Terrorism Risk Assessment:
Best Practices for Insurers and Reinsurers

Jack Seaquist
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Introduction

Quantifying risk is particularly challenging when the risk is dynamic. Since the events of September 11, the changing risk climate, coupled with nationwide efforts to prepare for and mitigate that risk, has created an environment of considerable uncertainty.

Over the past year, for example, there has been a general consensus that increased homeland security measures at critical facilities have shifted the focus toward smaller devices and softer targets. Specifically, there is a perceived increase in the likelihood that improvised explosive devices will be directed at transportation nodes, commercial buildings and other public places—as demonstrated by the July 2005 London attacks. These softer targets are highly likely to incur insured losses.

Adding to the uncertainty, the Terrorism Risk Insurance Act (TRIA)—enacted in response to the events of September 11, 2001—is due to expire at the end of 2005 and its future, at the time of this writing, is unclear.

Faced with such uncertainty, insurers, brokers, reinsurers, and government agencies are increasingly turning to sophisticated modeling tools for handling a wide variety of business processes designed to quantify and manage the risk of losses from future terrorist attacks.

This paper presents an overview of terrorism risk assessment practices and tools used in the insurance industry. It includes a discussion of effective metrics for monitoring and managing exposure accumulations, and alternative risk assessment approaches.

Quantifying the Risk

In general, the goals and processes of terrorism risk assessment mirror those of natural catastrophe risk analysis, so many of the most effective risk measurement tools and metrics will be familiar to the seasoned user of catastrophe modeling applications.

A sound assessment of terrorism risk includes the quantification of exposure to catastrophic losses using the following metrics:

- Maximum loss
- Landmark scenario risk
- Probability distribution of losses

Each of these approaches has its own inherent benefits and limitations, which are discussed in detail below.
Maximum Loss

For terrorism, as with any modeled peril, loss amounts are associated with specific events. Maximum potential loss is a measure used to identify events and measure exposure to those events that would maximize loss to the portfolio of interest, such as a book, a business unit, or the enterprise.

There are four measures of exposure for maximum loss:
- Single address exposure
- Ring concentration
- Aggregate exposure
- Deterministic loss scenarios

Single Address Exposure

Single address exposure quantifies the loss amount should an individual building be destroyed. For property policies, this is the dollar amount of the policy less any terms, such as deductibles and policy limits.

For casualty lines, the basic measure of exposure is the number of individuals in the building. If multiple lines are involved, a dollar value should be used for each exposed individual. A typical measure used for workers’ compensation insurance is the anticipated average death benefit. This should consider all forms of compensation, including survivor benefits. If disability is covered, benefits should also include significant long term medical expenses and indemnity costs for those individuals sustaining life threatening/permanent disability injuries, which could greatly exceed the death benefit.

For companies exposed to both property and casualty losses, the maximum exposure is determined by combining the maximum loss for each line of business.

A limitation of the single address exposure measure is that it ignores possible losses sustained at nearby exposures. For example, a bomb blast on the street could affect multiple buildings and their occupants.

Ring Concentration

To better identify the potential maximum loss to a portfolio of risks, it is useful to measure exposure concentration over an area wider than a single building. The analysis should consider the entire area within which losses could occur as a result of a single event, such as a truck bomb. By using the same measures of exposure used in the single address exposure (property policy exposure and a dollar value estimate of casualty exposure), worst-case losses can be approximated for exposures within circles of user-defined radii.

The following figures illustrate two ways in which a ring exposure concentration analysis might be performed. In the first example, a single ring with a 0.25 mile radius is used.
Estimated maximum potential losses within the ring can be determined for both property and workers’ compensation policy types, as shown in Figure 1.

![Figure 1: Estimated Maximum Potential Loss for a Single Location Ring](image1)

Figure 2 shows the results of a multiple ring analysis for a workers’ compensation portfolio. The results are sorted by the number of employees within each ring to determine the areas of highest exposure for the portfolio.

