



Report
3M: Anchored Safety Film Blast Tests

Prepared by

Benjamin Fry, BSc AMInstP
Engineer
TPS Ltd

Simon Volpe, MEng
Engineer
TPS Ltd

Approved by

Ken Holt, BSc CEng MICE
Associate Director
TPS Ltd

Prepared for

Product Engineering Specialist
3M Building Safety
Solutions Department
3M Center, Building 0207-01-W-08
St. Paul, MN 55144-1000

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Executive Summary

Blast testing of anchored film glazing systems, under supervision of TPS, was undertaken at the Spadeadam Test Facility, MoD R5, Spadeadam, Gilsand, Cumbria CA36 7AT, England by Advantica Technologies Limited from the 23rd to the June 2008 to the 1st of July 2008.

Glazing systems tested consisted of combinations of glazing, film type and anchoring mechanisms.

The object of the tests was to assess and compare the bomb blast resistance of a selection of systems to the International Organisation for Standards (ISO) and US General Services Administration (GSA) glazing. In particular, the hazard ratings and confidence levels for the ISO EXV 25, GSA C and GSA D standards. Each sample was tested using a single bomb blast. Note: to achieve full compliance with GSA, each sample would need to be tested 3 times.

The glazing systems were mounted three in each test structure, with two test structures per test. 8 tests were undertaken with 48 window systems tested in total. Each test structure contained an internal pressure transducer and, for the majority of the tests, a high speed video camera.

3 pressure transducers were mounted on an external gauge block to measure the reflected pressure from the blast and calculate the blast loads on the test samples. 3 Free field transducers were mounted in aerodynamic casings and used to measure the free field pressure used to assess the explosive strength of the blast. Additionally each test structure had 2 gauges mounted on the front face, 1 between each of the windows.

The table on the following pages summarises the windows tested and the results of the tests.

The systems tested provide a good sample for comparing different anchoring methods and film types and assessing the bomb blast protection capabilities. This information could be used to decide on which systems would undergo further tests to provide consistency in the results and confidence in the protection afforded by the anchored safety film.

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Test	Location	Target Description	Blast Loading		%Difference to Test Standard		Rating Awarded	
			Pressure (PSI)	Impulse (PSI.mS)	Pressure	Impulse	GSA	ISO
Test 1 GSA D	1A	P-IG Ultra 600 Profile	14.94	82.07	49.47	-7.78	5	High Hazard
	1B	A-IG Ultra 400 IPA	15.18	85.42	51.86	-4.02	5	High Hazard
	1C	A-IG Ultra 600 Profile	14.94	82.07	49.47	-7.78	3b	Low Hazard
	2A	Calibration shot	14.94	82.07	49.47	-7.78	n/a	n/a
	2B	A-IG Ultra 600 IPA	15.18	85.42	51.86	-4.02	3b	Low Hazard
	2C	Calibration shot	14.94	82.07	49.47	-7.78	n/a	n/a
Test 2 GSA D	1A	A-IG Ultra 600 Profile	17.05	88.94	70.50	-0.06	4	Low Hazard
	1B	A-IG Ultra 400 IPA	17.32	92.57	73.25	4.02	5	High Hazard
	1C	A-IG SH7CLARL IPA	17.05	88.94	70.50	-0.06	3b	Low Hazard
	2A	A-IG Ultra 600 Profile	17.05	88.94	70.50	-0.06	4	Low Hazard
	2B	P-IG Ultra 600 IPA	17.32	92.57	73.25	4.02	4	Low Hazard
	2C	A-IG Ultra 400 Profile	17.05	88.94	70.50	-0.06	4	Low Hazard
Test 3 GSA C	1A	A-Monolithic Ultra 400 IPA 2 sides	4.47	31.38	11.77	12.07	5	High Hazard
	1B	P-Monolithic Ultra 400 Profile 2 sides	4.49	32.80	12.44	17.16	3b	Low Hazard
	1C	P-Monolithic Ultra 400 IPA 2 sides	4.47	31.38	11.77	12.07	3b	Low Hazard
	2A	A-Monolithic Ultra 400 IPA 2 sides	4.47	31.38	11.77	12.07	3b	Low Hazard
	2B	A-Monolithic Ultra 400 IPA 2 sides	4.49	32.80	12.44	17.16	3b	Low Hazard
	2C	A-Monolithic Ultra 400 Profile 2 sides	4.47	31.38	11.77	12.07	3b	Low Hazard

Legend:	P - Painted (powder coat) frame	IPA - Impact Protection Adhesive
	A - Anodized frame	
	Monolithic – single pane glass ¼” annealed (6mm)	Profile - IPP Impact Protection Profile
	IG - Insulated Glass double pane ¼” annealed (6mm)	Daylight - Film only, no attachment of film to frame

