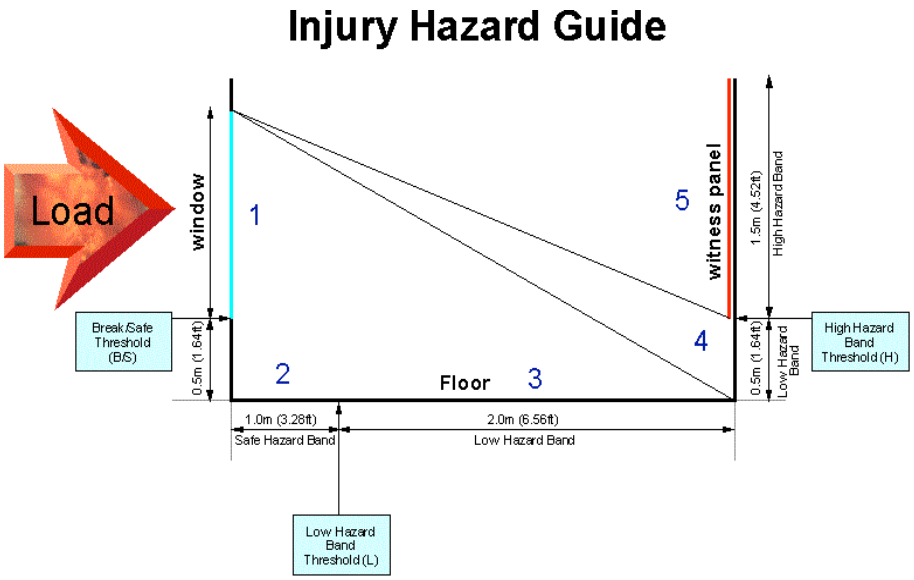


Figure 3: UK PSDB hazard zones.

3.1 Details Of The Test Specimens

Window test specimens were mounted into a steel test structure details of which are included within Annex A.



P4: View of test structure prior to detonation

The individual test specimens are numbered as follows:

L1 [left]: Aluminium framed window containing 6mm annealed float glass with Garware 175 micron two-ply film fitted with the Bomb Gard Edge Retention System manufactured by View Plus Window Film Products Inc, Canada, supplied and fitted by Garware Polyester Limited/Anglian Technical Windows Ltd,UK.

C2 [centre]: Aluminium framed window containing 6mm annealed float glass with Garware 175 micron single-ply film fitted with the Bomb Gard Edge Retention System manufactured by View Plus Window Film Products Inc, Canada..

R3 [right]: Aluminium framed window containing 6mm annealed float glass with Garware 200 micron two-ply film fitted with the Bomb Gard Edge Retention System manufactured by View Plus Window Film Products Inc, Canada.



P5: Typical film anchoring detail

All three test specimens were fitted with the Bomb Gard Edge Retention System manufactured by View Plus Window Film Products Inc, Canada. The attachment system comprises a folded aluminium section, indicated as black trim to the interior of the window. The aluminium metal thickness was observed as approximately 1.5mm although details of the system were not disclosed to the testing authority.

Photo shows the M10 mounting bolts used for retaining the window frame into the test cubicle opening.

3.1.1 Security Window Film

The trials were undertaken using window film manufactured by Garware Polyester Limited based in Aurangabad, India.

One sample of each film type was tested as follows:

175 micron/7mil two-ply safety film manufacturer's reference Garsafe, Glassafe, Garware Sun Control and Global Window Film.

175 micron/7mil single-ply safety film manufacturer's reference Garsafe, Glassafe, Garware Sun Control and Global Window Film

200 micron/8mil two-ply safety film manufacturer's reference Garsafe, Glassafe, Garware Sun Control and Global Window Film

3.1.2 Disclaimer

The test results recorded within this report apply only to the items tested and any modification of either the window film material or anchoring systems used in these tests will require a separate test for validation of test performance.

