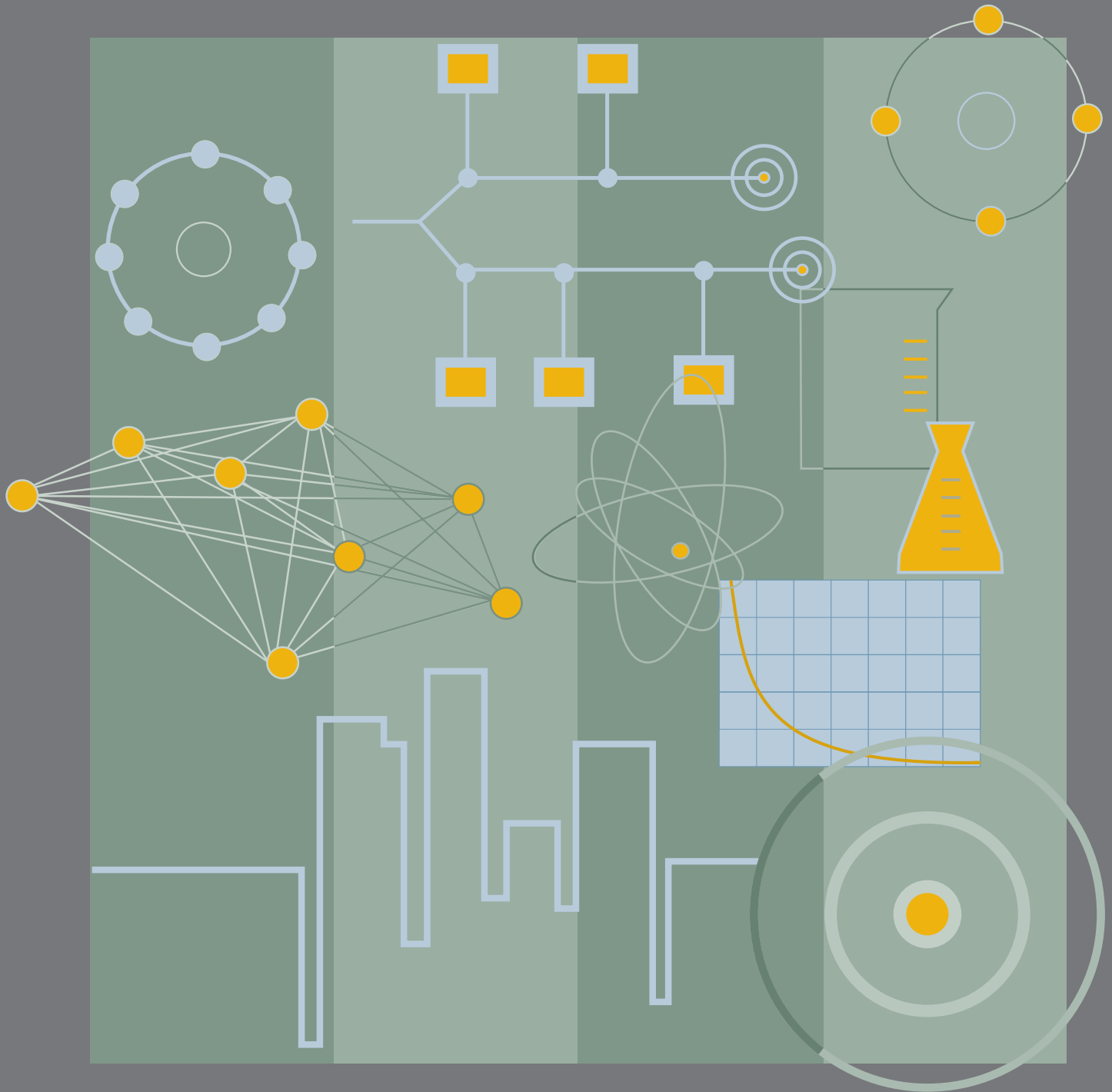


# Understanding and Managing Terrorism Risk



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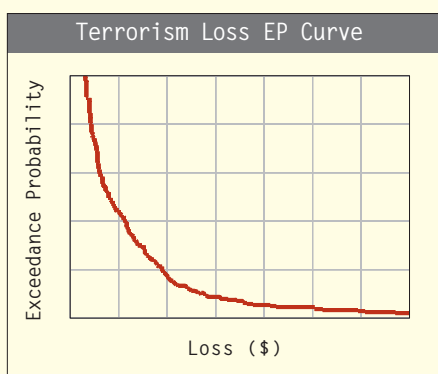


## Understanding and Managing Terrorism Risk

Since the terrorist attacks of September 2001, RMS has been working with its clients to deliver innovative solutions for managing terrorism risk. These efforts have ranged from detailed scenario loss analyses in the months immediately after the attacks, to the development of a probabilistic loss model based on game theory and expert opinion. In September 2002, industry representatives gathered in New York to hear from RMS' team of external advisors and internal modeling experts. This document summarizes the seminar proceedings and provides background on RMS terrorism modeling tools and capabilities.

### The RMS™ U.S. Terrorism Risk Model

The RMS model quantifies the potential for catastrophic terrorism losses across the U.S. It is focused on 'macro-terrorism' events that could result in over \$1 billion of loss or cause more than 500 casualties. The model provides loss estimates for property, business interruption, workers compensation, and life insurance, reflecting the importance of multi-line risk analysis since the World Trade Center attacks.



*A terrorism loss EP curve can be generated for a given portfolio to assess company-wide loss potential, capital requirements, and risk transfer options*

The model includes a stochastic event set that considers the probability of various attack modes at target locations throughout the U.S. The selection and relative ranking of targets is based on input from leading global

experts on the aims and objectives of terrorist organizations. Events are further differentiated based on the relative probability of attack modes, ranging from conventional weapons to chemical, biological, radiological, and nuclear (CBRN) attacks. The probability that counter-terrorism efforts or site-level security measures will disrupt or deter attacks is assessed using game theory.

RMS also brings to bear its engineering and financial modeling expertise to quantify losses for each stochastic event. Estimates are generated based on detailed analysis of losses for each attack mode, using high resolution exposure information.