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Test	Location	Target Description	Blast Loading		%Difference to Test Standard		Rating Awarded	
			Pressure (PSI)	Impulse (PSI.mS)	Pressure	Impulse	GSA	ISO
Test 4 GSA C	1A	A-Monolithic Ultra 400 IPA	4.24	28.12	6.16	0.45	5	High Hazard
	1B	A-Monolithic Ultra 400 Profile	4.27	29.40	6.79	5.02	4	Low Hazard
	1C	P-Monolithic Ultra 400 Profile	4.24	28.12	6.16	0.45	5	High Hazard
	2A	P-Monolithic Ultra Prestige70 Profile	4.24	28.12	6.16	0.45	3b	Low Hazard
	2B	P-Monolithic Ultra 400 Profile	4.27	29.40	6.79	5.02	2	No Hazard
	2C	P-Monolithic Ultra 400 IPA	4.24	28.12	6.16	0.45	5	High Hazard
Test 5 GSA C	1A	A-Monolithic Profile SH8	4.70	28.26	17.60	0.95	3b	Low Hazard
	1B	P-Monolithic Ultra 400 IPA	4.72	29.55	18.22	5.54	3b	Low Hazard
	1C	P-Monolithic Ultra 400 IPA	4.70	28.26	17.60	0.95	3b	Low Hazard
	2A	P-Monolithic Ultra Prestige70 Profile	4.70	28.26	17.60	0.95	4	Low Hazard
	2B	P-Monolithic Ultra 400 Profile	4.72	29.55	18.22	5.54	3b	Low Hazard
	2C	P-Monolithic Ultra 400 IPA	4.70	28.26	17.60	0.95	3b	Low Hazard
Test 6 GSA C	1A	A-Monolithic Ultra 400 Small Profile	4.72	28.41	18.12	1.48	3b	Low hazard
	1B	A-Monolithic Ultra 400 Small Profile	4.74	29.70	18.75	6.09	4	Low hazard
	1C	A-Monolithic Ultra 400 Small Profile	4.72	28.41	18.12	1.48	3b	Low hazard
	2A	P-Monolithic SH8 IPA	4.72	28.41	18.12	1.48	3b	Low hazard
	2B	P-Monolithic PR70 Profile	4.74	29.70	18.75	6.09	3b	Low hazard
	2C	A-Monolithic Ultra 400 Small Profile	4.72	28.41	18.12	1.48	3b	Low hazard

Legend:	P - Painted (powder coat) frame	IPA - Impact Protection Adhesive
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	Monolithic – single pane glass ¼” annealed (6mm)	Daylight - Film only, no attachment of film to frame
	IG - Insulated Glass double pane ¼” annealed (6mm)	

Test	Location	Target Description	Blast Loading		%Difference to Test Standard		Rating Awarded	
			Pressure (PSI)	Impulse (PSI.mS)	Pressure	Impulse	GSA	ISO
Test 7 ISO EXV25	1A	P-IG Ultra 600 IPA	15.15	58.68	30.61	6.49	3a	Very low hazard
	1B	P-IG Ultra 600 Profile 4mm glass	15.18	60.46	60.86	9.72	3b	Low hazard
	1C	A-IG Ultra 600 Profile 4mm glass	15.15	58.68	30.61	6.49	3a	Very low hazard
	2A	P-IG SH14 Daylight	15.15	58.68	30.61	6.49	3b	Low hazard
	2B	A-IG SH8 IPA 4mm glass	15.18	60.46	60.86	9.72	3b	Low hazard
	2C	P-IG SH8 Profile 4mm glass	15.15	58.68	30.61	6.49	4	Low hazard
Test 8 ISO EXV25	1A	A-IG Ultra 600 IPA	14.19	60.66	22.38	10.07	2	No Hazard
	1B	A-IG SH8 Profile	14.28	63.41	23.12	15.07	3b	Low hazard
	1C	A-IG Ultra 600 IPA 4mm glass	14.19	60.66	22.38	10.07	3b	Low hazard
	2A	P-IG SH8 Profile	14.19	60.66	22.38	10.07	3b	Low hazard
	2B	A-IG SH8 Profile	14.28	63.41	23.12	15.07	3b	Low hazard
	2C	A-Monolithic Ultra Prestige70 IPA 4mm glass	14.19	60.66	22.38	10.07	5	High Hazard

Legend:	P - Painted (powder coat) frame	IPA - Impact Protection Adhesive
	A - Anodized frame	Profile - IPP Impact Protection Profile
	Monolithic – single pane glass ¼” annealed (6mm)	Daylight - Film only, no attachment of film to frame
	IG - Insulated Glass double pane ¼” annealed (6mm)	

Figure 1: Summary of Test Results

Notes:

1. The ISO standard states that percentage difference values for Pressure and Impulse up to -15 % are acceptable as long as the average of the pressure and impulse percentage difference is greater than 0.
2. GSA - General Services Administration
3. ISO - International Standards Organization
4. EXV25 - External Vehicle with charge set @ 25 meters standoff distance
5. GSA full compliance requires three samples per condition