EXPLOSION EROSION

SHUTTERSTOCK

Planning ahead is critical to mitigating the potential of vehicle bombs.

By I. Paul Lew, P.E., CAPP

It's been nearly two years since a failed attempt to detonate a vehicle bomb in New York's Times Square. As was demonstrated in this event and more so in the 1995 Oklahoma City federal building bombing and bomb in the garage of the World Trade Center in 1993, vehicle-borne bombs offer terrorists an opportunity to bring large amounts of explosives close to a target. Parking provides a convenient way to accomplish these terrorist objectives. Pre-emptive planning can be critical to preventing these sorts of crises, and parking professionals have an important role to play.

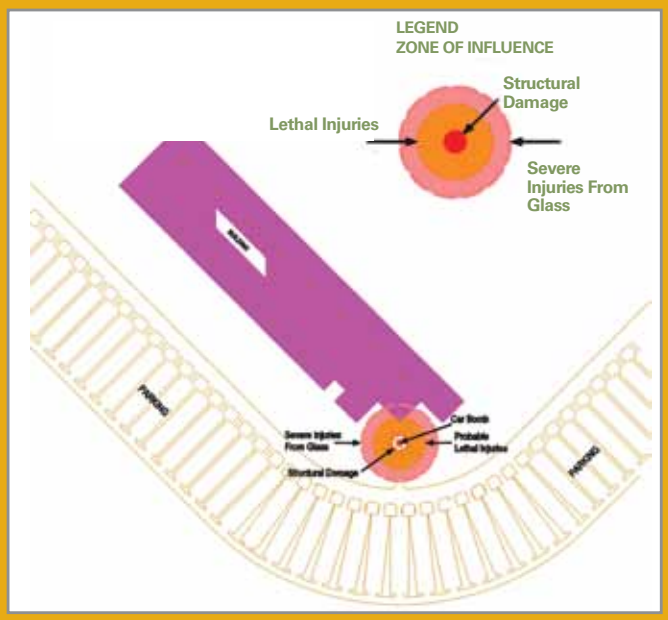


Figure 1—Blast Analysis of Car Bomb Detonated in Entry Cul De Sac

FIgure 2—Blast Analysis of Truck Bomb Detonated in Entry Cul de Sac

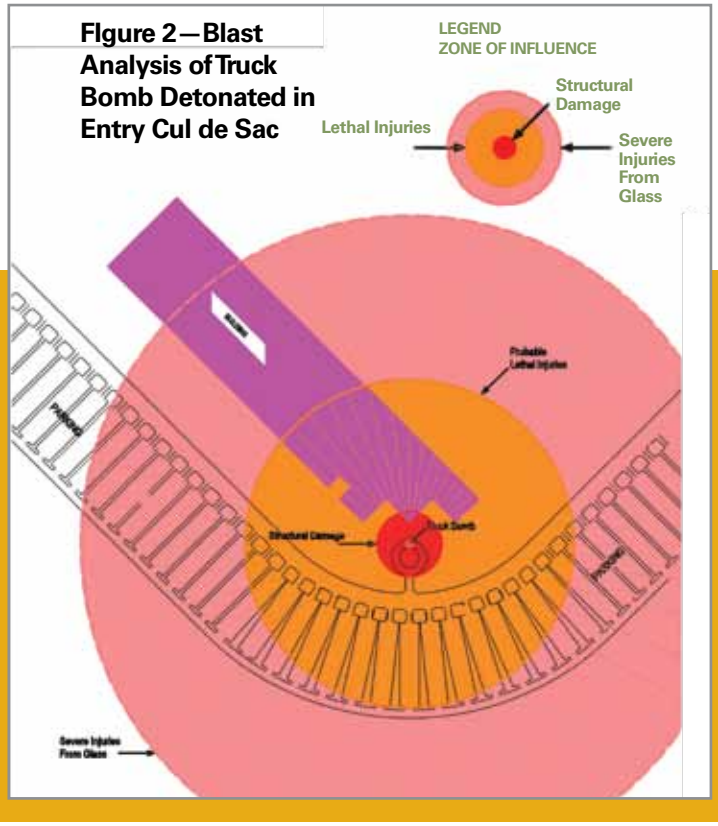


Figure 3—Blast Range Effects

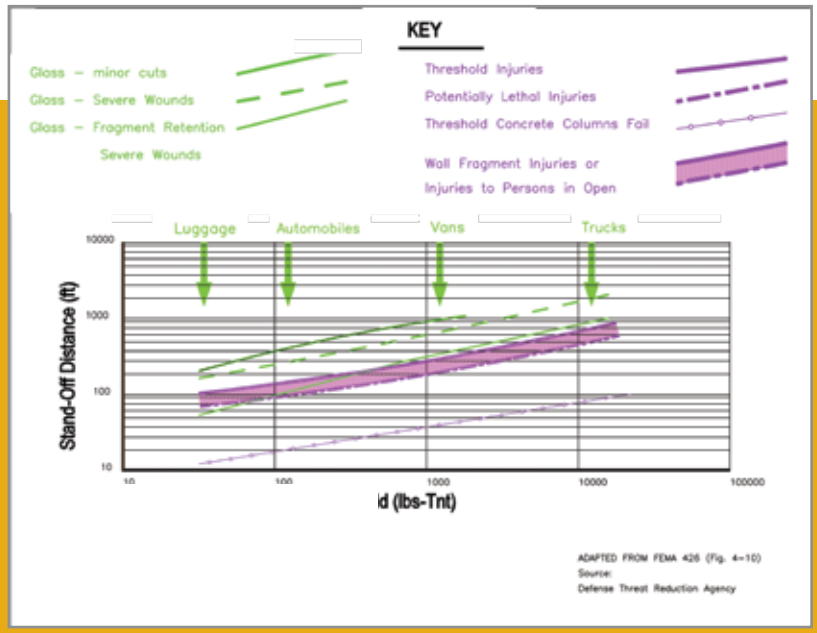


Figure 1 shows the zone of effect of a car bomb. Although large, its damage is more limited than that of larger vehicle attacks. Figure 2 shows the zone of effect of a truck bomb. In a truck explosion, the zone is much more extensive and the ability to mitigate the damage and injury is much more limited.

The key factor in determining the effect of a given blast is the "standoff distance," which is the distance between the blast and the target. The greater the standoff distance, the less damage and injury to the target can be anticipated. Figure 3 provides a comparison of standoff distance and size of explosive payload that various vehicles can deliver, and the damage and injury that can result. Obviously, trucks are the greatest risk; where possible, remote truck loading and docking is advisable to limit access to a main campus.

