

# Last line of defense

If prevention and deterrence fail, the ability of a government building to survive an attack may be the only thing protecting its occupants.

By Douglas Page, Technology Correspondent



The Wilkie D. Ferguson Jr. U.S. Courthouse in Miami, completed last summer, incorporates laminated glass among other hardening features. The building faces not only major security threats, as one of the nation's largest federal courthouses, but because of its location must also be able to withstand potential hurricane-force winds.

Early on a Sunday morning soon, a flatbed truck with four 55-gallon barrels of the explosive ANFO (ammonium nitrate and fuel oil) strapped against the bulkhead races down Church Street toward the front gate of the Milan (Ohio) Village Water Department.

Similar vehicles laden with equally destructive payloads approach city water facilities in Toledo, Sandusky, Cleveland and several other northern Ohio cities at approximately the same time. The assailants' intent is to crash through gated barriers and detonate the explosives, crippling as much of the water delivery infrastructure as possible.

But if city fathers and water managers have anticipated correctly, the attack is foiled at the front entrance to the facility by a barrier that looks and functions exactly like a standard wrought iron gate, but which is in reality a shield capable of withstanding the direct impact of a large truck traveling at 40 mph. Anti-ram barriers like this one have begun to surface at critical infrastructure facilities, such as government and military bases, airport flight lines, and water-treatment facilities.

The State Department certifies gate-barriers for its own purposes. To qualify for a State "K" rating, a gate must be able to resist a 15,000 lb. vehicle traveling at 50 mph (for a K12 rating), 40 mph (K8) or 30 mph (K4), while preventing the bed of the truck from penetrating the barrier more than 36 inches.

## Multiple strategies and components

Perimeter control is just one form of the emerging practice of building hardening that has risen out of the residue of fear left by terror events that started with the 1996 bombing of the Murrah Federal Building in Oklahoma City.

"Four primary strategies exist for protecting against attack: deter, delay, detect and prevent," says Robert Solomon, assistant vice president for building and life safety at the National Fire Protection Association.

Hardening is a prevention strategy intended to mitigate consequences should the first three strategies fail. It's the last line of defense, Solomon says.

Ted Krauthammer, PH.D., director of the Protective Technology Center at Penn State University <[www.ptc.psu.edu/](http://www.ptc.psu.edu/)>, says hardening is only one component of a total protection package, which begins with an assessment of how best to protect assets. Perimeter control, surveillance and warning systems follow. Krauthammer was involved after 9-11 with the Army Corps of Engineers on the Pentagon redesign, although no details are available.

Krauthammer does note that the 9-11 incident impacted two wedges of the Pentagon, one that had already been renovated and one that hadn't under an earlier hardening project.

"The renovated wedge performed well," he says. "Most damage was to the adjacent wedge that had not been hardened." Still, further hardening recommendations were implemented throughout the building after the attack.

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## Modern-day castles

Hardening concepts are not new. In the era of castles, security was sought from rings of protection: cleared fields, a moat, outer walls, inner walls and towers. These methods are reflected in today's automatic wedge barriers, bollards, anti-ram gates, glazed windows and blast-resistant columns. (Wedge barriers are angled steel plates that can be hydraulically raised two or three feet from a road surface to block vehicles.)

The DHS 2005 National Infrastructure Protection Plan calls for all levels of government to consider appropriate mitigation against potential hazards, whether natural, criminal, accidental or terror-related. So far, most building hardening has focused on federal buildings.

The Department of Defense and the General Services Administration, which is responsible for all non-military federal facilities, now require that all new buildings be able to resist disproportionate collapse. Some are designed to resist street-level car-bomb blasts.

Last year, the Government Accountability Office issued a 57-page report ("Actions Needed to Better Protect National Icons and Federal Office Buildings from Terrorism," GAO-05-790, June 2005) intended to identify strategic challenges faced in protecting federal facilities. <[www.gao.gov/new.items/do5790.pdf](http://www.gao.gov/new.items/do5790.pdf)>

According to Patricia Dalton, managing director of GAO's Physical Infrastructure Team, building hardening comes in many flavors, so there is no vanilla solution. "Security solutions need to be developed in the context of an organization's mission, the risks faced and the risks it's willing to bear."