![Figure 2: Location Ring Analysis Report](image2)
Each ring should be checked to ensure the data is accurate. The following figure shows the details for the first ring listed in the report above. Each insured location within the ring is identified, along with its contribution to the total exposure.

<table>
<thead>
<tr>
<th>#</th>
<th>Policy ID</th>
<th>Location ID</th>
<th>Location Address</th>
<th>City</th>
<th>State</th>
<th>Geocode Match</th>
<th># Loc</th>
<th>Exposure</th>
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<tr>
<td>1</td>
<td>10912937</td>
<td>127</td>
<td>127 Madison Avenue</td>
<td>MANHATTAN</td>
<td>NY</td>
<td>Exact Address</td>
<td>32</td>
<td>52</td>
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<td>2</td>
<td>12449237</td>
<td>7</td>
<td>224 East 96th Street</td>
<td>MANHATTAN</td>
<td>NY</td>
<td>Exact Address</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>12327982</td>
<td>1</td>
<td>One Gustave L. Levy Place</td>
<td>MANHATTAN</td>
<td>NY</td>
<td>Exact Address</td>
<td>370</td>
<td>3,370</td>
</tr>
<tr>
<td>4</td>
<td>12380014</td>
<td>1</td>
<td>570 East 87th St</td>
<td>MANHATTAN</td>
<td>NY</td>
<td>Exact Address</td>
<td>1,100</td>
<td>1,100</td>
</tr>
<tr>
<td>5</td>
<td>2703561</td>
<td>10</td>
<td>1901 1st avenue Apt. B</td>
<td>MANHATTAN</td>
<td>NY</td>
<td>Exact Address</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>6</td>
<td>9697731</td>
<td>1</td>
<td>1905 1st avenue</td>
<td>MANHATTAN</td>
<td>NY</td>
<td>Exact Address</td>
<td>407</td>
<td>407</td>
</tr>
<tr>
<td>Total for all Policies</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td>6</td>
<td>10,040</td>
</tr>
</tbody>
</table>

**Figure 3: Location Ring Analysis Report Details**

The maximum potential loss calculation, in this case, is affected by the assumption that the ring exposure represents the maximum exposure to a given event. However, if the user-defined ring radius is too small, there will be exposure outside the ring that may not be included. If the radius is too large, there could be significant exposure in the ring that has a very small likelihood of loss. As a starting point, AIR recommends a 500-foot radius, which would capture most of the damage from a delivery truck bomb.

A second limitation of this approach is that all exposures in the ring are counted at the full exposure amount. Since damages and injuries are a function of such things as the distance from the blast and construction type, damage and loss would diminish as the distance from an actual event increases.

**Aggregate Exposure**

In situations where street address data or exact latitude and longitude (i.e., a geocode) is unavailable, aggregate exposure accumulations provide an alternative risk measure. For example, reinsurers may not have complete sets of detailed address data, but may have aggregate ZIP Code, city or county level exposure data.

Also, large-scale chemical, biological, radiological, or nuclear (CBRN) attacks can produce very high losses at distances of several miles. Therefore, city- or county-level
aggregations may be useful for representing the maximum potential loss for CBRN attacks.

**Deterministic Loss Scenarios**

A better measure of maximum potential loss can be obtained by estimating the loss from a specific scenario such as a truck bomb. Using a physical damage and injury model, property damage, as well as injuries and fatalities can be estimated at each location affected by the event. The resulting losses should account for weapon characteristics, as well as the construction type and distance of each exposure from the event location. This type of analysis is not constrained by an arbitrary distance cut-off (as with the ring concentration), or a political boundary (as with aggregate exposure). It also includes the costs of all injury classes, from minor to fatality, and is not constrained to a single dollar value per exposed life, as is the case for the location, ring, and aggregate concentration exposure measures. Additionally, deterministic loss analyses can be performed for both CBRN and conventional attacks.

The following figure shows an example of a deterministic analysis for a large truck bomb. Note that estimated total losses are provided in the data pane on the right for both property and workers’ compensation policy types.