Fortunately, truck access is not the parking professional's primary concern, but medium range vehicles, such as vans, are. Vans have been the vehicle of choice in some of the most lethal terrorist attacks in America, and the strategies to address the potential threat from these, SUVs, and small pickup trucks are all part of a parking risk management plan.

The First Step: Risk Assessment

The parking risk management plan is itself based on a risk assessment. It's important to understand that the goal of terrorism is not to blow up a parking lot or structure, but rather to blow up an adjacent asset or target. A risk assessment covers the adjoining asset's risk and its proximity to parking. A key source for this risk assessment is the Federal Emergency Management Agency (FEMA) publication 426, entitled "Reference Manual to Mitigate Potential Terrorist Attacks Against Buildings."(1) This is a good source for preemptive planning for a terrorist event, and helps parking professionals and other stakeholders ascertain the risk for a particular situation.

A risk assessment covers three things: the asset's value, the asset's vulnerability, and a threat assessment. The assessment of the asset's value is a first step in the risk assessment; in this context, it's defined as a "resource of value requiring protection."(1)

The asset's values can be identified as core functions and processes, including services and outputs; activities; the building's occupants and visitors; and inputs and outputs to external organizations.

Once the building's core functions are identified, the impact of a terrorist attack can be evaluated. This includes:

- How many people would be injured or killed in a terrorist attack?
- What happens to the building's functions and services if the asset is lost or degraded?
- Whether critical or sensitive information is stored in the building.
- Whether backups exist.
- Replacement availability.