Table 3. GSA Criteria for Test Specimen Performance Conditions

Performance Condition	Description	Glass Fragments		Hazard Level	Protection Level
		Exterior to structure	Interior to structure		
1	Glass not cracked, fully survived and/or fully retained by frame and no glass fragments either inside or outside structure.	None	None	NA	Very High
2	Glass may be cracked but is retained by the frame.	Yes	No significant fragments. Dusting or very small fragments near sill or on floor acceptable.	Very Low	Very High
3a	Glass failed and not fully retained in frame.	Yes	Yes - land on floor no more than 40 inches from window	Low	High
3b	Glass failed and not fully retained in frame.	Yes	Yes - land on floor no more than 10 ft from window.	Low	High
4	Glass failed and not fully retained in frame.	Yes	Yes - Land on floor more than 10 ft from window and impact a vertical surface located not more than 10 ft behind the window no higher than 2 ft above floor level.	Medium	Medium
5	Glass fails catastrophically.	Yes	Yes - land on floor more than 10 ft from window and impact a vertical surface not more than 10 ft behind window above a height of 2 ft.	High	Low

Note: In the USA, Category C facilities require protection from window fragments up to a blast load with a peak pressure of 4psi and an impulse of 28 psi-ms. A performance condition (Damage Level) 4 is permitted for Category C. A graphical depiction of the performance conditions contained in the criteria is shown in Figure 1. A description of the performance conditions and hazard levels are outlined in Table 3.

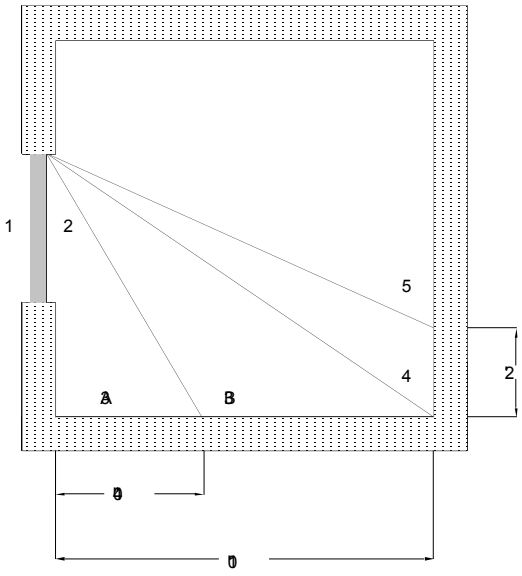


Figure 1. GSA Performance Conditions

3.2 Measurement Of Glass Fragments Ejected From Test Specimen

The ISO, UK PSDB and GSA classification systems recognise the fact that the primary aim of any glass protection system is to limit the travel of the external window glass into the interior of a building where persons might be working and moving about in close proximity to the glass.

The classification of performance of glazing systems in both the US and UK allows for fragments of glass or indeed the entire pane of glass to fall inside the test cubicle [building] so long as the fragments or pane of glass do not travel inwards at sufficient velocity to impact a witness panel mounted 3metres away from the test specimen.

There is evidently a considerable difference in hazard between some loose fragments falling inside the test cubicle compared to an entire sheet of glass entering the room. Falling glass fragments will cause considerably less injury as a rule compared to being impacted by a sheet of glass weighing in excess of 20kg as in the case of these tests. However, both the ISO, US GSA and UK PSDB classification system would appear to classify both loose fragments [even one] and the entire sheet entering the test cubicle as offering similar levels of protection.

In previous trials of window film for the US General Services Administration, GDA in partnership with EQE Limited of San Antonio USA developed a hazard level classification for total glass fragment mass in Zone 3A and 3B. A Low mass level was defined as a total mass less than or equal to 100 g. Medium mass level is a total mass greater than 100 g but less than 501 g. The High mass level is defined as a fragment mass greater than 500 g. These hazard levels, which are not included in the GSA criteria, are used to differentiate between the severity of hazard, risk of injury, and probability of fragment impact within Zone 3 since they are an indication of the number of fragments. Two tests which both produce a Level 3B performance condition may differ greatly in the hazard to personnel depending on the amount of glass fragments in the test cubicle. Comment is therefore provided within the results section of each test as to the overall mass of glass fragments found within the test cubicle and in which section of the cubicle they were found.

4. Results And Photographic Record Of Tests

4.1 Shot No 1: 100kg TNT Equivalent Charge Weight @ 31 Metres



P8: View of test cubicle post detonation of 100kg TNT at 31metres stand off.

L1 [left]:

Aluminium framed window containing 6mm annealed float glass with Garware 175 micron two-ply film fitted with the Bomb Gard Edge Retention System manufactured by View Plus Window Film Products Inc, Canada.

