

TEST 1 SUMMARY

Date: 24 September 2003
 Nominal Charge Weight, lb ANFO: 600
 Standoff to each structure, ft: 170
 Avg. Measured Peak Pressure, psi: 4.19
 Avg. Measured Positive Impulse, psi-msec: 28.96
 Time of Detonation: 12:34 pm
 Ambient Temperature, deg F: 75

	Window 1	Window 2	Window 3	Window 4
Specimen Description	1/4" monolithic AG, wet-glazed 8-mil security film (4-sided attachment – 3M Ultraflex)	1/4" monolithic AG, wet-glazed 4-mil security film (4-sided attachment – 3M Ultraflex)	1/4" monolithic AG, mechanically attached 4-mil security film (4-sided batten bar attachment)	1/4" AG (outer), 1/2" air gap, 1/4" AG (inner), wet-glazed 4-mil security film (4-sided attachment – 3M Ultraflex)
Damage Description	Glazing left frame and landed 90 inches to the exterior of the structure. Right side ⁶ of frame deformed into window opening approximately 1 inch.	Glazing left frame and landed 103 inches to the exterior of the structure. No visible frame deformation.	Batten bar attachment screws failed along lower left side ⁶ , and film tore in lower left hand corner ⁶ . Bottom of frame deformed into window opening approximately 3 inches.	Outer pane failed with fragments landing outside of structure. Inner pane film remained attached to frame. No visible frame deformation.
Window Glazing Response	Glazing landed outside of structure. Fragments landed in 3b region inside of structure. No impacts evident on witness panel.	Glazing landed outside of structure. Fragments landed in 3b region inside of structure. No impacts evident on witness panel.	Film remained attached to the frame, but most of the glass was stripped from the film and landed to the exterior of the structure. One glass fragment impacted the witness panel in Region 4.	Inner pane film remained attached to the frame, but some of the glass was stripped from the film and landed to the exterior of the structure. Light dusting of glass on sill. No impacts evident on witness panel.
Hazard Level	Low	Low	Medium	None
Protection Level	High	High	Medium	Very High
Performance Condition	3b	3b	4	2

Test Notes:

- 1) All window units had a 1/2 inch minimum bite.
- 2) Windows were mounted in commercial aluminum frames: clear opening = 46.00 inches x 64.00 inches.
- 3) AG = annealed glass, TTG = tempered glass.
- 4) Witness panels were located 120 inches behind window.
- 5) The test bed is situated at an altitude of 6200 ft above sea level.
- 6) Window edges (left and right) are based on a person standing to the exterior of the window looking inward.
- 7) All wet glazed systems contained 1/2 inch (glazing edge) x 3/4 inch (frame edge) silicone contact lengths.
- 8) 3M Ultraflex was used for all wet-glazed attachments.
- 9) Windows were mounted by "sandwiching" the frame between steel plates (mounted to the outside of the window opening) and steel tubes (mounted to the inside of the window opening). The steel plates were mounted to the structure using 1/2 inch diameter bolts spaced at 12 inches on center while tube bolts were spaced at 6 inches on center. #10 self-tapping screws spaced at 12 inches on center connected the outer steel plates to the aluminum frame.
- 10) 2-sided mechanical attachments were connected along the jambs of the window frame.

TEST 2 SUMMARY

Date:	24 September 2003
Nominal Charge Weight, lb ANFO:	600
Standoff to each structure, ft:	170
Avg. Measured Peak Pressure, psi:	4.15
Avg. Measured Positive Impulse, psi-msec:	29.08
Time of Detonation:	3:47 pm
Ambient Temperature, deg F:	79