FEMA 426 also provides a basis to weigh the impact of the possible destruction of the asset, from grave to very low. These weights can be adjusted by the stakeholders.

Next is a vulnerability assessment of the asset. The key factors in the vulnerability assessment are utility, visibility, accessibility, presence of hazardous materials,

The Real Threat of Bombs

Thankfully, bombs aren't an everyday find in parking garages and lots, but explosions in parking facilities aren't unheard of. A sampling:

Date	Location	Aftermath
October 2008	Clayton, Mo.	One severely injured
February 1993	World Trade Center, N.Y.	Six killed, 1,000 injured
July 2011	Ashland, Ky.	One injured
May 2007	Las Vegas, Nev.	One killed, one injured
September 2008	West Chester, Pa.	Three bombs discovered before detonation
August 2011	Beirut, Lebanon	Two killed
December 2006	Madrid, Spain	Two killed, 52 injured

collateral damage potential, and population density.

In 1995, the Department of Justice developed scaled recommended asset value standards for federal facilities. General definitions of these value standards on the scale of one to five are:

1. Limited employees and low public contact.
2. Fewer than 150 employees, with moderate public contact and routine operations.
3. 151 to 450 employees with moderate to high public contact and either law enforcement roles or government records.
4. More than 450 employees with high public contact and high risk law enforcement activities or intelligence roles.
5. High-profile agencies or mission critical agencies to national security.

The modification of this scale to a particular situation is a subject for determination by stake holders in each unique situation, but it provides a context for making decisions.

The last aspect of the risk assessment is a threat assessment. The aggressor may seek publicity for his cause, monetary gain, or revenge for some perceived action against him or his group. A common method to evaluate terrorist threats is to analyze five conditions that may exist:

- Existence: Who is hostile?
- Capability: Can they get access to the material?
- History: Is there a history of violence?
- Intention: What does the terrorist hope to achieve?
- Target: Ability to perform surveillance.

Once a risk assessment is performed using the asset's value, vulnerability, and threat, risk management strategies can be developed.

Parking Risk Management

A key factor in any parking risk management scenario for blasts is standoff distance. The feasibility of having the necessary standoff distance may be constrained by site conditions, but planning must be developed within the limits available.

First, let's address trucks. When possible, try to provide relatively remote truck loading docks that do not require trucks to traverse the main campus. At the John Hopkins Medical Center, Baltimore, Md., a central loading dock facility was placed above a parking facility that sits across a wide boulevard from the hospital's main campus. This greatly increased the standoff distance from the main campus and negated the need for truck traffic to be on the main hospital campus. As a result, the potential damage from explosive events was substantially reduced.

Many university campuses have adopted pedestrian-only zones to increase the viability of campus life. In some instances, all parking is at the periphery of the campus and shuttles are provided to the academic quad. This strategy obviously facilitates security and increases the standoff distance while enhancing campus life.

Another approach to site planning is to have exclusive and non-exclusive zones that are typically based on standoff distances. Entry into the exclusive zone, where standoff distances are small, is through controlled access and only permitted for authorized vehicles.

Controlled access is warranted where risk assessment has indicated a threat. One approach is to limit access to