#### APPLYING MODEL OUTPUT

RMS works on a consultative basis to apply the U.S. Terrorism Risk model and associated tools and databases to the unique risk management requirements of each client. Key applications include:

##### Exposure Management

- Identify exposure concentrations around potential targets
- Define accumulation zones for exposure control and capital allocation
- Establish data requirements for multi-line exposure management

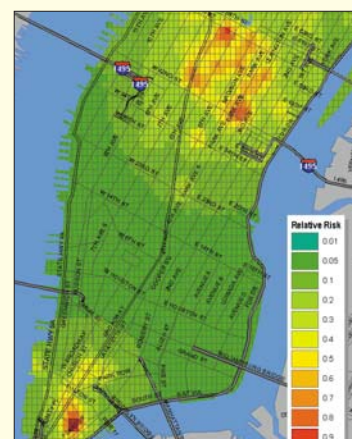
##### Portfolio Management

- Select benchmark scenarios for portfolio stress tests
- Assess exceedance probability (EP) for losses by line of business
- Analyze risk transfer options
- Explore the impact of changes in exclusions, limits, and deductibles

##### Underwriting

- Develop underwriting guidelines
- Assess cost of risk and account pricing
- Establish underwriting processes and systems to link exposure management and portfolio management

By applying RMS modeling and expertise, companies can identify both the risks and the potential opportunities associated with terrorism risk.



*High resolution maps of relative risk provide underwriting guidance in major cities*



***Hemant Shah** is co-founder, president & CEO of RMS. Since the founding of RMS in 1988, Hemant has played a central role in the changes that have taken place within the insurance industry through its adoption of technologies and risk-based strategies to manage catastrophe exposure. He has advised hundreds of insurers, reinsurers, and financial institutions and is a regular participant in industry initiatives,*

*conferences, and publications. Mr. Shah received a B.S. in Civil Engineering and M.S. in Engineering Management from Stanford University.*

“Nature may be subtle but it is not malicious. Terrorists are both subtle and malicious and operate in a framework of intent and strategy. Modeling terrorism risk requires a different approach from natural hazards.”

## A New Modeling Approach

Terrorism is a peril quite unlike the natural catastrophes RMS has traditionally sought to model. For natural perils, hazard modeling may be technically and computationally demanding, but modelers can take comfort from Einstein’s dictum that “nature may be subtle, but it is not malicious.” Terrorists, on the other hand, are both subtle and malicious, and operate in a space framed by strategic intent, by their operational, logistical, and technological capabilities and constraints, and by the dynamics of security and counter-intelligence.

Modeling macro-terrorism risk thus requires an approach quite different from the methodologies modelers have relied on for natural hazards. A terrorism model cannot consider concepts of hazard, vulnerability, and risk as discrete issues within a traditional probabilistic framework. To quote from a recent paper by John Major of Guy Carpenter, “Terrorism risk differs in kind from natural catastrophes because of the elements of intelligence and intent. As a consequence, in modeling terrorism, probability is not enough.”

### TERRORISM HAS STRATEGIC GOALS

There is an earthquake engineering adage that an earthquake will expose the weakest link in a building. But if a number of structures are randomly distributed across a region, the pattern of seismicity does not adapt so that the

highest value structure with the weakest design is most likely to be shaken. By contrast, the geography of terrorism hazard is defined not by coastlines or faults, but by the correlated dynamics of several factors. First, the terrorists’ clear desire to maximize the ‘utility’ of their attacks, inflicting extreme damage and disruption in deliberately planned and executed attacks; second, their ability to obtain and deploy various classes of weapons; and third, their rational responses to, and anticipation of the moves and counter-moves of the security and intelligence services.

### CONFLICT ANALYSIS WITH GAME THEORY

Rather than convolution or Poisson distributions to determine probability, at the heart of our methodology is the application of game theory, a mathematical framework made famous by John Nash’s receipt of the Nobel Prize in Economic Science, and subsequently popularized by the film, “A Beautiful Mind.”

Game theory is a model for planning under conflict. While new to the world of insurance risk, game theory is highly regarded for modeling war games, economic behavior, and geopolitical outcomes. The continued possibility for ‘swarm’ or simultaneous attacks, perhaps using less sophisticated weapons, that strike a class of target before security has a chance to harden is but one of the outputs of the game theory approach.

### A WORLD-CLASS TEAM OF ADVISORS

Any framework for quantifying terrorism risk, however logically designed, will ultimately have to involve a measure of expert judgment. In developing our model, we have sought input from an extensive team of highly qualified advisors, all of whom are authorities in the field of assessing the terrorism threat.

Input to the project has been elicited from senior, and currently active government officials participating with Gordon Woo in the CIA-sponsored Homeland Security Forum, and from a number of specialists and organizations we have chosen to work with in the development of this model.

These expert elicitations helped us understand the underlying ideologies, structures, and operational capacities of terrorist organizations; their prioritization of targets; the weapons that might be acquired and their availability, deployability, and capability; the state and influence of security and counter-intelligence measures; and ultimately, the dynamics between these various factors.



*Dr. Gordon Woo, senior risk consultant at RMS, is a mathematician and the principal architect of the RMS Terrorism Risk model. Gordon's familiarity with game theory stems from his tenure in the Society of Fellows at Harvard University, and follows an academic career at Cambridge University and M.I.T. Gordon is the author of "The Mathematics of Natural Catastrophes," and has published extensively in the areas of quantitative risk*

*assessment for the insurance industry, the military, and the nuclear and petrochemical industries. His work on terrorism risk has been critically acclaimed in a number of forums and publications.*

"The most potent weapon in the terrorist arsenal is the human brain."

## Analyzing Terrorism Risk Using Game Theory

Game theory is the mathematical theory of conflict, and is well suited to modeling the threat from a terrorist organization, such as Al Qaeda, which seeks to maximize the damage caused by its operations in the U.S. homeland. RMS has been advised on Al Qaeda modus operandi by the leading international experts on Al Qaeda, Dr. Rohan Gunaratna and Dr. Magnus Ranstorp. Principles established from discussions with these and other external experts have guided the structure of the RMS™ Terrorism Risk model.

### PRIORITIZATION OF WEAPONS

One important Al Qaeda operational directive may be expressed in the language of physical science as, "follow the path of least resistance." The flow of Al Qaeda terrorism activity is toward weapon modes with the lowest barriers to mission success. Adaptive learning from past successes and failures is also influential. Accordingly, a probability distribution for weapon prioritization favors ready-to-use weapons (such as SAM missiles, hijacked aircraft, and gas tankers), or improvised conventional explosive devices which do not involve intricate and potentially failure-prone technological development. In general, the more complex the weapon, the more time it takes to make it reliable and effective, and the higher the risk of detection.

### PRIORITIZATION OF TARGETS

The hijacking of a Singapore Airlines plane in 1991 by Pakistani militants provided an early case study of the use of game theory in the context of terrorist negotiations, but target prioritization is a further area of terrorism application. Terrorism experts rank potential targets in the U.S. by city and by target classes according to their attractiveness (or utility) to Al Qaeda. Economic and human loss consequences, symbolic value, and name recognition are factors in gauging target utility. The ranking by city and target type is converted into the quantification of target priorities by invoking Fechner's Law, which states that an arithmetic progression in perceptions requires a geometrical progression in their stimuli.