	Window 1	Window 2	Window 3	Window 4
Specimen Description	1/4" monolithic AG, mechanically attached 8-mil security film (2-sided batten bar attachment) ¹⁰	1/4" monolithic AG, mechanically attached 4-mil security film (2-sided batten bar attachment) ¹⁰	1/4" monolithic AG, mechanically attached 6-mil security film (2-sided batten bar attachment) ¹⁰	1/4" AG (outer), 1/2" air gap, 1/4" AG (inner), wet-glazed 6-mil security film (4-sided attachment – 3M Ultraflex)
Damage Description	Glazing left frame and fell just outside of structure. Batten bar attachment screws failed along left side ⁶ , and film tore along right side ⁶ batten bar. Sides of frame deformed into window opening up to 1-3/4 inches.	Glazing left frame and landed 36 inches to the exterior of the structure. Film tore along both left and right batten bars. Sides of frame deformed into window opening up to 1-3/4 inches.	Glazing remained in window opening due to mechanical attachment of film, although the film tore along a significant length of the batten bars. Sides of frame deformed into window opening up to 2 inches.	Outer pane failed with fragments landing outside of structure. Inner pane remained attached to frame. Slight deformation at bottom of frame.
Window Glazing Response	Glazing landed outside of structure. Glass fragments landed inside of structure. One glass fragment impacted the witness panel in Region 5.	Glazing landed outside of structure. Glass fragments landed inside of structure. Two glass fragments impacted the witness panel in Region 4.	Film remained attached to the frame in just two small areas along the batten bars, but glazing did not fall. Two glass fragments impacted the witness panel in Region 4.	Inner pane cracked but remained intact. No fragments visible inside structure. No impacts evident on witness panel.
Hazard Level	High	Medium	Medium	None
Protection Level	Low	Medium	Medium	Very High
Performance Condition	5	4	4	2

Test Notes:

- 1) All window units had a 1/2 inch minimum bite.
- 2) Windows were mounted in commercial aluminum frames: clear opening = 46.00 inches x 64.00 inches.
- 3) AG = annealed glass, TTG = tempered glass.
- 4) Witness panels were located 120 inches behind window.
- 5) The test bed is situated at an altitude of 6200 ft above sea level.
- 6) Window edges (left and right) are based on a person standing to the exterior of the window looking inward.
- 7) All wet glazed systems contained 1/2 inch (glazing edge) x 3/4 inch (frame edge) silicone contact lengths.
- 8) 3M Ultraflex was used for all wet-glazed attachments.
- 9) Windows were mounted by "sandwiching" the frame between steel plates (mounted to the outside of the window opening) and steel tubes (mounted to the inside of the window opening). The steel plates were mounted to the structure using 1/2 inch diameter bolts spaced at 12 inches on center while tube bolts were spaced at 6 inches on center. #10 self-tapping screws spaced at 12 inches on center connected the outer steel plates to the aluminum frame.
- 10) 2-sided mechanical attachments were connected along the jambs of the window frame.

TEST 3 SUMMARY

Date:	25 September 2003
Nominal Charge Weight, lb ANFO:	600
Standoff to each structure, ft:	170
Avg. Measured Peak Pressure, psi:	4.23
Avg. Measured Positive Impulse, psi-msec:	29.88
Time of Detonation:	10:38 am
Ambient Temperature, deg F:	67

	Window 1	Window 2	Window 3	Window 4
Specimen Description	1/4" monolithic AG, mechanically attached 8-mil security film (4-sided batten bar attachment)	1/4" monolithic TTG, daylight applied 8-mil security film	1/4" monolithic AG, daylight applied 8-mil security film	1/4" AG (outer), 1/2" air gap, 1/4" AG (inner), mechanically attached 4-mil security film (4-sided batten bar attachment)
Damage Description	Glazing remained in frame. Bottom of frame deformed into window opening approximately 3-1/4 inches. Sides of frame deformed into window opening approximately 1-1/4 inches.	Glazing left frame and landed 96 inches to the exterior of the structure. Minor deformation at bottom of frame. No other visible frame deformation.	Glazing left frame and fell just outside of structure. Slight deformation at bottom of frame. No other visible frame deformation.	Outer pane failed with fragments landing outside of structure. Inner pane remained attached to frame. No visible frame deformation.
Window Glazing Response	Film remained attached to the frame, but some of the glass was stripped from the film and landed to the exterior of the structure. Fragments landed in 3b region inside of structure. No impacts evident on witness panel.	Glazing landed outside of structure. Fragments landed in 3b region inside of structure. No impacts evident on witness panel.	Glazing landed outside of structure. Fragments landed in 3b region inside of structure. No impacts evident on witness panel.	Inner pane cracked but remained intact. No fragments visible inside structure. No impacts evident on witness panel.
Hazard Level	Low	Low	Low	None
Protection Level	High	High	High	Very High
Performance Condition	3b	3b	3b	2