Figure 4—Blast Mitigation Strategies: Unbraced Columns

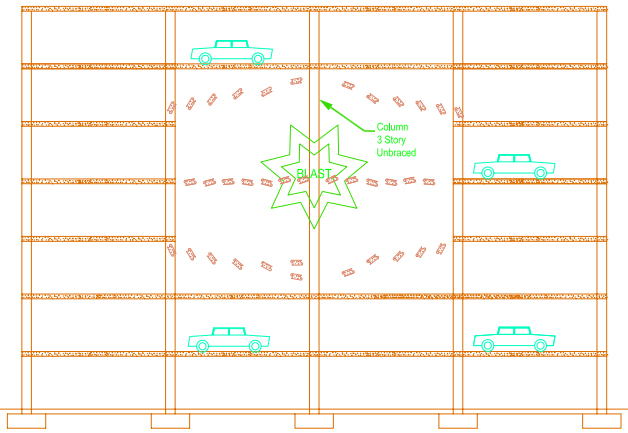
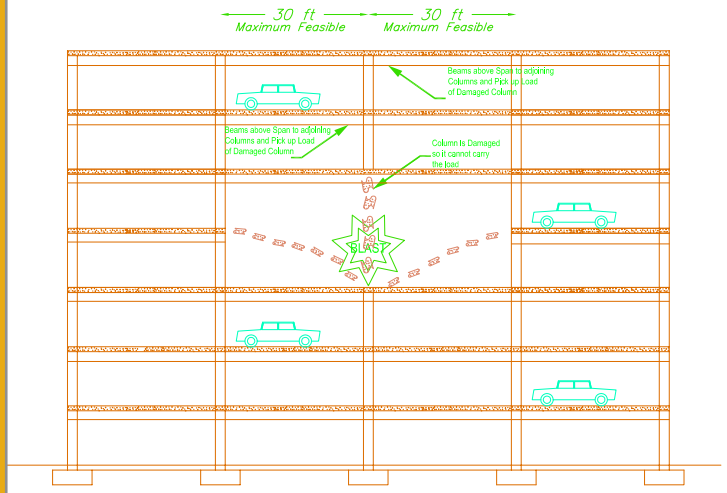


Figure 5—Blast Mitigation Strategies: Damaged Column



only authorized vehicles only via decals, placards, and card readers, with in-depth vehicle inspection required to access exclusive zones. These procedures limit or prohibit access of vans and require greater scrutiny of SUVs, which frequently have tinted rear windows that obscure any view of the cargo area. In cases where the risk assessment warrants, retractable bollards at entrances can be used to prevent entry.

Another way of screening vehicles entering large office or industrial campuses is to have a gated complex with a visitors' center to verify credentials and potentially inspect vehicles. Staff can then direct the visitors to the proper parking area.

Structural Mitigation

Parking structures can be designed to better withstand blasts from automobiles, SUVs, and small pickup trucks. Floors should be designed for upward pressure as well as gravity loads. This is a key consideration: blasts work upward on ceilings and downward on floors. This upward load is typically not considered in a building, but was a contributing factor in the Oklahoma City bombing.

Column spacing should be limited where blasts are a major consideration. Thirty foot column spacing is a practical limit that allows for short-span parking. Columns, too, should be designed to stand the weight of multiple floors (see Figure 4). This is to allow the building above to stand if floors are damaged. Designing columns for three stories unbraced has been suggested where circumstances warrant.

A critical concern in blast mitigation is progressive collapse, which is defined in FEMA 426 as a situation where a local failure of a primary structural member leads to the collapse of adjoining members in an expanding manner until part or all of the building collapses. Transfer girders should not be located in an area where vehicle-borne explosives could have access; this is because of the potential damage that could occur due to the lack of redundancy of such critical members.

Redundancy of load paths for both gravity and lateral load is a primary goal of blast mitigation from a progressive collapse. Where blasts are a significant concern, strategies that find alternate structural load paths when one primary member (typically a column) is destroyed can be implemented. Figure 5 shows the structural methodology that allows a building to stand when a column is destroyed. This approach comes at a large cost premium, and where structural mitigation of blasts is sought, structural engineers skilled in this matter should be engaged.

A final consideration is blast screens. As can be seen in Figure 3, the zone of injury from glass fragments can be very large, and blast screens can be used to deflect the fragments from areas of high population density. But blast screens tend to be unsightly and, as a result, are not typically used if other measures can provide protection.

Assessing when conditions warrant special concern for vehicle-borne explosives is the first step in the risk management process. Once this risk assessment is determined, the preemptive risk management strategies described here can be used to mitigate injury and damage.

I. PAUL LEW, P.E., CAPP, is senior vice president with Thornton Tomasetti. He can be reached at PLew@ThorntonTomasetti.com or 917.661.7800.

Reference:

1. FEMA 426 "Reference Manual to Mitigate Potential Terrorist Attacks Against Buildings" December 2003