### UTILITY TO THE TERRORIST

The target probability distribution is derived from the functional dependence of target probability on utility. For this, game theory is required. It is known that Al Qaeda is committed to achieving success, is watchful that missions are cost-effective, and is sensitive to target hardening. In order to ensure that a strike will be successful, irrespective of defensive action by security forces, Al Qaeda will effectively seek to minimize the impact of target hardening. Al Qaeda is known to adopt a mixed strategy of randomizing its target selection,

meticulously undertaking surveillance on targets, and avoiding targets where the level of security is very uncertain. For an attack using a specific weapon against a target in a certain category with a given level of defense, there is a definable probability that the defense is unable to prevent the attack. As increasing defensive resources are applied to protect targets of high utility, the marginal improvement in security diminishes. This is reflected by a defense saturation condition, the power-law form of which is motivated by the fractal nature of defense-in-depth hierarchy.

### GAME THEORY OPTIMIZATION

For a mixed attack strategy, designed so as not to be impaired by changes in defense strategy, game theory optimization analysis suggests that the probability of selecting a target may be expressed in equations reminiscent of the Gutenberg-Richter relation in seismology, which is the cornerstone of seismic hazard analysis. As with the Gutenberg-Richter relation, the parsimony of the equation compensates for the approximate nature of the model. Similar to the seismological b-value, the parameters are estimated from empirical data, supplemented by expert judgment. The game theory impact is to shift the target probability distribution away from the targets of highest utility, which are likely to be well defended.





*Dr. Rohan Gunaratna, senior research fellow at the Centre for the Study of Terrorism and Political Violence, University of St. Andrews, is one of the world's most knowledgeable terrorism authorities. His recent acclaimed book on Al Qaeda is based on five years of research into the network and extensive interviews with Al Qaeda members. He travels the world extensively on the terrorism trail. Following*

*September 11, 2001 he was called to address the U.S. Congress and the United Nations. His views are sought by the media and decision makers in several countries.*

“Al Qaeda always goes for symbolic targets, high prestige targets – targets that matter. Targets that inspire and influence their followers to go and take similar targets. The inspirational value is embedded in their targeting.”

## The Al Qaeda Threat

The wave of terrorism that we are witnessing today has its origins in the Middle East as long ago as 1968. Terrorist organizations that are active today are using tactics and targeting that have been developed by organizations over the past thirty years.

We have seen three distinct waves of terrorism – left and right wing ideological terrorism, ethno-nationalist groups, and Islamic militancy. The rise in Islamism and the growth of the radical interpretation of Islam accelerated rapidly after 1979 with the Soviet intervention in Afghanistan and the Iranian revolution. In Iran, Muslim youth demonstrated that they could defy the U.S., when for 444 days they held American diplomats hostage. In Afghanistan, the Mujahidin fought and eventually defeated the world's largest land army – that of the Soviet Union. They learned from this and, boosted in their self-confidence, they felt that they could take on the remaining superpower, the United States. These events shaped the attitudes and are deep seated in the psyche of the radical Muslims who are now fighting what they term “the American Imperialism.”

### HOW DID AL QAEDA ORIGINATE?

Many Islamic groups sprang up during this political emergence of Islam, including the Afghan Service Bureau, headed by Dr. Abdullah Azam, a great theoretician and

tactician. He set up his organization inside the U.S., Europe, and other countries for the purposes of recruitment, procurement, and publicity to sustain the anti-Soviet initiative in Afghanistan. In 1998 Dr. Abdullah set out the founding charter for ‘Al Jihad’ – his vision for radicalizing and leading the various Islamic movements that were proliferating. Al Qaeda was created, representing the ‘spearhead’ of Islam and establishing a pioneering vanguard for the radical Islamic movements.

### WHAT IS AL QAEDA?

Al Qaeda leads other Islamic terrorist organizations. It wants to set the agenda and to inspire Muslim militancy worldwide. Its constituency is the nationalist groups in many countries in the Middle East, the Muslim migrant communities in the West, and other Islamic terrorist groups.

Other terrorist groups are not generally active outside their own countries – groups like the GIA in Algeria, the Islamic group of Egypt, and Hamas in Palestine and Israel. Al Qaeda is the only terrorist group that is advocating universal jihad. It operates internationally and is known to have a presence in 98 different countries. It has recruited from many Muslim countries as well as from the Muslim migrant communities of Western Europe and America. Its diversity across many countries has given it a global reach, and it has

demonstrated that it can operate successfully in the U.S., Canada, Europe, South East Asia, and many other regions.

This inspirational role that Al Qaeda aspires to is important. Al Qaeda always goes for symbolic targets, high prestige targets – targets that matter. Targets that inspire and influence their followers to go and take similar targets. The inspirational and instigational value is embedded in their targeting.

### WHY DID AL QAEDA ATTACK THE UNITED STATES?

Al Qaeda's main dream is to create Islamic states in the Middle East. They are critical of the existing governments in many of the countries in the Middle East and have actively tried to overthrow these regimes. Al Qaeda's initial attacks were all in the Middle East – in Libya, Egypt, Saudi Arabia, Yemen – but most of their attacks failed. These attacks were costly to Al Qaeda and they concluded that they would make little progress toward their Islamic state goals because these regimes were being backed by the U.S. Osama Bin Laden compared the U.S. to a poisonous snake whose head is shielding and protecting the corrupt Muslim rulers of middle eastern countries. He claims it is essential to target the U.S. to force it to disengage and abandon its geopolitical alliances in the region.

## HOW RESILIENT IS AL QAEDA?

Al Qaeda has evolved from an Afghan guerrilla organization fighting the Soviet army, into a sophisticated global terrorist organization that is now going after civilian targets. It has a command structure that is capable of disciplined and diligent planning and it is experienced in asymmetrical warfare – fighting an enemy with more resources. It is unique among Islamic terrorist groups in that it has developed a trans-national reach and it is specifically targeting the U.S.

It is a threat that is likely to persist over a long period of time. Al Qaeda has a resilient organizational structure and command hierarchy that can probably withstand considerable levels of losses and disruption. It has a highly professionalized co-leadership and designated succession designed to outlast the removal of a single individual. Beneath the leadership there is also a Shura council involving the heads of a dozen leaders of terrorist groups and Muslim nationalist movements from throughout the Middle East, Asia, Africa, and other parts of the world.

Al Qaeda should be seen as an organization of organizations. It has a relatively small membership of around 3,000 operational activists but has trained tens of thousands of members of other organizations. Although it may be unpalatable for the West to recognize this, it clearly has widespread and deeply embedded support in many countries. The organization of Al Qaeda has strategic depth and it has patience.