C2 [centre]:

Aluminium framed window containing 6mm annealed float glass with Garware 175 micron single-ply film fitted with the Bomb Gard Edge Retention System manufactured by View Plus Window Film Products Inc, Canada..

R3 [right]:

Aluminium framed window containing 6mm annealed float glass with Garware 200 micron two-ply film fitted with the Bomb Gard Edge Retention System manufactured by View Plus Window Film Products Inc, Canada.

4.1.1 Results Of Test Specimen L1

View of test specimen L1 post detonation.



P9

- The filmed glass lite was partially retained on one side after failure of the Bomb Gard anchoring system in the blast.
- The Garware 175micron two-ply window film retained approximately 95% of the broken glass fragments.
- Glass fragments, totalling less than 100grammes, were found on the floor of the test structure within GSA hazard zone 3A. Minor glass fragments were noted within zone 3B but of insufficient mass to reduce the 3A performance rating.

Test specimen L1 achieved Low Hazard classification in accordance with UK PSDB and ISO methods of classification. The test specimen also achieved an equivalent 3A performance to the US General Services Administration performance classification although the pressure and impulse loading were considerably above the required GSA level.

Classification of a single test specimen is not permitted under the ASTM or ISO standards where a minimum of 3 identical test specimens must achieve the same performance. Therefore, it should be noted that a single test, while providing an indication of the likely result, does not imply formal classification of a systems performance under blast load.



P10 View of interior of test chamber L1.

Interior photograph shows glass fragment scatter on interior of test chamber within GSA zone 3A and 3B. Total mass of glass fragments less than 100 gram in weight.



P11

View of test specimen from inside cubicle. The Bomb Gard anchoring system delaminated from the film at the cill and was pulled out of the frame at the side and head.

4.1.2 Results Of Test Specimen C2

View of test specimen C2 post detonation.



P12

- The Garware 175 micron single-ply film ripped in the blast and was driven into the test cubicle landing on the floor. The Bomb Gard anchoring system remained attached to the window frame on three sides and portions of the window film was left attached to the anchoring bars as evident in the above photograph.
- The system achieved a Low Hazard classification with the glass landing within GSA zone 3B inside the test cubicle. There was no indication of glass fragments embedded in the witness boards on the rear wall although the entire lite weighing approximately 20kg landed inside the cubicle.
- The test was conducted at a range where 6mm annealed float glass with 200 micron anti-shatter window film at 31 metres range from 100kg TNT was predicted to travel further into the test cubicle. A pre-test using proved that daylight window film landed in the same location as this test specimen.

Test specimen C2 achieved the equivalent of an ISO Low Hazard classification. The test specimen also achieved an equivalent 3B performance to the US General Services Administration performance classification although the pressure and impulse loading were considerably above the required GSA level.

Classification of a single test specimen is not permitted under the ASTM or ISO standards where a minimum of 3 identical test specimens must achieve the same performance. Therefore, it should be noted that a single test, while providing an indication of the likely result, does not imply formal classification of a systems performance under blast load



P13

View of interior of test chamber showing the filmed lite within zone 3B and extensive glass fragment scattered throughout the entire cubicle.

The Bomb Gard anchoring bar struck the left hand wall and buckled, tearing from the file and landing separate as indicated in the above photograph.

4.1.3 Results Of Test Specimen R3

View of test specimen R3 post detonation.



P14

- The filmed glass lite was ejected from the frame to land within 0,50m of the front face of the cubicle. The filmed lite had one side of the Bomb Gard anchoring system still attached with the remaining three sides of the anchoring system still fixed to the window frame.
- The Garware 200 micron two-ply window film retained approximately 70% of the broken glass fragments.
- Glass fragments, totalling less than 100grammes, were found on the floor of the test structure within GSA hazard zone 3A. Minor glass fragments were noted within zone 3B but of insufficient mass to reduce the 3A performance rating.

Test specimen R3 achieved Low Hazard classification in accordance with UK PSDB and ISO methods of classification. The test specimen also achieved an equivalent 3A performance to the US General Services Administration performance classification although the pressure and impulse loading were considerably above the required GSA level.

Classification of a single test specimen is not permitted under the ASTM or ISO standards where a minimum of 3 identical test specimens must achieve the same performance. Therefore, it should be noted that a single test, while providing an indication of the likely result, does not imply formal classification of a systems performance under blast load



P15

Test specimen R3: View of cill and floor of test chamber. The Bomb Gard anchoring system possessed insufficient strength or adhesion to retain the filmed lite in the opening.