Wade D. Belcher, an architect in GSA's Office of the Chief Architect, says primary areas of mitigation include reducing the potential for progressive collapse, protection against shattered glass and flying building façade material, and reducing the opportunity for airborne substances being introduced into ventilation systems.

It's not a one-size-fits-all situation, agrees Belcher. "Actual mitigation techniques are building-specific."

In 2004, GSA released an interagency directive ("ISC Security Design Criteria for New Federal Office Buildings and Major Modernization Projects: A Review and Commentary") that made security-level distinctions for its approximately 8,000 facilities. For example, the highest-risk establishments now require 20-foot setbacks.

"This led to an urban exodus to the suburbs, where land allows acreage for this ring of defense," says Brad Wiggins, president of attack protection at CompuDyne Corp., Annapolis, Md.

Walls, fences, automatic wedge barriers, bollards and gates are placed at this distance, creating a "hardline" of defense so car bombs can't come within range.

"This hardline is typically accompanied by a softline of perimeter detection, surveillance and countermeasures to



Though no hardening was applied to the skin of the new Jack Evans Police Headquarters in Dallas, the 6-story, 650,000-sq.-ft. building incorporates several hardening techniques, including a 90-foot setback from surrounding streets. Bollards to prevent vehicles from approaching were installed between the building and the street and hidden in landscaping and planter walls. Police can also quickly close any of the streets flanking the complex by tripping pop-up wedge barriers buried in the road surface.

unimpeded foot or vehicle approach," says Wiggins. "One such detection system utilizes fiber-optic cable monitored by a series of relay stations. If the cable is moved or tampered with, the light waves in the cable are interrupted, triggering a motion alarm.... This system is resistant to electrical and chemical attack and will notify monitors of cut cable."

A setback of nearly 150 feet is currently being used at new U.S. embassy compounds. Once blast impacts are calculated, engineers can design walls and windows to meet specific pressures.

"If this setback is not present, buildings must be constructed as hardened bunkers, carrying a price tag typically four times that of ringed buildings," Wiggins says.

## Blast loading

Material technologies combined with engineering advances in blast loading have resulted in impressive designs. Many new facilities now include glass that is not only strong enough to resist a blast load, but is also designed not to fly far even if it does shatter.

"Flying glass shards can be more lethal than the blast itself," says Brian Murray, vice president of Skanska USA, a leading construction company.

Skanska and other engineering firms have seen hardening trends develop recently in state and federal courthouses, border patrol stations, FBI offices, police headquarters, and banking communications complexes. The federal courthouse in Jacksonville, Fla., for example, is designed both as a hardened structure and to be resistant to progressive collapse.

"The building is raised from ground level to provide additional protection," Murray says. The lower five floors have a combination of concrete panels, continuously filled masonry and customized glass. Murray declines to provide specific details.

David Bilow, director of engineered structures for the Portland Cement Association, says new DOD and GSA con-



crete buildings are designed to resist progressive collapse. "Other owners of new multistory buildings may elect to have their structural engineers design more robust high-risk structures if they believe their building may be a target," he adds.

Most experts believe that taller buildings are at greater risk of attack, which might make the job of hardening them a little less unmanageable. According to the PCA, of all the non-residential buildings constructed in 2005, 67% were three stories or less and 20% were four to seven stories. Only 13% were eight stories or higher.

### Learning from the Brits

Billow says technologies now being used in new building design to resist collapse are based on British standards. The United Kingdom has had standards to avoid progressive collapse in buildings since 1968. The current versions are "Building Regulations 2004 A3 Section 5: Reducing the sensitivity of the building to progressive collapse" and "BS 8110: Structural use of concrete, Code of practice for design and construction, Parts 1 and 2."