## WHAT IS THE SHORT-TERM AND LONG-TERM THREAT FROM AL QAEDA?

The U.S. military operation in Afghanistan has had considerable success in destroying the infrastructure of Al Qaeda and severely disrupting its operations. It will take time for it to regroup. In this current environment of high

security and awareness, its scope for activity is very limited. But it has not stopped operating. The core leadership and organizational structure of Al Qaeda is still largely intact. It retains its support and it is replenishing its membership – for every three members captured or killed in Afghanistan, Al Qaeda has been able to recruit at least a dozen new members. In the year following September 11, 2001 it has mounted over a dozen terrorist attacks. These have been largely opportunistic attacks, all of them outside the U.S., and most have been unsuccessful. But the organization is still active and the ambition is clearly there.

The modus operandi of the organization is one of deliberate action with careful planning and preparation. It carries out small numbers of attacks, not 30 a year like some terrorist groups, but only one or two, designed to cause spectacular results. These types of attack take a long time to plan – sometimes several years. Its preferred pattern is multiple simultaneous attacks which takes considerable time to prepare.

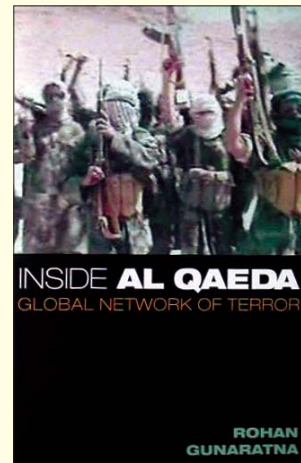
Al Qaeda has also demonstrated a clear ambition to use weapons of mass destruction (WMD). It has made several attempts to obtain radioactive materials, recorded tests of chemical agents, and explored distribution techniques for biological and chemical agents. The Al Qaeda organization has very ambitious goals to obtain WMD weapons and it will use them if it is able to obtain them.

## IS AL QAEDA LIKELY TO ATTACK AGAIN?

Al Qaeda has had an infrastructure within the U.S. since the 1990s – it has terrorist support cells within ethnic communities across the U.S. These are likely to continue to perpetuate propaganda, raise funds, and provide logistical support. In due course, this support structure can again be used by the operational members – fanatical supporters ready

to die for their cause. There is no doubt that the organization is researching, waiting, and probing the defenses. Once Al Qaeda identifies the post September 11 security architecture, it will penetrate the loopholes and will once again mount a major attack against the U.S.

To thwart this, the U.S. must remain alert. It cannot afford to let its guard slip. It needs to stay focused, to mount a multi-pronged response that challenges the arguments and beliefs of Al Qaeda as well as destroying its facilities. It needs to maintain a broad base of international allies within the Muslim world to destroy the support for terror. In this way it can destroy the organization of Al Qaeda and remove it as a threat of future terrorist attacks in the homeland of the U.S.



*Dr. Gunaratna's book "Inside Al Qaeda: Global Network of Terror," is based on five years of research into the ideology and operations of the terrorist organization. (ISBN 0-231-12692-1, Columbia University Press, 2002)*



*Dr. Magnus Ranstorp, director of the Centre for the Study of Terrorism and Political Violence, University of St. Andrews, specializes in the study of political violence and terrorism in the Middle East, and in particular the growth and influence of fundamentalist Islamist movements. His latest book is "Hizballah in Lebanon: The Politics of the Western Hostage Crisis." He is currently completing a textbook*

*on "The Changing Face of Terrorism" and a book entitled "In the Service of Al Qaeda: Radical Islamic Movements."*

"Al Qaeda is meticulous in understanding the vulnerability of its enemy. It undertakes meticulous planning to minimize failure and maximize success. It focuses on simple means and methods, thinking up new ways to enhance the effects."

## Operational Techniques of Terrorist Organizations

The main insights that we have into Al Qaeda operational techniques come from the terrorist operatives that have been debriefed, manuals that have been recovered, and the videotapes used to disseminate their teachings. My colleagues and I have interviewed hundreds of terrorists and have helped government officials interpret many of the key documents that have come to light.

The manual that was retrieved in arrests prior to September 11, 2001 entitled "Military Studies in the Jihad Against Tyrants" defines the type of targets and guidelines for mounting an attack. The Al Qaeda master manual is "The Encyclopedia of Jihad," a 5,000 page tract, much of which is derived from U.S. Army field manuals, and consists of a compendium for using a wide variety of weapons. Al Qaeda web sites give their followers analysis of targeting and the disruptive and economic impacts of attacks.

### STRATEGIC AND TACTICAL FRAMEWORK

These teachings provide a strategic and tactical framework for mounting attacks against 'godless regimes'. First, they emphasize gathering information about the enemy, the target installation, and its surroundings. They use open source information, surveillance, and research. They take a long-term perspective and expend a lot of resources on planning.

The documents also set a framework for selecting targets. Advice tends to be generic but toward targets of economic and symbolic significance. The guidelines include attacking vital economic centers and targets that represent the regime, such as embassies, diplomatic, and military installations. They provide military manuals for blowing up bridges and transportation routes. At a lower level of priority, they condemn places of amusement, immorality, and sin.

The types of attacks that are described range across the terrorist lexicon, from assassination to "blasting and destroying" the enemy's heartland. They also cover the psychological dimension of attacks, sapping the enemy's morale through disinformation and rumor, and causing disruptive scares with minimal effort. The power of the image of weapons of mass destruction is as much psychological as physical.

### MAXIMIZING THE DESTRUCTIVE POWER

There is a clear emphasis on operational decision making to minimize failure and maximize success. In particular these groups try to use simple means – using explosives that can be mixed from common ingredients, for example – but thinking up new ways in which they can enhance the destructive power. This has been demonstrated in many of their past attacks, for example when a gas tanker was used

**Centre for the Study of Terrorism and Political Violence, University of St. Andrews, Scotland**

[www.standrews.ac.uk/academic/intrel/research/cstpv/](http://www.standrews.ac.uk/academic/intrel/research/cstpv/)

*The Centre for the Study of Terrorism and Political Violence (CSTPV) at the University of St. Andrews in Scotland, was established in 1994. It aims to investigate the roots of political violence, to develop a body of theory spanning its various disparate elements, and to study the impact of violence and responses to it at societal, governmental, and international levels. The Centre has a wide-ranging and intensive research programme. Members of CSTPV have been advisors to the U.S. government and leading policy-making groups, and are principal consultants to CNN.*

in a suicide attack on a synagogue in Jerba, Tunisia. The perpetrators had thought through the processes of maximizing the destructive impact of this unsophisticated weapon.

In the longer term, there is a clear interest in more advanced technology of terror. The 11<sup>th</sup> volume of "The Encyclopedia of Jihad" documented a 'superbomb' – a radiological dispersal device – demonstrating that the terrorists had gone to great lengths to compile a detailed knowledge base. Similarly, videos show their testing of gas agents on animals, so we know that they are thinking about these deadly weapons seriously.