Test Notes:

- 1) All window units had a 1/2 inch minimum bite.
- 2) Windows were mounted in commercial aluminum frames: clear opening = 46.00 inches x 64.00 inches.
- 3) AG = annealed glass, TTG = tempered glass.
- 4) Witness panels were located 120 inches behind window.
- 5) The test bed is situated at an altitude of 6200 ft above sea level.
- 6) Window edges (left and right) are based on a person standing to the exterior of the window looking inward.
- 7) All wet glazed systems contained 1/2 inch (glazing edge) x 3/4 inch (frame edge) silicone contact lengths.
- 8) 3M Ultraflex was used for all wet-glazed attachments.
- 9) Windows were mounted by "sandwiching" the frame between steel plates (mounted to the outside of the window opening) and steel tubes (mounted to the inside of the window opening). The steel plates were mounted to the structure using 1/2 inch diameter bolts spaced at 12 inches on center while tube bolts were spaced at 6 inches on center. #10 self-tapping screws spaced at 12 inches on center connected the outer steel plates to the aluminum frame.
- 10) 2-sided mechanical attachments were connected along the jambs of the window frame.

TEST 4 SUMMARY

Date:	25 September 2003
Nominal Charge Weight, lb ANFO:	600
Standoff to each structure, ft:	170
Avg. Measured Peak Pressure, psi:	4.21
Avg. Measured Positive Impulse, psi-msec:	29.72
Time of Detonation:	1:30 pm
Ambient Temperature, deg F:	75

	Window 1	Window 2	Window 3	Window 4
Specimen Description	1/4" AG (outer), 1/2" air gap, 1/4" AG (inner), wet-glazed 8-mil security film (4-sided attachment – 3M Ultraflex)	1/4" AG (outer), 1/2" air gap, 1/4" AG (inner), daylight applied 6-mil security film	1/4" AG (outer), 1/2" air gap, 1/4" AG (inner), daylight applied 8-mil security film	1/4" AG (outer), 1/2" air gap, 1/4" AG (inner), mechanically attached 8-mil security film (4-sided batten bar attachment)
Damage Description	Outer pane failed with fragments landing outside of structure. Inner pane remained attached to frame. No visible frame deformation.	Outer pane failed with fragments landing outside of structure. Inner pane left the frame and fell just outside of structure. Minor deformation at bottom of frame. No other visible frame deformation.	Outer pane failed with fragments landing outside of structure. Top and bottom of inner pane pulled out of frame while the sides remained attached. Deformation occurred at bottom of frame. No other visible frame deformation.	Outer pane failed with fragments landing outside of structure. Inner pane did not leave frame, but small tears (approximately 8 to 11 inches in length) occurred in film at bottom corners. No visible frame deformation.
Window Glazing Response	Inner pane cracked but remained in frame. Light dusting of glass on sill. No impacts evident on witness panel.	Glazing landed outside of structure. Fragments landed in 3b region inside of structure. No impacts evident on witness panel.	Inner pane cracked but remained in frame and attached at the sides. One glass fragment impacted the witness panel in Region 4. Two glass fragments impacted the witness panel in Region 5.	Inner pane cracked but remained in frame. Fragments landed in 3a region inside of structure. No impacts evident on witness panel.
Hazard Level	None	Low	High	Very Low
Protection Level	Very High	High	Low	High
Performance Condition	2	3b	5	3a

Test Notes:

- 1) All window units had a 1/2 inch minimum bite.
- 2) Windows were mounted in commercial aluminum frames: clear opening = 46.00 inches x 64.00 inches.
- 3) AG = annealed glass, TTG = tempered glass.
- 4) Witness panels were located 120 inches behind window.
- 5) The test bed is situated at an altitude of 6200 ft above sea level.
- 6) Window edges (left and right) are based on a person standing to the exterior of the window looking inward.
- 7) All wet glazed systems contained 1/2 inch (glazing edge) x 3/4 inch (frame edge) silicone contact lengths.
- 8) 3M Ultraflex was used for all wet-glazed attachments.
- 9) Windows were mounted by "sandwiching" the frame between steel plates (mounted to the outside of the window opening) and steel tubes (mounted to the inside of the window opening). The steel plates were mounted to the structure using 1/2 inch diameter bolts spaced at 12 inches on center while tube bolts were spaced at 6 inches on center. #10 self-tapping screws spaced at 12 inches on center connected the outer steel plates to the aluminum frame.
- 10) 2-sided mechanical attachments were connected along the jambs of the window frame.

TEST 5 SUMMARY

Date: 25 September 2003
 Nominal Charge Weight, lb ANFO: 600
 Standoff to each structure, ft: 170
 Avg. Measured Peak Pressure, psi: 4.21
 Avg. Measured Positive Impulse, psi-msec: 30.07
 Time of Detonation: 3:49 pm
 Ambient Temperature, deg F: 77

	Window 1	Window 2	Window 3	Window 4
Specimen Description	1/4" monolithic AG, mechanically attached 4-mil security film (2-sided batten bar attachment) ¹⁰	1/4" monolithic TTG, mechanically attached 4-mil security film (4-sided batten bar attachment)	1/4" monolithic AG, wet-glazed 4-mil security film (4-sided attachment – 3M Ultraflex)	1/4" monolithic AG, wet-glazed 6-mil security film (4-sided attachment – 3M Ultraflex)
Damage Description	Film tore along entire left edge ⁶ and glazing folded into window opening, attached to frame only at the right edge ⁶ . Sides of frame deformed into window opening up to 1-1/2 inches.	Film tore throughout large center region of glazing with torn area falling to the exterior of the structure. Sides of frame deformed into window opening up to 1-1/2 inches.	Top, bottom, and right edge ⁶ of glazing pulled out of frame. Glazing attached to the frame only at left edge ⁶ . No visible frame deformation.	Glazing left frame and landed approximately 48 inches to the exterior of the structure. Sides of frame deformed into window opening up to 1 inches.
Window Glazing Response	Glazing hung half inside and half outside the structure. Fragments landed in 3b region inside of structure. No impacts evident on witness panel.	Center area of glazing hung outside of structure. Fragments landed in 3b region inside of structure. No impacts evident on witness panel.	Glazing hung outside of structure. One glass fragment impacted the witness panel in Region 5.	Glazing landed outside of structure. One glass fragment impacted the witness panel in Region 4.
Hazard Level	Low	Low	High	Medium
Protection Level	High	High	Low	Medium
Performance Condition	3b	3b	5	4

Test Notes:

- 1) All window units had a 1/2 inch minimum bite.
- 2) Windows were mounted in commercial aluminum frames: clear opening = 46.00 inches x 64.00 inches.
- 3) AG = annealed glass, TTG = tempered glass.
- 4) Witness panels were located 120 inches behind window.
- 5) The test bed is situated at an altitude of 6200 ft above sea level.
- 6) Window edges (left and right) are based on a person standing to the exterior of the window looking inward.
- 7) All wet glazed systems contained 1/2 inch (glazing edge) x 3/4 inch (frame edge) silicone contact lengths.
- 8) 3M Ultraflex was used for all wet-glazed attachments.
- 9) Windows were mounted by "sandwiching" the frame between steel plates (mounted to the outside of the window opening) and steel tubes (mounted to the inside of the window opening). The steel plates were mounted to the structure using 1/2 inch diameter bolts spaced at 12 inches on center while tube bolts were spaced at 6 inches on center. #10 self-tapping screws spaced at 12 inches on center connected the outer steel plates to the aluminum frame.
- 10) 2-sided mechanical attachments were connected along the jambs of the window frame.