

# Engineering for terror

by Dwight Hamilton

**It is just over one year since two high-jacked jetliners struck New York's World Trade Center. What are professional engineers doing to help manage security for an uncertain and dangerous future?**

**I**t was the worst terrorist attack on North American soil and the largest loss of life from a building collapse in United States history. Of the estimated 58,000 people in the two 110-storey trade centre towers, over 2000 were killed. In addition, another high-jacked jetliner was flown into the Pentagon complex in Washington, D.C., headquarters of the U.S. Department of Defense, and a fourth crashed in rural Pennsylvania. Can anything be done to avoid another catastrophe?

"There's not much you can do to prevent a terrorist attack, but there's a lot you

can do to limit the effects of one," says John Thompson, executive director of the Toronto-based Mackenzie Institute and a leading expert on terrorism. "The nuts and bolts of emergency management are infrastructure design and its protection."

To that end, the U.S. Federal Emergency Management Agency and the Structural Engineering Institute of the American Society of Civil Engineers have published a *World Trade Center Building Performance Study* that examines the damage caused and develops an understanding of the response of each affected building. Its observations are now being debated by the U.S. Congress' House Science Committee and may lead to future building code changes.

## Research needed

Its most significant advice is to review current standards for the fire resistance of connections and to recommend a more comprehensive study into the collapse of World Trade Center Building 7, the first protected steel structure ever known to collapse due solely to fire.

"My recommendation is that, today, we cannot do much because we need more research into things like progressive collapsing," says Venkatesh Kodur, PhD, P.Eng., a research officer in the fire risk management program of the National Research Council of Canada and the only non-American on the team that produced the report.

The team's analysis posits that the towers of the World Trade Center could have remained standing indefinitely if fire had not overwhelmed the weakened structures. The full document can be viewed at [www.fema.gov/library/wtcstudy.shtm](http://www.fema.gov/library/wtcstudy.shtm). The U.S. National Institute of Standards and Technology is likely to conduct the next

round of studies and its work is expected to be complete in two years.

It's not just design and construction that authorities are looking at, however. Here in Ontario, the fire marshal's office of the Ministry of Public Safety and Security has released a *Guide to Strengthen Emergency Management of High-rise and High-risk Buildings* as part of the provincial government's commitment to improve the province's emergency preparedness. The publication is intended for property managers and building owners.

## Hard targets

"In a nutshell, what the government wanted to do was educate stakeholders, harden various targets and develop some heavy rescue capabilities," says Ed Gulbinas, P.Eng., manager, applied research section for the Ontario Fire Marshal. "A lot of building owners are motivated because of September 11 to improve their buildings and many occupants see there's a need for this material and are pushing owners down this road," he says.

The guide begins with a "building vulnerability assessment" taking into account the structure's geographic location, the immediate environment, the property type, the building's tenant mix or resident profile, its size and its construction. "The objective is to bring them as far along as possible in protecting the occupants of their buildings," Gulbinas says.

Subsequent sections examine incidents that can result from human activity. These include: fires and explosions; bomb threats; biological and chemical threats; dealing with suspicious packages or devices; reacting to physical threats; hazardous materials accidents; radiological accidents, carbon monoxide poisoning;

## Risk and code development

by Demir Delen, P.Eng.

**B**uilding and fire codes reflect society's tolerance of risk from hazards and establish minimum levels of safety. Historically, codes have evolved in response to events that have affected buildings, incorporating specific measures to address lessons learned. Arson or terrorism have never been a significant factor in code development.

Fire resistance rating requirements ensure that the fire separation and structural load-bearing elements of a building are effective for the duration of a fire or until fire fighters suppress it.

The problem is how fire resistance ratings are provided. The approach prescribed in Canada's National Building Code (NBC) is a numerical description of the heat exposure conditions in a standard fire test. This approach makes it possible to predict the fire resistance rating that would be achieved by a structural assembly if it were subjected to a fire test utilizing the standard time-temperature curve.

Clearly, actual fires do not always follow the time-temperature curve specified in the testing standard. The temperatures and times are representative of combustible contents found in typical office and residential occupancies. The severity of a sudden explosive fire fuelled by 91,000 litres of jet fuel does not follow this pattern. The temperatures reached and during the fire at the World Trade Center were much higher than those shown on a standard time-temperature curve. So the duration in which the fireproofing of the structural steel members would have been effective was much less than the fire resistance rating it was assigned (even if it had stayed intact after the collision). Code requirements assume a single fire that starts internally so that its severity is based on the expected type of combustible loading and operational hazards of a particular building type.

The requirements of the NBC regarding widths of exits and travel distance to exits make it possible for occupants of a floor on which a fire occurs to leave that floor within three to four minutes, provided their escape route is not cut off by the fire. Each floor in the trade center met this requirement. But when the whole building is evacuated, the occupants in every floor area evacuate into the exit stair shafts at the same time to go down the stairs and exit to the exterior through a metre-wide door. For high-rise office buildings, the NBC requires the floor assemblies and load-bearing walls and columns to have a fire resistance rating of two hours. But based on timed egress analysis, the total evacuation of one of the large towers would have taken five hours. The assumption inherent in the NBC is that the fire will be controlled or extinguished within two hours.

**Demir Delen, P.Eng., is a principal and director, fire protection engineering, for Morrison Hershfield in Toronto.**

natural gas leaks; elevator malfunctions; and medical emergencies. As well, such natural disasters as earthquakes, severe storms, floods, major electrical failures and roof collapses are covered. The guide suggests professional engineers must be involved in tasks such as assessing snow loads for roofs or evaluating damage after earthquakes.

An important related tool is the sample emergency procedures link that can be found on the fire marshal's emergency planning website ([www.ofmem.ca](http://www.ofmem.ca)). This tool enables design of a security plan tailored to a building's circumstances through progressive choice among options for several parameters, for example residential/commercial for building type. Gulbinas says large property companies may hire security consultants to draft a plan, but the majority of smaller businesses need something off-the-shelf that can be tailored to individual needs.

Building owners are paying more attention to security today, according to Cyril Hare, manager, life safety services, for consulting engineers Leber/Rubes Inc. in Toronto. While the firm's practice once comprised fire safety plans almost exclusively, these days see people looking for something more comprehensive that might include business recovery or continuity plans. Explosions, hazardous materials, biological threats and hostage taking are now part of the mix, he adds.

That's likely a good thing. While emergency planning is optional today for most building owners, says Gulbinas, in future, fire departments will look for emergency procedures as part of their inspection activities. He says the stakeholder group that consulted on the guide has recommended that regulations be put in place, if the audits reveal that owners and property managers have failed to address emergency preparedness. ♦