Al Qaeda is focused on understanding the vulnerability of its enemy. It undertakes meticulous planning and deconstructs its operational procedures in detail.





**Mark Mateski**, operations manager at Jane's Consultancy, directs proprietary defense and security assessments and is responsible for security and counter-terrorism 'red-teaming' activities. Prior to Jane's, he was the strategic studies branch manager for the technology research group of Science Applications International Corporation, where he directed war-gaming, facilitation, and support services for a number

of government clients. He has edited publications on topics ranging from weapons of mass destruction to conventional munitions.

"The trade-off between the logistical burden of mounting an attack and the destruction it achieves makes the use of explosives and coordinated attacks the terrorist's most likely near-term weapon."

## Potential Weapon Attack Modes

To understand the likelihood of different terrorist attack modes, we have examined a wide range of asymmetric weapon technologies and analyzed what is involved in preparing, planning, and carrying out attacks. These analyses help us understand the different choices that terrorists can make. The defining characteristic of the attacks is that they should be capable of achieving the macro-terrorist threshold of over \$1 billion loss or more than 500 casualties.

### ASSESSING DIFFERENT ATTACK MODES

A range of different attack modes were identified that have qualitatively different logistical requirements and quantitatively different impacts. Potential weapons range from improvised explosions, to appropriated military weaponry, hijacked civilian vehicles, and weapons of mass destruction. One

way of achieving high levels of destruction using conventional explosives, for example, is to set off multiple attacks simultaneously. This requires careful planning, large quantities of explosive materials, and precise execution, but it is well within the proven capabilities of Islamic militant groups.

We assess each attack mode using a 'red-teaming' methodology – developing a score-card where red favors the attacking team, blue favors the defending team. For each scenario we examine:

- Potential casualty levels
- Potential destruction
- Time required to plan
- Availability of key components
- Overall cost of operation
- Training and skill required
- Likelihood of detection

From these we assess the overall logistical burden, and together with the likely scale of destruction, rate the attractiveness to the terrorist.

### WEAPONS OF MASS DESTRUCTION

The attractiveness to the terrorists of weapons of mass destruction (WMD) is clear – the potential destruction is much greater than conventional weapons. However procuring, transporting, and successfully carrying out a WMD attack requires high skill levels, major resources, and long preparation periods.

That trade-off between logistical burden and destruction achievable makes the use of conventional weaponry and coordinated attacks

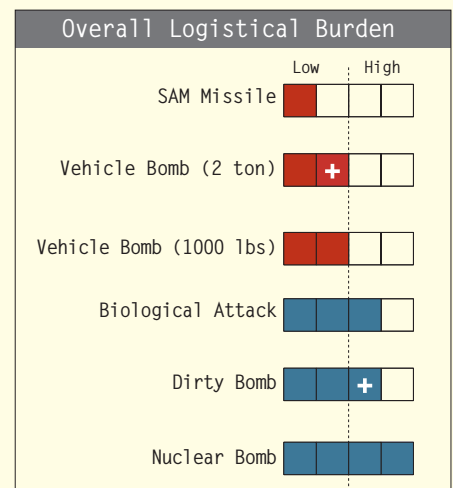
### Jane's Information Group

[www.janes.com](http://www.janes.com)

Described on the CBS program "60 Minutes" as the closest thing to a commercial intelligence agency, Jane's Information Group publishes over 200 titles annually, covering areas of military and security intelligence, weaponry, and public safety. Jane's Consultancy makes the expertise of their correspondents, many of them worldwide authorities, available commercially. In the area of counter-terrorism, Jane's has over 15 different publications including "Counter Terrorism," "Intelligence Review," and "Unconventional Weapons Response Handbook." Jane's Terrorism Intelligence Center (JTIC) provides country-by-country news, analysis, and reference databases on terrorism worldwide.

much more probable in the near term. Potential levels of destruction are still very high if coordinated and implemented well, while the logistical challenge and resource requirement barriers are much lower.

Potential Attack Modes
Weapons of mass destruction
• Chemical nerve gas attacks
• Biological agent attacks
• Radiological dispersal attacks
• Nuclear detonation attacks
Improvised explosive device
• Truck bombs
• Vehicle bombs
• Container bombs
Appropriated military weapons
• SAM missile attacks
• Sabotage armed attacks
Using civilian items as weapons
• Hijacked aircraft
• Hijacked gasoline/LPG tankers



Red-teaming analysis, where red favors attacking team, blue favors defending team



*Dr. K. Jack Riley leads projects on terrorism, gun violence, gun markets, and criminal justice reforms at RAND Public Safety and Justice. Prior to and following September 11, he served as principal investigator on projects to assist the state of California with both legislative and security measures against terrorism. His recent publications include "California's Vulnerability to Terrorism" (RAND, 2002) and "The*

*Implications of the September 11 Terrorism Attacks for California" (RAND, 2002). In addition, he co-authored one of the first empirical analyses of preparedness for domestic terrorism. Prior to RAND, Dr. Riley was with the U.S. Department of Justice.*

"As a nation, a year after September 11, we are still not very well prepared to face the threat of homeland terrorism. Resources are beginning to flow and issues are being addressed, but there are many structural challenges we face. How should we prioritize our efforts?"

## Assessing Homeland Security

Security against terrorism is a combination of three things. First, our collective security efforts to disrupt and interdict the terrorists' preparation. Second, the protection we deploy against individual targets to deter attack. And third, the emergency response to minimize the consequences of an attack.

### OUR COLLECTIVE SECURITY

As a nation we are still not very well prepared to face the terrorist threat that became evident in September 2001. Resources are beginning to flow and public awareness for now is high. But there are some significant public policy issues that we face. For example, how should we prioritize resources and actions to have the maximum impact on reducing terrorist threats?

We still use an 'old' model for homeland security terrorism risk, based on the patterns of smaller scale terrorist risk experienced over the past several decades. It will take time to adjust defenses to the new threat.

### HARDENING OF TARGETS

There are many different buildings and facilities across the United States that are currently being protected against terrorist attack. RMS has classified targets into six tiers of 'utility ranking'.

#### Examples of Utility Ranking of Targets

1. Presidential offices & residences, government buildings
2. Central business districts, airports, skyscrapers, hotels
3. Ports, harbors, stadiums, international buildings
4. Tourist attractions, corporate HQs, subways, tunnels
5. Main transport terminals, bridges, consulates
6. Shopping malls, theater districts

### Tier 1 & 2 Targets

Government buildings and major private sector facilities in this category have implemented 'inauguration level' and highly visible security procedures. Their defenses against chemical and biological attack, however, remain relatively weak. The risk managers at these facilities face a major burden to process the vast amount of information that is needed to implement resilient security procedures.

