Making an IMPACT

Designing for Blast Mitigation Criteria

by R. C. Goyal

Graham Architectural Products
800-755-6274

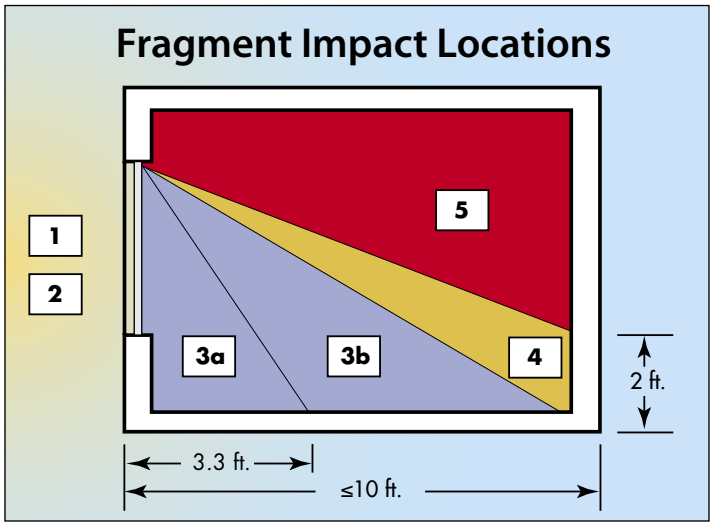
I have been in the window and curtainwall industry for more than three decades, and until a few years ago I could not have imagined that we would be designing windows, doors and curtainwall systems for bomb-blast mitigation.

The more we learn about blast mitigation, the more we want to know. This is one subject that still leaves more questions than answers, even after you delve into it. While our daily lives revolve around windows, blast-mitigation products represent, more so than other types of fenestration, the reality of life and death.

The fact is, the business of designing windows for blast remediation or mitigation cannot be taken lightly. These products are designed to protect people before all else. In the past, when the design of a window product was compromised it may have allowed excessive water or air to enter the premises, without consideration of loss of life or limb. Blast-mitigation product design, on the other hand, cannot be compromised. Doing so could mean loss of life or limb.

Design Criteria

Some window manufacturers seem to equate an AAMA HC-96 or AW-96 product to the current UFC 4-010-01 criteria for 1 psi (144 psf) static equivalent load for blast. Nothing could be further from the truth. If manufacturers review the October 2003 UFC 4-010-01 anti-terrorism force protection (ATFP) criteria, they should take note of the structural requirements in section three, paragraphs B-3.1.2.3 and B-3.1.2.2 to understand that a static 144 psf load (1-1/2 times an AAMA design load) will not be sufficient to remediate a 1 psi blast load. This illustrates the common lack of information that currently exists among procurement officers, contractors and the suppliers of windows alike. It is important to stress again that blast-mitigation products are designed to save lives and prevent injuries and keep the buildings operational during incidents of terrorism, whether home-grown or external.



The UFC 4-010-01, revised in October 2003, clearly states the requirements as follows in addition to the 1 psi static equivalent load and laminated glass:

1. The glazing bite is to be 3/8-inch for structural glazed units and a bite of 1 inch for non-structural glazed units.
2. Frame connections, glazing stops connections, hardware connections and connections to the substrate shall be 10.8 psi if glass is less than 1 square meter and 4.4 psi if the glass is 1 to 3 square meters.

This should make it clear that an AAMA HC/AW 96 product will not meet the UFC criteria.

Common Misunderstandings

It is also a misunderstanding that if the minimum standoff distance of 82 feet is met within a parameter-controlled area, UFC criteria of blast need not be applied. This is incorrect. The UFC tables show there are blast criteria requirements even when the minimum standoff distance is met in a parameter-controlled area.

A procurement officer recently told me he was seeking a "blast-deterring" and "blast-proof" window and not the "blast-mitigation" window that I was proposing. I had no choice but to tell him that there is no such thing as blast-proof windows. No matter how we design windows, they are designed to mitigate a given size blast. Since we cannot control the amount of charge or the distance, there can never be a blast-proof window. We can only design a window to mitigate the threat level defined by the risk assessment of the buildings.