A very significant accident occurred in the U.K. in 1968 when a gas explosion at dawn in an 18th-floor kitchen of the Ronan Point apartments in London's East End caused a wall to blow out, resulting in the collapse of 22 floors of one corner of the building and the deaths of five people. Following Ronan Point, the U.K. introduced a standard to increase the structural integrity of buildings.

In the U.S., after the Oklahoma City bombing in 1995, President Clinton issued an executive order creating the Interagency Security Committee to establish standards for federal buildings. After significant study, in 2001 the Defense Department established guidelines for resisting progressive collapse. In 2003, GSA published "Progressive Collapse Analysis and Design Guidelines for New Federal Office Buildings and Major Modernization Projects." Both the GSA and the DoD standards use structural concepts from the British standards.

"The British standards were used because they represent a reasonable structural engineering approach to this problem, which has been verified during IRA bombings," Billow says.

### New materials

Billow says for new buildings, concrete walls such as insulating concrete forms and precast concrete sandwich panels are being blast-tested by government agencies to determine which type of walls give the best protection against blast. "For existing facilities, fiber-reinforced polymers consisting of dry aramid or carbon fibers are applied with polymers on the surface of existing concrete columns, beams, slabs and walls in buildings, bridges and elsewhere to increase structural performance of concrete."

While new technologies are emerging, Belcher says we must make effective use of existing products and techniques that can potentially benefit security of public buildings. "There are efforts to perfect advanced technologies like sensors and smart systems to secure the infrastructure, but most new approaches are in pilot form, and details of any in actual operation are rarely available."

Appropriate risk management is the major issue in implementing adequate protections. Since protection against all possible threats is impossible, the decision on what levels of protection in which segment of the infrastructure is paramount.

"There are no guarantees, but we have learned to protect against fire, winds, lightning and earthquakes. Now we must use this experience to address extreme acts of terrorism," Belcher says.

"New construction prefers the more secure glass laminate products," Wiggins says. For instance, laminated

glass is installed in a Salt Lake City federal building and in federal courthouses in Phoenix and Miami.

Glass is a concern in Miami and elsewhere for reasons other than terrorism. The Federal Emergency Management Agency's 361 standard ("Design and Construction Guidance for Community Shelters," July 2000) applies to windows under threat of tornadic winds. Testing includes stopping a 15 lb. wooden 2-by-4 propelled at 100 mph.

### NGO targets

The prevailing assumption is that military, diplomatic and federal buildings are at highest risk, and thus need the greatest protection, but this isn't necessarily the case.



The new federal courthouse in Jacksonville, Fla., built in 2002, was designed to meet then-new General Services Administration security requirements, which include provisions for vehicular stand-off distance, a blast-resistant exterior enclosure system and a blast-resistant structure, including progressive collapse prevention.

"The fact is, nearly two-thirds of all terrorist attacks worldwide are directed at non-governmental targets," says Jon A. Schmidt, director of antiterrorism services for global engineering firm Burns & McDonnell. The bombings in Bali in 2002 (a night club) and 2005 (a food court and a town square) are examples.

While acts of terrorism are generally excluded from coverage by codes and standards, several civilian organizations are discussing how to improve protection.

Schmidt chairs a new initiative of the American Society of Civil Engineers, the Building Security Council <[www.buildingsecuritycouncil.org](http://www.buildingsecuritycouncil.org)>, which has developed a Building Security Rating System intended to create industry-wide collaboration among those responsible for securing buildings. "BSRS provides the private sector with a tool for measuring building security that it now lacks and sorely needs," he says.

Another group responding to the hardening call is the American Society of Heating, Refrigeration, and Air Conditioning Engineers, which is about to release a draft for public comment this summer called "Guideline for Risk Management of Public Health and Safety in Buildings." The measure deals with filtration, pressurization, system concepts and controls from an HVAC standpoint.