### Tier 3 & 4 Targets

Security at targets in these categories is currently much more variable. Their computer and personnel networks tend to be weaker, and the responsibility for security is more localized, which results in differential quality, occasional loopholes, and duplication of resources.

### Tier 5 & 6 Targets

Targets like shopping malls and public facilities are categorized as lower risk. In these types of facilities security is difficult because, if implemented too stringently, it can impact the economics of the business. It is often difficult to justify resources.

### EMERGENCY RESPONSE

There are also many issues around preparing our capability to respond to a macro-terrorist attack. Our civil defense needs to be robust across the

range of threats, including weapons of mass destruction, biological, and chemical attacks. Public health systems need to

### RAND

[www.rand.org](http://www.rand.org)

*RAND is a nonprofit institution that helps improve policy and decision making through research and analysis. RAND was the first organization to be called a 'think tank', a term coined soon after its creation in 1946. Its work includes new knowledge to inform decision makers of available options, analyzing their relative advantages and disadvantages. RAND also advances specific policy recommendations based on the results of its research. In all cases, its goal is to serve the public interest by widely disseminating its research findings. RAND employs more than 1,600 full and part-time staff. Eighty-five percent of the research staff hold advanced degrees, with more than 65 percent having earned a Ph.D. or masters degree. These staff are engaged in diverse lines of policy research and development, including public safety; civil and criminal justice; national security; science and technology; labor, population and demography; and health.*

prepare for the case of a mass casualty attack. Our civil readiness needs to work at home, at our children's schools, and in the workplace.

### IMPLICATIONS FOR RISK ANALYSIS

Maintaining a strong focus on civil defense is critical. Our civil defense is most effective at the collective level rather than at individual targets. We need good data collection and analysis and a constant alert to keep WMD out of the hands of terrorists. Finally, recognize that risk is dynamic – circumstances change quickly and the threat is always adapting. It is vital to perform regular risk assessments.



*Dr. Andrew Coburn is the chief knowledge architect at RMS, and is widely recognized as a leader in the science of catastrophe risk. He was one of the principal architects of RMS' earthquake workers compensation model, was co-author of the RMS "World Trade Center Disaster" special report, and has written several articles on terrorism risk. Andrew received his Ph.D. from Cambridge University, and has had his*

*research published widely. In the 1990s, he consulted with insurance clients and the U.K. government during the formation of Pool Re, a government-backed reinsurance facility for terrorism risk.*

"There is a relatively small number of targets that will generate the kind of payoff that the terrorists are looking for – the large majority of macro-terrorism risk comes from about a thousand targets across a dozen cities."

## Development of Target Lists

To explore the risk posed by Islamic militant terrorist groups to the insurance industry, the RMS model simulates the range of potential terrorist attack modes against an extensive list of targets across major U.S. cities.

RMS has compiled an authoritative database distilling the relevant high risk sites from hundreds of thousands of large commercial buildings and other key facilities across the U.S. The range of potential targets is ostensibly very wide – almost any public place could be the location of a terrorist strike. However, the insights that have been gained into the aspirations of key terrorist groups allows the targets to be prioritized based on the terrorists' objectives. The scale of economic loss and loss of life that could be inflicted, and the symbolic nature of the target all contribute to the likelihood that a particular target is attacked.

### CITIES AT RISK

The highest priority for a terrorist seeking to mount a spectacular attack against the economy and apparatus of the U.S. is in the major cities. This is where the "targets that matter, targets that inspire" can be found. The size, economic importance, symbolic value, and name recognition of the city are all important in determining how likely terrorists are to attack it. Cities are prioritized according to the 'utility' their attack would provide to the terrorists.



*Cities and other target locations, such as nuclear power plants, military bases, and major industrial facilities*

assess the industry losses that would result from different types of attacks at the target sites.

### RISK IS CONCENTRATED

For every target, each appropriate type of attack mode is analyzed to calculate the loss. The analysis shows how and where various thresholds of loss can be achieved through combinations of attack mode and concentrations of exposure. The probabilities of each event are derived from a game theory engine that assesses the likelihood of attack mode choice and target selection, against security and logistical constraints.

There is a relatively small number of targets that will generate the kind of payoff that the terrorists are looking for. The large majority of macro-terrorism risk comes from about a thousand targets across a dozen cities.

### DETAILED DATA COMPILATION

Targets in the RMS database consist of 'locations'. These can be individual buildings, the centroid of a cluster of buildings – such as the center of a business district or a port – or a place, like a public park or a tourist attraction. For these targets, detailed data on their characteristics are compiled, including a classification of target utility.

RMS maintains databases on insured exposure across the U.S. To assist clients with managing terrorism risk, this data has been refined to high resolution. Detailed information on buildings, economic activity, and human occupancy levels have been compiled for major cities of the U.S. The datasets make it possible to



*Sample targets in Manhattan*





*Dr. Robert Muir-Wood is managing director of RMS' Global Risk Modeling practice. He is widely recognized within both the research community and the insurance industry as a leading thinker on the development and application of extreme event models for natural and man-made catastrophes. Robert received his Ph.D. from Cambridge University, is the author of six books, has been published extensively in*

*trade and scientific journals, and has taught courses on catastrophe risk for Lloyds of London.*

“Each attack mode has its own characteristics and agents of damage, and losses can vary greatly by line of business. Ultimately, the question of insurers’ risk requires consideration of contractual terms of the coverage.”

## Modeling the Losses from Potential Terrorist Events

What kind of loss would terrorist attacks cause? To accurately model the impact of the full range of potential terrorist attacks, a detailed analysis is required of processes as diverse as explosions, aircraft impacts, fires, decontamination processes, diseases spread through populations by biological and chemical agents, missile technology, and other phenomena.

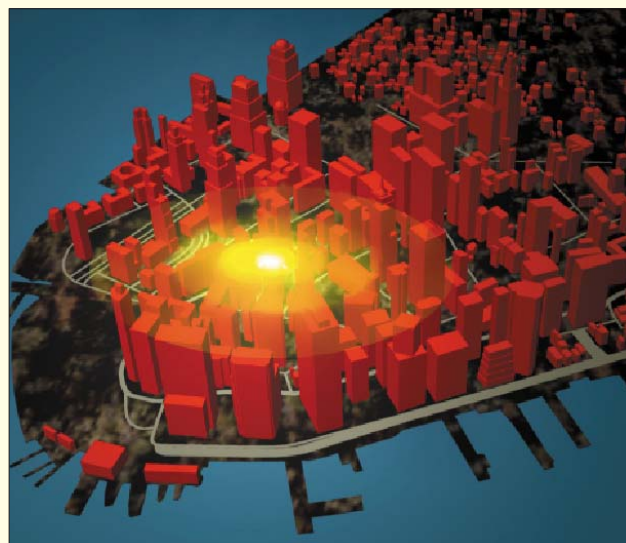
For each process, and with assistance from a number of experts in different fields, RMS has researched and developed ways of modeling what the impact would be on property, people, and business activity. The analysis assesses the

scope of damage that would be inflicted, and estimates how insurance policy coverages would determine the loss to the insurer.