![Figure 4: Deterministic Loss Analysis](image)

**Landmark Risk**

The maximum potential loss metrics described above focus on the worst possible events from a portfolio perspective. These approaches ignore the inherent variability of risk by location, since they do not consider whether a location faces a greater or lesser likelihood of attack, or of being in the vicinity of an attack.
Terrorists choose attack locations to further their objectives. These may include maximizing economic disruption, causing mass casualties, punishing government or corporate entities, and disrupting transport of resources or individuals. To achieve such objectives, terrorists typically choose specific targets, gather information about those targets and target areas, and then plan, rehearse and conduct the attacks. Target types include, but are not limited to, government facilities, corporate offices, energy facilities, hotels, and transportation hubs.

AIR has developed a comprehensive database of potential targets, or “landmarks”, across the United States. Attacks at landmarks affect not only the landmark itself, but can also affect exposures in their vicinity. When managing risk, it is prudent that the exposures in the vicinity of landmarks be quantified. To provide an identification and quantification of exposure based on the potential targets themselves, three measures should be considered:

- **Landmark exposure**
- **Landmark ring concentration**
- **Landmark deterministic scenarios**

**Landmark Exposure**

A landmark exposure analysis identifies insured exposure at properties identified as potential terrorist targets. The results of this type of analysis provide a ranked list that identifies the landmarks with the highest exposure, representing the worst-case scenarios for possible targets. This analysis can be performed for specific landmark categories, such as prominent buildings or subway stations, or across multiple landmark categories.

As in the case of single address exposures, analysis results do not consider the effects of an attack on nearby exposures.

**Landmark Ring Concentration**

Since exposures in close proximity to the landmark will likely be impacted, the accumulation of exposure in rings around the landmark is a useful measure of maximum potential loss.

Again, this measure is limited in that it considers all exposures within the specified ring at their full exposure amount even though buildings (and occupants) at some distance may only be minimally affected, while excluding all exposures outside the ring.
Landmark Deterministic Scenarios

Deterministic attack scenarios on individual landmarks provide a better assessment of potential losses than exposure analyses. This type of analysis considers property losses and injuries at all severity levels for all affected locations on the basis of weapon characteristics, construction and distance from attack location.

Deterministic scenarios should be analyzed for all landmarks in proximity to the exposures in the portfolio. An example of such a scenario—in this case a plane crash—is shown below.
A list of landmark event losses, ranked by size, provides a relative view of the risk within the portfolio. These landmark risk measures provide estimated exposure to and losses from a realistic set of events, but are limited in that they do not consider the relative likelihood of the different events, or the compound effect of locations being exposed to events at multiple targets. These limitations are addressed by using probabilistic loss analyses, as discussed in the following section.

**Probabilistic Loss Analysis**

Probabilistic loss analysis is the standard risk management approach for natural catastrophe modeling. It considers both the frequency and severity of possible future events. Based on a comprehensive set of possible events, the analysis results provide an indication of loss potential at various levels of probability (or, inversely, at various return periods, such as the 1-in-100 year loss).

In a probabilistic model, as in deterministic event scenarios, the model should calculate—for each defined event—damage to all affected properties and the injuries to the insured individuals, and the costs of each after application of policy conditions. AIR models simulate the occurrence of events over thousands of simulated years, thus providing thousands of versions of what might happen in the next year. For terrorism, event frequencies are determined through detailed analyses of the methods and objectives of known terrorist organizations. The AIR terrorism model employs 500,000 simulated years to capture even very low probability, high impact events.

Probabilistic models are used by insurers to produce complete probability distributions of losses, also known as exceedance probability curves. Output includes probability distributions of gross and net losses, which can also be expressed as return periods. That is, the loss associated with a return period of 10 years is likely to be exceeded only 10 percent of the time or, on average, in one year out of ten. For example, the model may indicate that, for a given company’s book of business, $70 million or more in insured losses would be expected to result once in 50 years on average in a defined geographical area, and that losses of $175 million or more would be expected, on average, once every 250 years.
Probabilistic loss analyses can be used to measure risk at both the policy and portfolio levels.