Fragments of window film remained attached to the anchoring in the window opening implying delamination between layers of the 200 miron two-ply film.

Glass fragments were identified inside zone 3B [in accordance with GSA classification].



P16

200 micron two-ply film showing large area of clear film on bottom left corner where the glass has become detached in the explosion.

5. Observations

The selection of the 31 metre range proved correct in that it is the base line comparison where the daylight filmed 6mm annealed float glass is typically ejected from the frame to land inside the test cubicle.

While all three test specimens gained the same Low Hazard classification there was a clear difference in the performance of the multi-ply films over the single ply 175 micron film which landed inside the test chamber.

The more flexible multi-ply films appeared to stretch under blast load and absorb sufficient energy to last until the negative suction phase pulled the film out of the window opening, completely in the case of the 200 micron two-ply film and partially [on three sides] with the 175 micron two-ply film.

The Bomb Gard anchoring system did not stand up to the forces transmitted through the film and failed either through lack of adhesion either to the window film or to the window frame.

Only one sample of each type of product was tested and therefore is not considered a valid certification of performance under internationally recognised ASTM or ISO standards which require a minimum of three identical test specimens to achieve the same result.

These test results also relate only to the materials and the configurations tested and no alterations to the material manufacturer, composition or assembly method can be accepted unless further testing is undertaken.

Report concludes:

Author:



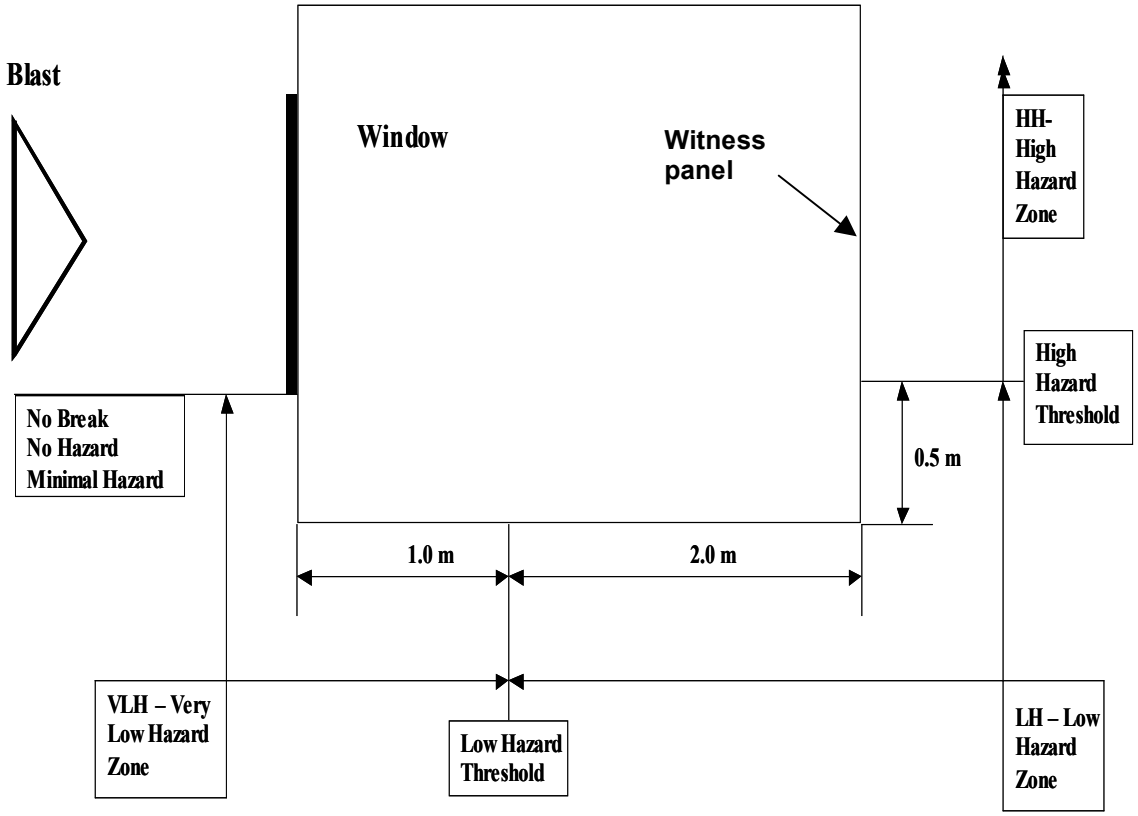
Simon Trundle:

Commercial Trials manager

ComBlast 2005-1

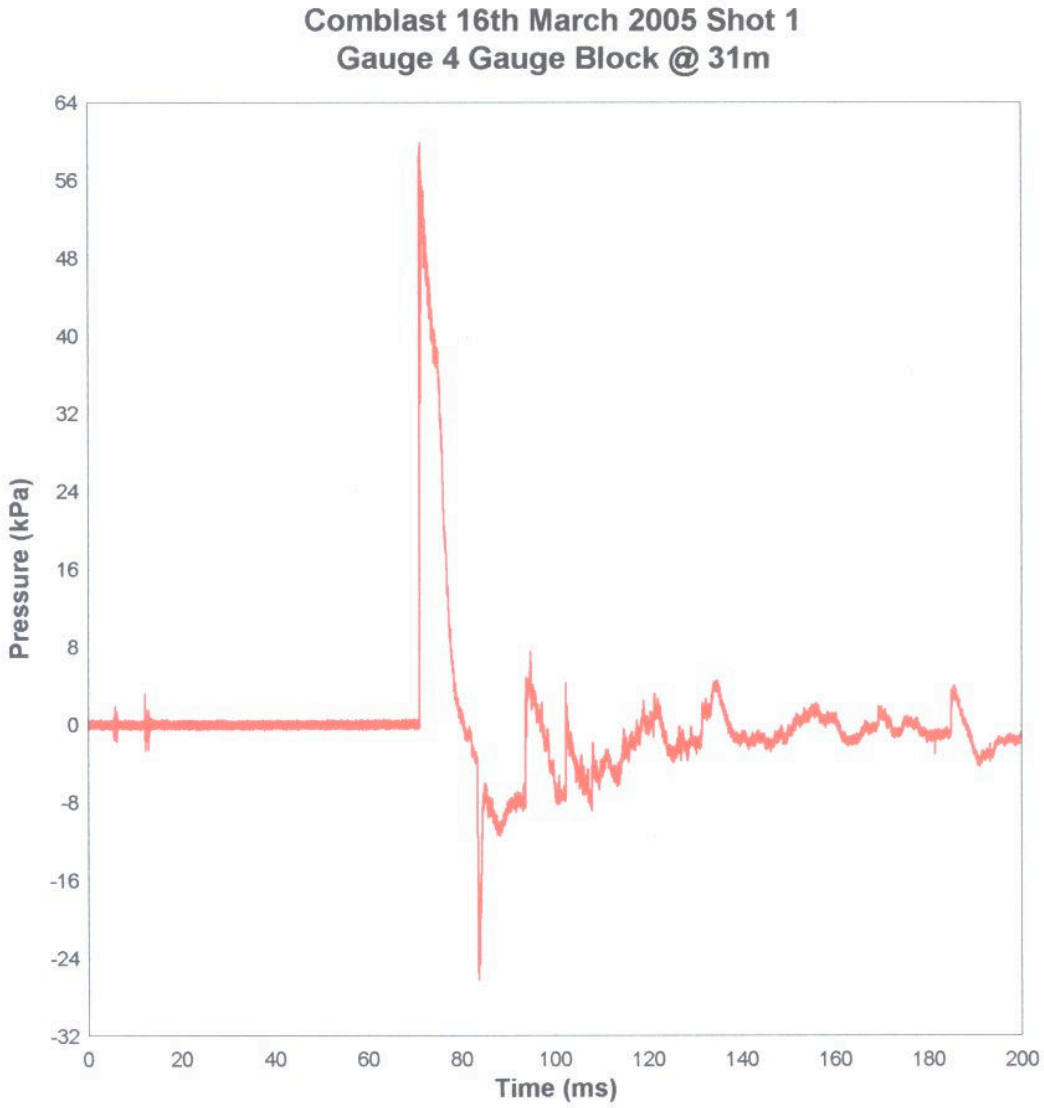
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Annex A: ISO Hazard Classification Diagram

