



# Performance Testing of Historically Appropriate Blast-Resistant Windows

04-219

## Background:

Conventional building components are not designed to withstand the excessive loads arising from a terrorist bomb attack. Common annealed glass windows shatter at very low pressures, and the resulting fragmentation debris is widely understood to be the single greatest cause of injuries to building occupants in a bomb blast. Research activities by some federal agencies have led to significant improvements in protecting occupants of conventional government facilities from blast effects, and DoD maintains a standards document that specifies minimum antiterrorism standards for its more densely occupied buildings. That document, UFC 4-010-01, directs considerable attention toward the issue of window performance in a blast environment.

Window manufacturers are continually introducing innovative methods and products for which persuasive-sounding blast performance claims are made. Products include both window modification hardware and full replacement systems. Blast-resistant replacement windows may often represent the best choice for meeting the occupant protection requirements of UFC 4-010-01. The problem for military buyers is that manufacturer claims for many available systems have not been analyzed or tested under ASTM F1642, *Standard Test Method for Glazing Systems Subject to Airblast Loadings*, as stipulated by UFC 4-010-01.

The procurement of blast-resistant windows is further complicated when the building to be protected is listed or eligible for listing on the National Register of Historic Places. Such buildings must be rehabilitated according to the Secretary of the Interior's Standards for Rehabilitation (36 CFR Part 67) in order to comply with the National Historic Preservation Act of 1966 as amended (16 USC 470). However, most blast-resistant windows currently on the market do not comply with those standards.

## Objective:

The principal objective of this research was to provide DoD with manufacturer-independent test data for historically compatible blast-resistant windows and interpret the findings in terms of the minimum threats and levels of protection defined in UFC 4-010-01. A secondary objective was to provide DoD with a listing of blast test facilities and blast-resistant window manufacturers, capable of complying with UFC 4-010-01 and 36 CFR Part 67.

## Summary of Approach:

Research began with a literature review to explore blast-resistant window performance, testing, and related issues. Then it was necessary to identify blast resistant window vendors thought to have manufacturing capabilities and products suitable for historic building applications. This was accomplished using referrals, the Internet, and introductory correspondence. Based on company profiles, brochures, test data, reports, and completed projects, 18 capable manufacturers were identified. These companies were solicited for interest in the testing program.

Interested parties completed a Prequalification Worksheet developed by the project team that outlined blast testing program parameters and requirements. Vendor input on the worksheet provided the basis for final participant selections. Each finalist then entered into a Cooperative Research and Development Agreement (CRADA) with ERDC-CERL that established roles and responsibilities for program participation. Window specimens manufactured under the CRADA were shipped directly to the contract test facility. Blast performance testing occurred over a 2-day period in August 2007 and the test facility subsequently provided the ASTM F1642-compliant window test reports found in the technical report.

## Benefit:

Those who procure blast-resistant window systems for historic military buildings can benefit from manufacturer-independent test data that confirms product compliance with UFC 4-010-01. Since professional expertise is also required to determine whether replacement windows comply with 36 CFR Part 67, installation personnel can benefit from guidance on selecting historically appropriate window replacements.

## Accomplishments:

The technical report steps the reader through the process of designing and testing blast-resistant windows compliant with both UFC 4-010-01 and the SOI standards. It also provides a directory of U.S. blast test facilities and blast-resistant window manufacturers.

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