**Policy Level Analyses**

At the policy level, analysis results such as the average annual loss, standard deviation and losses at different return periods offer measures of relative risk for the policy. This data enables underwriters to evaluate the risk of each policy consistently and provides knowledge of the marginal impact of an individual policy on a portfolio, enabling intelligent decision-making about whether to accept a given risk.

**Portfolio Level Analyses**

Portfolio level analyses provide a measure of the relative risk of a portfolio and can be used to compare and combine portfolios, optimize portfolios, negotiate reinsurance, or
structure the capital of the organization, all in a manner similar to that employed today in managing natural catastrophe risk.

![Portfolio Level Analysis Results](image)

Figure 9: Portfolio Level Analysis Results

**Implementation Best Practices**

Once a company chooses its risk assessment strategy and implements the necessary tools and technologies, there are a number of practical decisions to be made. Among key considerations are the collection, monitoring, importing, and maintenance of the exposure data.

**Detailed Data Collection**

Of vital importance to the reliability of all measures of terrorism risk is the availability of street address level location data. The latitude and longitude of a location, known as the *geocode*, are necessary to accurately calculate losses based on distance-sensitive damage and injury severity functions, measure ring concentrations, etc.

Because location address data may be incomplete, contain non-standard formats or have errors, effective geocoding utilities must include functionality to “scrub” the addresses. Scrubbing is a process whereby the address data is standardized so that the geocoder can create the most accurate geocode possible. In cases where exact address geocode matches are impossible, locations may be assigned the geocode of the centroid of the ZIP Code, city, or county. Such approximate locations will not provide reliable results in ring accumulations and event loss scenarios.

While there has been considerable improvement in collecting data at a street address level for U.S. property risks, for casualty lines of business this level of detail is generally lacking. Group life and workers’ compensation insurers often have insufficient information about the location of their clients’ employees. In many cases, information about where employees work is not readily available and an insurer may only have the corporate headquarters as a single data point, even if the company has thousands of employees located in many locations across the country.
To help insurers assess and improve the accuracy of their exposure data, AIR has compiled a proprietary database containing detailed information on more than six million buildings and 12 million businesses in the United States. For clients with no other location information than the name of the business, AIR uses this database to determine where its offices are located and the number of employees in each office. Detailed information on size, construction and occupancy, which is critical for modeling, is also incorporated.

As data for new policy submissions is typically collected in the field, it must be checked for completeness, quality, and accuracy, and provided in a format that can be interpreted by the analysis software. AIR has developed a data review and validation process to help clients generate accurate exposure data for use in catastrophe modeling. The process involves close communication with the client to guarantee an appropriate interpretation of exposure values and policy terms.

**Data Management and Access Control**

Proper data management procedures are also important. The data collection and import process prepares new data for analysis. New submittals are analyzed together with bound business. The next step is maintaining the new submissions data. Since many submissions never become bound, they must eventually be purged, though they may need to be maintained as submittals for a certain period. Rules must be established for this transition based on the nature of the company’s operational timelines.

Should submittals be updated to “bound” status? Should they be entered anew from an underwriting or policy management system after being bound? Details to be considered include the policy numbering system, the hierarchy of books and business units, and the capture of any subsequent changes to the submittal. A valid solution should support several approaches, including the use of policy effective dates, status update processes, and automated integration with existing underwriting and policy management systems.

Finally, access control policies must be established and enforced. Roles of supervisors, system administrators, and users must be defined. Questions such as whether there should be isolation between business units, whether users need complete access at the enterprise level, and who will manage passwords and permissions must be addressed in order to create a well-designed access control system to meet corporate security policies. To that end, system administrators should have complete control over user access, including jurisdiction over passwords and the ability to customize levels and types of access to the portfolio for different users or even groups of users.

**Risk Control**

An effective terrorism risk analysis program not only measures risk and establishes thresholds, but also institutes procedures for situations where the thresholds are exceeded. In the operation of an insurance business, there are existing bound policies and new submittals to be considered. The bound policies are already in force, providing a baseline
measure of existing risk. New submissions may present an underwriting dilemma if they add too much to the company’s overall risk. Bound policies eventually come up for renewal.