### AGENTS OF DAMAGE

Each attack mode causes loss from one or more agents of damage, many of which affect a geographical area around the attack

location. For example, a truck bomb explosion causes property damage and casualties through blast overpressure and debris projectiles that radiate out and upward from the detonation point, through and between buildings. The blast may also trigger fires that cause additional damage. Dust and debris clean-up costs can extend over a large area and if a pollutant is spread, decontamination costs can be severe. The disruption to the neighboring businesses causes losses, and police exclusion zones cause business interruption to commercial activity in and beyond the exclusion zone. Experience from



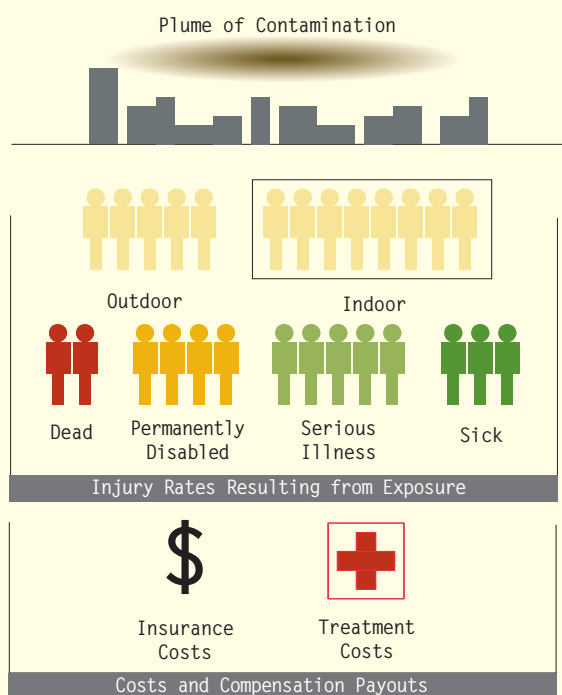
*Truck bomb simulation in the financial district of Manhattan*

many urban explosions around the world, both terrorist and accidental, provide data to understand and model the consequences of this type of event.

### DETAILED HAZARD FOOTPRINTS

Each attack mode has its own characteristics and agents of damage. Radiological dispersal devices cause irradiation of an area, and biological attacks disperse disease vectors that affect people working and living in the vicinity. In general, these impacts are concentrated and fall off rapidly with distance from the source. The localized impact of many terrorist events means that modeling has to be carried out at very fine resolution.

For this reason, RMS has generated three classes of detailed exposure down to city block resolution. First there are the values of properties and their contents; next, the level of business activity



*Modeling workers comp and life insurance losses are due to chemical, biological, radiological, and nuclear (CBRN) attacks*



taking place within the properties, from which business interruption costs can be calculated; and last, the occupancy levels of people, in particular those at work within the buildings, and how these occupancies vary through the day.

### CASUALTY MODELING

For casualty modeling, both for public safety issues and for workers compensation, life insurance, and other liability claims, it is necessary to determine the numbers of potential injuries and fatalities in an event. Estimating casualty rates and the uncertainties around them requires assessing the number of people in a building, or passing by, at the time of the event, as well as the availability of evacuation paths and time. For each attack type it is important to understand the number of fatalities, the numbers and types of physical injuries, and specific types of injuries such as burns, ingestion of toxins, infection (from biological agents), and stress.

The treatment and insurance claim cost for each injury type vary significantly, but data on these are available. RMS has provided clients with catastrophe casualty models for natural perils for many years, and the methodology for assessing casualty claims is similar for terrorism events.

### POLICY COVERAGES – WHO PAYS?

Loss modeling for terrorism risk has initially concentrated on calculating financial or economic impacts. The question of how much loss will be paid by insurers requires consideration of the contractual policy terms and the regulatory climate.

While all reinsurers and many insurers have attempted to exclude terrorism coverage, even a restricted exclusion on commercial policies has not been permitted in three states: New York, Florida, and California. Terrorism also remains included in all workers comp policies. Even when terrorism exclusions are in place, fire after a terrorism bombing, for example, is still covered in a standard insurance policy. Decontamination remains a thorny subject as to what is considered an acceptable level of contaminant and how much of the cost falls on the insurer. Business interruption payouts could follow from secondary consequences of an attack.

Given the unprecedented nature of some attack types, many exclusions would be tested in the courts. Where exclusions stick, there could be political pressure for insurers to pay up based on their ‘social obligations’. Questions of event definitions would be raised if multiple attacks occurred at widely separated locations.

In performing the work to model insurance payouts from the economic losses of different attacks, we have assessed what proportion of different agents of loss would be expected to fall within specific coverages. We recommend clients pay particular attention to reviewing their potential liabilities in this area.

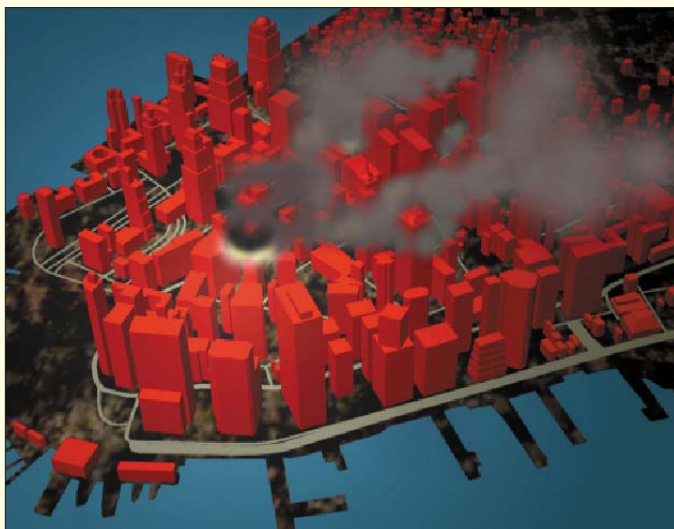


*Loss modeling uses high resolution exposure data to create a detailed loss footprint*

### QUANTIFYING FINANCIAL LOSS

RMS probabilistic modeling is based on sampling a representative set of sixteen characteristic attack types from the universe of possible incidents. For each attack at each location or target there are a range of other contributory factors that also affect the impacts, such as time of day and state of the weather. However, while time of day would be an independent variable for a natural catastrophe, for a terrorist incident one could assume that the attack would be launched at a time likely to cause maximum casualties. Similarly, terrorists familiar with research on toxic releases are likely to release some biohazardous agents in light wind conditions appropriate to maximizing the ground-level spread.