"While there are many products being offered that claim benefits, ASHRAE is attempting to provide balanced technical coverage and evaluation," says Larry Spielvogel, chair of the association's Homeland Security Committee. "More and more is being done to improve resiliency to natural and accidental incidents, which can parallel those related to intentional incidents, thus making them more attractive to implement."

## A rush to protect

Landscaping also plays a significant role in building hardening efforts, which landscape architects say should begin with realistic threat analysis before considering any design response.

"Performing a risk assessment is in sharp contrast to the immediate reaction to 9-11 that resulted in heavy precast concrete barriers placed indiscriminately around buildings and along streets," says Leonard J. Hopper, past president of the American Society of Landscape Architects and co-author (with Martha Droge) of "Security and Site Design: A Landscape Architectural Approach to Analysis, Assessment, and Design Implementation" (Wiley & Sons, 2005).

Hopper says the important analysis step can easily be overlooked in the rush to protect, resulting in a tendency to over-design security or create unnecessary redundancies. "Not every facility requires the same level of protection," he says.

Accepting the notion that there are different levels of threat allows a more varied response to how threats are addressed. "Site security interventions should be aimed at threats deemed likely to occur, not at frightening-but-unlikely scenarios," Hopper says.

He says good security design, particularly for public spaces, integrates site and security elements. Site amenities that can be creatively used to provide perimeter security include large trees with tree guards, benches, planters, bike racks, kiosks, bus shelters, steps, ramps, railings, signage and flagpoles.

"The idea is to explore approaches using a variety of elements as opposed to being dependent on one element for perimeter security, such as the over-use of a long line of perimeter bollards," Hopper says.

## How a national icon was hardened

A GAO report issued last year (see main story) considered the challenges in protecting national icons, such as the Washington Monument, Lincoln Memorial, Statue of Liberty and Mt. Rushmore, especially given the inherent conflict between physical security and public access. The Department of the Interior is responsible for security at most national monuments and icons, as well as 471 dams and reservoirs, along with 1.3 million daily visitors.

Hoover Dam, operated by the Interior Department's Bureau of Reclamation, provides an example of the difficulty securing a public structure. Every year, about 1 million people visit Hoover Dam, which provides electricity for the entire Southwest. In addition, nearly 9 million people recreate on adjacent Lake Mead, the nation's largest manmade lake.

Following 9-11, to help control the flow of tourists, BOR hired more guards and canceled some public tours. In addition, the agency installed blast-

resistant film on windows and improved gates and fencing in areas surrounding the dam. BOR also floated a series of buoys and boom lines to provide a secure water perimeter and created two traffic checkpoints, one in Arizona and one in Nevada, to screen vehicles crossing the dam.

The biggest concern, however, is the highway that uses the dam for a bridge across the Colorado River gorge. Consider what damage a truck heavy with TNT could cause if detonated on top of the dam. Water churning through the breach would likely cause the dam to fail, flooding Imperial Valley farms. The last time the Colorado River breached a diversion, in 1905, the Salton Sea was formed.

Other than closing the highway (U.S. 93), the only solution was to move it. It's being moved, about 1,500 feet downstream, at a cost of \$234 million. The project includes a new bridge almost 2,000 feet long and is scheduled for completion in June 2008. — D.P.

Still, almost five years after 9-11, some experts are disappointed at the amount of hardening that has solidified in the collective consciousness.

"The government still lets trucks up against the façades of buildings and in some cases into underground parking," says security consultant Hank Chase, director of federal programs at consulting firm Smart and Associates LLP, Towson, Md.

Chase also hasn't seen much retrofitting with regard to window treatment or structural integrity, even in Washington, D.C. He fears that it might take another attack to motivate more hardening efforts.

"We're resting on our laurels," he says. "Other than a few champions in government and private sectors, we're too complacent. We think that since it hasn't happened since 9-11, it won't happen again." **HPP**

*Douglas Page writes about science and technology from Pine Mountain, Calif.*