

**Safetydrape® – Blast Curtain**  
**Test Report ARA-TR-98-4626.1-2**

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*Engineering and Applied Science*

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# **Safetydrape® Blast Curtain**

Test Report



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# Safetydrape® – Blast Curtain

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### Abstract

Applied Research Associates, Inc. (ARA) performed an explosive test on January 26, 1998 to evaluate the performance of a blast curtain. The test was conducted in accordance with the US General Services Administration's "Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loadings." This draft standard is an adaptation of the ASTM method F1642-96. The blast curtain was designed, manufactured and installed by Mitigation Technologies of Columbia, MD. During the explosive test, ¼ in. thick annealed glass windows were subjected to a 4 psi blast overpressure from the detonation of 600 lb of Ammonium Nitrate and Fuel Oil (ANFO is the same explosive type used in the Oklahoma City Bombing). The test explosion was equivalent to the detonation of 500 lb of TNT. Test windows were nominally 4 by 5-1/2 ft, and included windows with and without blast curtain protection.

The test showed that a window with no blast curtain failed catastrophically propelling hazardous shards of glass to the back of the enclosed test cubicle at high velocity. This response corresponds to a GSA hazard/protection Condition 5 (high hazard and low level of protection). An identical window with the Safetydrape® blast curtain installed and tested to identical blast conditions showed a significant reduction in hazard. For the protected window, the glass shards were caught and retained by the blast curtain. This result corresponds to a GSA Condition 3 (low hazard and high level of protection). The tested pressure level and resulting Condition 3 indicate that the Safetydrape® blast curtain is an appropriate and viable technology for meeting GSA's glazing protection requirements for Level C buildings in the federal inventory.

### Background

Propelled by the forces of a terrorist bomb, glass fragments cause large numbers of serious injuries. In response to the heightened concern about terrorism, the US Government and private industry are developing and testing new technologies to mitigate hazards to people in the vicinity of a terrorist bombing. One such technology is a blast curtain. The Safetydrape® blast curtain is made of a tear resistant warped knit fabric. The curtain is hung from a curtain rod and is installed

*ARA performed this explosive test on a Defense Special Weapons Agency test site on Kirtland Air Force Base. The test articles are shown to the left of the detonation.*

*Using high explosives and enclosed structures allows test articles to experience realistic effects during a test to include both positive and negative pressures.*

*This test used the GSA standard test method to evaluate the Safetydrape® blast curtain.*



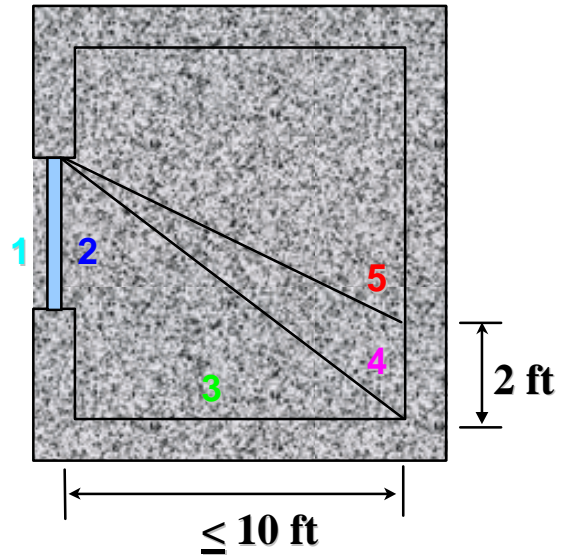
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so that the curtain is longer than the height of the window. The excess curtain at the bottom of the window is folded into an aluminum tray. The bottom seam of the curtain is weighted with lead. Upon breakage of the window due to the blast and upon experiencing the infill pressures from the blast, the curtain billows out and catches the glass fragments.

The GSA developed criteria for evaluation of acceptable levels of protection for the glass fragment hazard. This criteria is part of a comprehensive document (GSA Security Criteria, Final Working Version, January 1997) that includes all aspects of physical and operational security for blast considerations. The GSA criteria requires that manufacturers test their products against the criteria to evaluate the performance of these products in blast.