To address these issues, underwriting guidelines can be used to specify thresholds for various underwriting criteria and automatically monitor them for violations. For example, the following figure shows an underwriting guideline to limit total replacement values by ZIP Code to $25 million.

![Figure 10: A Sample Underwriting Guideline](image)

In defining the business process for risk control, the following questions need to be answered:

- Should renewals be given precedence over other submittals if there is a threshold violation?
- Should the decision be based on the importance and history with the client?
- Who decides?

Implementing such decisions in the business process requires that sufficiently robust results be provided by the risk analysis. Specific policies and locations contributing to threshold violations must be identified. Information must be readily available to managers and underwriters both at headquarters and in the field. Critical threshold violations should be examined in detail to ensure that the offending location’s data—such as geocode, employee count, and property values—are correct.
Summary

In today’s environment, a critical component of insurers’ risk management strategies is the ability to assess and manage terrorism risk. With the extension of catastrophe models to cover the terrorism peril, a number of techniques are now available for performing robust terrorism risk assessments. Applications are available that enable insurers to examine portfolio locations in relation to potential terrorist target locations and perform analyses ranging from single building deterministic scenarios to portfolio-level probabilistic loss analyses. These tools and techniques can be used to create a clear picture of a company’s overall exposure to risk across their portfolio and are an essential component of a company’s overall risk assessment strategy.
### Appendix A: Benefits and Limitations of Various Risk Measures

#### Table 1: Benefits and Limitations of Various Risk Measures

<table>
<thead>
<tr>
<th>Risk Measures</th>
<th>Benefits</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maximum Loss</strong></td>
<td>• Maximum loss to insured</td>
<td>• Does not consider likelihood of attack</td>
</tr>
<tr>
<td>Single address exposure</td>
<td>• Worst-case scenario for single building loss</td>
<td>• Does not consider nearby exposures</td>
</tr>
<tr>
<td>Ring concentration</td>
<td>• Identifies portfolio exposure to a worst-case scenario</td>
<td>• Dependent on radius chosen</td>
</tr>
<tr>
<td>Aggregate exposure</td>
<td>• Maximum exposure to large CBRN events</td>
<td>• Does not consider variability of losses</td>
</tr>
<tr>
<td>Deterministic loss scenarios</td>
<td>• Accounts for weapon type and building characteristics</td>
<td>• Does not consider the range of possible losses</td>
</tr>
<tr>
<td><strong>Landmark Risk</strong></td>
<td>• Considers likely terrorist attack scenarios</td>
<td>• Does not consider relative likelihood of scenarios</td>
</tr>
<tr>
<td>Landmark exposure</td>
<td>• Worst-case scenario for identified possible targets</td>
<td>• Does not consider nearby exposures</td>
</tr>
<tr>
<td>Landmark ring concentration</td>
<td>• Identifies portfolio exposure at possible targets</td>
<td>• Dependent on radius chosen</td>
</tr>
<tr>
<td>Landmark deterministic scenarios</td>
<td>• Accounts for potential target and weapon, as well as building characteristics</td>
<td>• Does not consider variability of losses</td>
</tr>
<tr>
<td><strong>Probabilistic Loss Analysis</strong></td>
<td>• Considers comprehensive set of possible scenarios</td>
<td>• Frequency is dependent on the participating experts’ estimates of the likelihood of each scenario</td>
</tr>
<tr>
<td></td>
<td>• Accounts for specific building characteristics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Considers expert estimate of relative likelihood of different scenarios</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Provides full distribution of loss</td>
<td></td>
</tr>
<tr>
<td>Policy level</td>
<td>• Single measure of relative risk for different policies</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Can be used in pricing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Marginal impact can be quantified</td>
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</tr>
<tr>
<td>Portfolio level</td>
<td>• Single measure of relative risk of entire portfolio</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Can be used to compare and combine portfolios</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Can be used to optimize portfolio</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Can be used in reinsurance negotiation</td>
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