Buildings cannot be made bombproof. We have to accept the limitation of how extensive or how widespread the damage can be or, in essence, the acceptable damage to life and property. Blast pressures of more than 15 psi can collapse lungs and/or crush the skull, whereas in real life, we have seen blast pressures of the magnitude of 4,000 psi, such as in the Oklahoma City bombing. That is why the damage and injuries were sustained as far away as 20 blocks (2 1/2 miles) from the blast.

A Need for Remediation

Blast-remediation requirements may be seen as linked to the 9-11-2001 tragedy — an attack on our homeland. In reality, the federal government and FBI have been tracking bombing incidents since the early 1980's, including:

1983 - U.S. Beirut car bomb and Kuwait car bomb;
1984 - Beirut mob attack;
1995 - Oklahoma Federal Building;
1996 - Khobar Towers; and
1998 - Embassy bombings in Nairobi and Dar es Salaam.

The 9-11 tragedy in New York and at the Pentagon accelerated the process for us to strengthen the buildings to protect people. The General Service Administration (GSA) had already conducted a survey of 1,239 buildings in 1995 to assess the risk factors for these buildings and had proposed a criterion to protect these buildings from many threats, including blasts. The risk assessment of these buildings ultimately resulted in the protection level matrix to help define the hazards and appropriate protection levels.

"... blast mitigation products are designed to save lives and prevent injuries and keep the buildings operational during incidents of terrorism, whether it is home grown or external.

The most commonly used protection levels are 2, 3a and 3b (see chart below). Essentially, level 2 protection is when no debris after the blast comes to the inside of the building. Level 3a protection provides that the debris can fall within 1 meter of the windowsill and level 3b provides that the debris cannot travel beyond three meters. It is intended that in level 2 there will not be any injuries. Level 3a may sustain cuts and bruises, whereas level 3b may sustain non life-threatening injuries. These risk factors are a compromise of the accepted level of risk since the cost of the product goes up exponentially as the level of protection approaches level 1.

Standard Development

As it stands there is no single blast-remediation standard. GSA has a testing criterion and test protocol, but not a standard for blast mitigation. DOD uses the UFC 2003 recommendation, which stipulates a minimum of 7KPA (1 psi) protection for all buildings with a standoff distance of 82 feet, and higher blast loads when the building is located less than 82 feet. All agencies of the federal government do accept the shock tube and the arena test methods as a way to verify compliance.

Since there is no single standard and no guidelines available to the specifiers and manufacturers, The National Institute of Building Sciences (NIBS) contacted AAMA to facilitate the formulation of an industry and government group to develop a road map so that the specifiers and manufacturers could work toward developing an understanding of what is needed for blast remediation of windows. Since it requires that standoff distances and charge weights be converted to pressures and impulses, a great deal of expertise was needed among members of this industry group. The group consists of a standing committee of experts from AAMA, PGC, blast consultants and government agencies such as GSA, DOD, USACE, NIBS, DOJ and DOS. It has already developed a fifth draft and hopes to finish the task by the end of 2004. The plan is for the document to be published by AAMA in cooperation with NIBS. The goal is to help clarify many misunderstandings regarding blast remediation to protect people first.

R. C. (Raj) Goyal is director of marketing and business development for Graham Architectural Products of York, Pa.

Protection Levels Based on Fragment Impact Locations

Condition	Description	Glazing Response	Hazard	Protection
1	Glass not cracked, fully survived and/or fully retained by frame and no glass fragments either inside or outside structure.	None	None	Safe
2	Glass may be cracked but is retained in frame.	No significant fragments. Dusting or very small fragments near sill or on floor acceptable.	None	Very High
3a	Glass failed and not fully retained in frame.	Yes – Lands on floor no more than 3.3 feet from window.	Very Low	High
3b	Glass failed and not fully retained in frame.	Yes – Lands on floor no more than 10 feet from window.	Low	High
4	Glass failed and not fully retained.	Yes – Lands on floor more than 10 feet from window and impacts a vertical surface located not more than 10 feet behind window no higher than 2 feet above floor level.	Medium	Medium
5	Glass fails catastrophically.	Yes – Lands on floor more than 10 feet from window and impacts a vertical surface located not more than 10 feet behind window above a height of 2 feet.	High	Low