The GSA glass fragment hazard rating scheme is summarized below. The approach

compares potential hazards based on the type and location of glass fragments interior and exterior to the test cubicle. These criteria indirectly reflect the velocity (hence lethality) of fragments based on their distance from the window. A Condition 3 meets the requirements for federal buildings requiring Level C protection in accordance with GSA's criteria.



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
3	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

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## Test Summary

Date:	1/26/98
Time of Detonation:	12:30 pm
Location:	Chesnut Range, Kirtland AFB, Albuquerque, NM
Temperature:	56 degrees F
Charge Type:	ANFO
Charge Weight:	600 lbs
Stand-off Distance:	190 ft
Predicted:	
Peak Pressure:	4.0 psi
Peak Impulse:	28.8 psi-msec
Average Measured:	
Peak Pressure:	4.02 psi
Peak Impulse:	29.76 psi-msec
Test Window Samples:	<ol style="list-style-type: none"> <li>1. ¼ in. thick annealed glass with no blast curtain</li> <li>2. ¼ in. thick annealed glass with the Safetydrape® blast curtain installed</li> </ol>
All samples used 48 X 66 in. glass panes	
Test Method:	<p>“Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loadings.” This draft standard is an adaptation of the ASTM method F1642-96.</p>

The explosive charge was placed in a cylindrical configuration at 190 ft from the test windows. The windows were mounted in enclosed concrete reaction structures. Foam witness panels were mounted approximately 10 ft behind the window glass to record any glass fragment impacts during the test.



Blast pressures were measured with pressure gages mounted on the face of the reaction structures.

## Test Results

The test was conducted as planned. All instrumentation and cameras functioned as designed.

The results for the unprotected window and the window protected with the Safetydrape® blast curtain are as follows:

### ***Unprotected Window (HIGH HAZARD)***

The window glass with no protection catastrophically failed under the 4 psi blast load. Large shards of hazardous glass were propelled to the back of the concrete reaction structure impacting the witness panel. Approximately 95 percent of the glass was separated from the window frame and landed inside the structure.

This catastrophic, hazardous failure is rated a Condition 5 (HIGH HAZARD) by the GSA rating criteria. This result also corresponds to a HIGH HAZARD in accordance with the British Glazing Hazard Guide.

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## *Unprotected Window (HIGH HAZARD)*

Exterior and interior views of the unprotected window before and after the test explosion are shown on this page. Note the highly hazardous glass fragments that are strewn throughout the test cubicle.



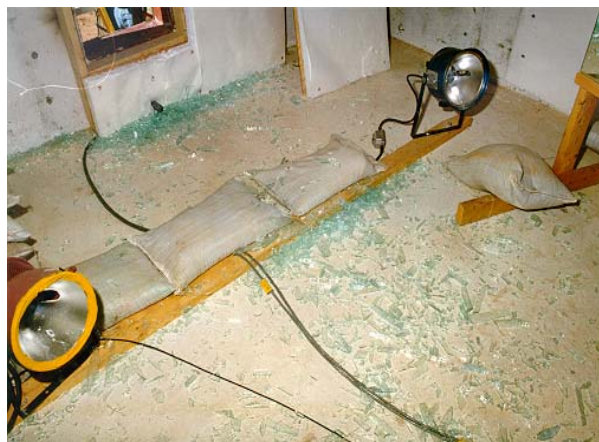
*Exterior view of the unprotected window before the test.*



*Interior view of glass fragments inside the reaction structure.*



*Exterior view of the unprotected window after the test.*



*Interior close up view of glass fragments looking toward the rear of the reaction structure.*

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## *Protected Window (LOW HAZARD)*

The window glass catastrophically failed under the 4 psi blast load. Large shards of hazardous glass were propelled into the reaction structure but were caught and retained by the Safetydrape® blast curtain. There were no glass fragment impact marks at the rear of the structure.

This controlled glass failure is rated a Condition 3 (LOW HAZARD) by the GSA rating criteria. This result also corresponds to a LOW HAZARD in accordance with the British Glazing Hazard Guide.



*Pre- and Post-test exterior views of the window protected with the Safetydrape® blast curtain system.*