These inherent correlations should not obscure the significant uncertainties that affect the outcome. For example, the way in which an aircraft impacts a building affects both the number of people on higher floors unable to escape, and the time available for those on lower floors to evacuate before collapse. In performing the modeling of specific insurance coverages, RMS recommends a particular focus on the sources and magnitude of uncertainties in loss estimates.



*Simulation of the impact of a radiological dispersal device in Manhattan*



**Peter Ulrich** is managing director of the RMS Enterprise Risk Management practice. He has worked with RMS for nine years, consulting with the insurance industry on catastrophe and financial risk management strategies. Recently, Peter has lectured on the linkages between terrorism and enterprise risk at numerous seminars and conferences, and was co-author of the RMS white paper "Managing Enterprise Risk in

the Aftermath of the WTC Catastrophe." Prior to RMS, Peter worked at Peterson Consulting, helping corporations understand their exposures to environmental risk.

"What can you do with this information? Managing terrorism risk requires a layered approach. We can support a range of applications from multi-line exposure accumulation around key targets to loss assessment and underwriting data."

## Managing Terrorism Risk using Model Output

RMS is working with its clients to help them understand and manage their terrorism risk. To assist clients, RMS has developed tools and a layered approach that support a range of risk management applications.

### HIGH DETAIL EXPOSURE TRACKING

RMS is working with clients that have a renewed commitment to managing exposure accumulations, for both property and workers compensation lines, at the highest level of detail. Ensuring the quality of this information is of paramount importance. RMS is providing software and data to allow clients to capture and geocode both property and workers compensation exposures to a building-specific level of resolution, monitor these exposures dynamically against pre-existing portfolio accumulations, and track concentrations using a variety of reporting and analytical tools.

### UNDERSTANDING DRIVERS OF RISK

Analysis of modeled losses helps insurers understand what is driving their terrorism risk. It shows the scale of loss potential, the types of events, and the locations and lines of business that most contribute to the potential losses. This helps prioritize a risk management strategy.

### BENCHMARK SCENARIO STRESS TESTS

Selected attack scenarios on targets can be used as benchmarks to define portfolio stress tests. Was the World

Trade Center loss a worst-case event? Modeling shows that most conventional events would not cause comparable losses, but that there are events using conventional weapons and simultaneous attacks that can equal and surpass WTC loss levels, and many chemical, biological, radiological, and nuclear (CBRN) scenarios are worse. Selecting benchmark scenarios can help monitor risk levels.

### UNDERWRITING GUIDELINES

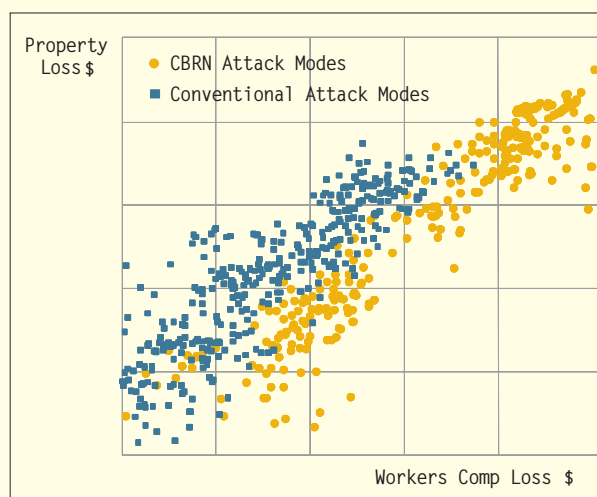
Many clients are seeking to develop underwriting guidelines for terrorism risk. Model output is useful to optimize the required distance from high-risk targets and set other underwriting criteria. RMS city risk maps can be used to define objective accumulation zones. The conceptual framework provided by the model shows the relative levels of risk across geography and between cities – for example, is Los Angeles more at risk than Miami?

### EXCEEDANCE PROBABILITY

Terrorism risk is dynamic, but the relativities between outcomes are less volatile than the overall activity rate for attacks. EP curves conditional on an event occurrence provide useful risk relativities. In addition,

simulation models of event frequencies constrain the range of annual or multi-year EP curves. Terrorism EP curves can be used in the same way as other catastrophe EP curves for risk management, providing benchmarks for risk pricing, insight into the chances of exhausting surplus, and support for risk transfer decisions.

Although complex and superficially unknowable, terrorism risk does lend itself to rational analysis. It differs from natural catastrophe perils in a number of ways: geographical scale, multi-line impact, loss potential, and its dynamic adaptation to attempts to thwart it. New strategies and techniques are required to manage this risk. RMS is supporting its clients by developing the new generation of risk management solutions that will address clients' business needs.



Understanding loss correlation for different lines of business and attack types helps define risk management priorities

# Selected RMS Publications on Terrorism Risk Management 2001/2002

## **The Al Qaeda War Game**

by Dr. Gordon Woo, December 2002; *Swiss Military Review*

## **Quantitative Terrorism Risk Assessment**

by Dr. Gordon Woo, October 2002; *Journal of Risk Finance*

## **Coming to Terms with Terrorism Risk**

by Dr. Gordon Woo, October 2002; *Risk & Insurance*

## **Alternatives for Terror**

by Dr. Gordon Woo, September 2002; *Reinsurance*

## **Mathematical Aspects of Terrorism Hazard**

by Dr. Gordon Woo, September 2002; *Catastrophe Risk Management*

## **The Art of Terror**

by Dr. Gordon Woo, September 2002; *Risk Transfer*

## **Game Theory and Terrorism Risk**

by Dr. Gordon Woo, July 2002; *Lloyds.com*

## **Terrorism Modelling – an insoluble problem?**

featuring the research of Dr. Gordon Woo, July 2002; *Reactions*

## **Quantifying Insurance Terrorism Risk**

by Dr. Gordon Woo in *Alternative Risk Strategies* (Morton Lane Ed.), Risk Books, 2002

## **Benefit-cost Analyses for Malevolent Human Actions**

by Dr. Gordon Woo, April 2002; *Columbia/Penn Roundtable*, Palisades, New York

## **Quantifying Insurance Terrorism Risk**

by Dr. Gordon Woo, February 2002; *National Bureau of Economic Research meeting*, Cambridge, Massachusetts

## **Counting the Cost of Terrorism Risk**

by Dr. Robert Muir-Wood, February 2002; *Insurance Day*

## **Urban Catastrophe: A New Class of Risk**

by Dr. Andrew Coburn, January 2002; *Global Reinsurance*

## **Managing Risk in the Aftermath of the World Trade Center Catastrophe**

December 2001, RMS White Paper

## **World Trade Center Disaster**

September 18, 2001, RMS Special Report