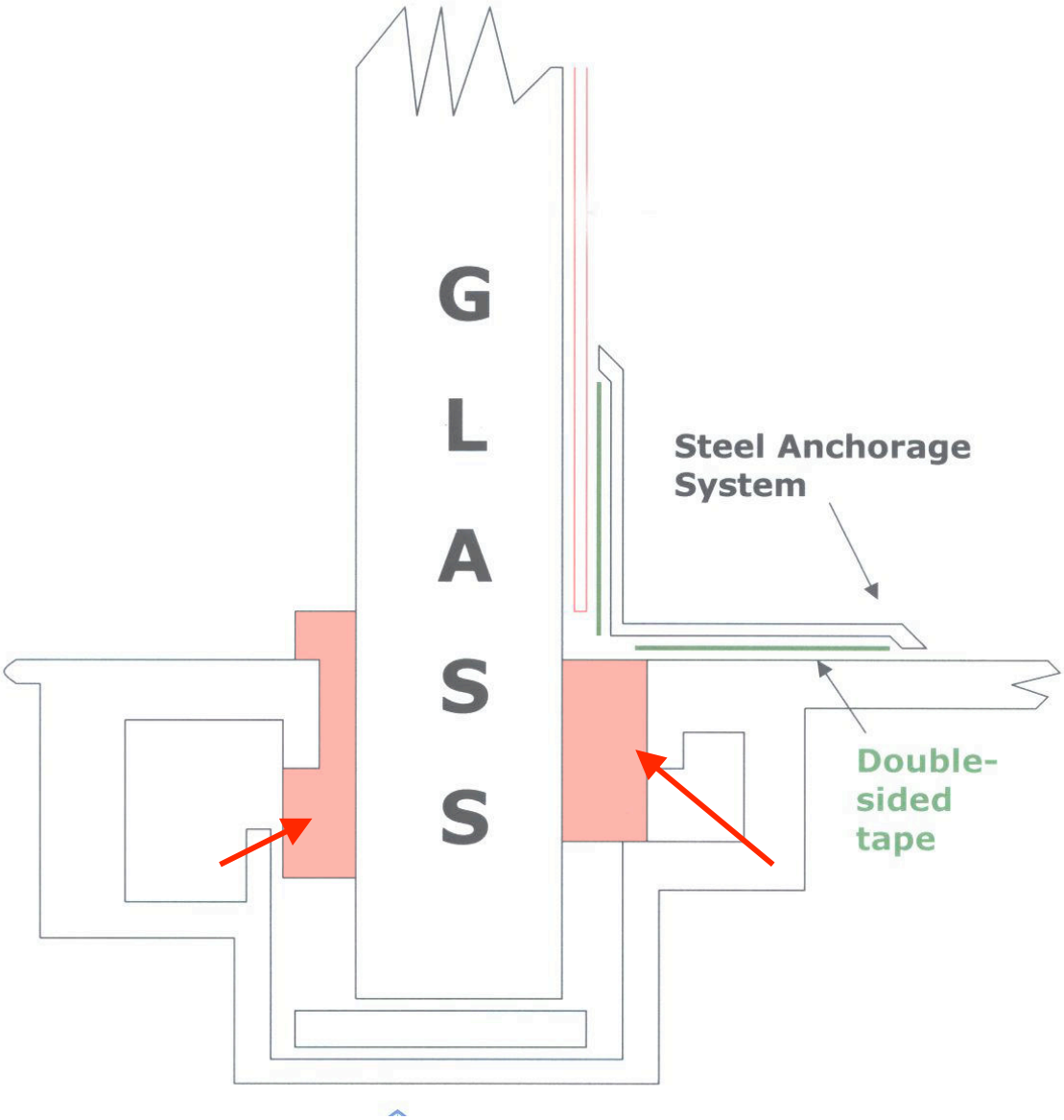


Cross-section through Witness Area

Annex B: Blast Plot


Comblast 16th March 2005 Shot 1
Gauge 4 Gauge Block @ 31m
Pressure (kPa)
64
56
48
40
32
24
16
8
0
-8
-16
-24
-32
0
20
40
60
80
100
120
140
160
180
200
Time (ms)

Annex C: Drawings Of Test Specimen



The above sketch is illustrative only of the arrangement of the window film and the Bomb Gard anchoring system. The glass was retained by compression type wedge gaskets at the locations indicated by the red arrows and not by an adhesive tape as implied by the shape of the gasket in the above sketch. The compression gaskets were approximately 8mm in height.