Use of Terrorism Catastrophe Risk Modeling to Manage Terrorism Exposure in the Insurance Industry

Terrorism Risk Analysis Symposium
University of Southern California
January 15, 2005

Jack Seaquist
AIR Worldwide Corporation
www.air-worldwide.com
AIR Timeline

- Founded in 1987
- Pioneered “probabilistic” catastrophe modeling technology
- Accurate real time loss estimates for Hurricane Andrew (1992) solidified industry use of catastrophe modeling
- AIR Terrorism Loss Estimation Model released in September 2002
Purpose of AIR Terrorism Modeling

- Evaluate the risk quantitatively
- Obtain more complete picture of extreme event risk
- Respond to Terrorism Risk Insurance Act (TRIA) mandate to offer coverage
  - Identify loss costs by business lines and policy or property
    - Average cost per $100 value by ZIP or other area
  - ISO advisory loss cost filings based on credible modeling
    - Approved for use in all of the states
- Establish underwriting guidelines to offer profitable coverage while controlling risk
- Provide better understanding of reinsurance needs
- Demonstrate sound risk management practices to rating agencies
- Support homeland security risk management quantification
Terrorism Model Components

Hazard
- Weapons
- Targets/Landmarks
- Frequency Estimate

Engineering
- Terrorism Events
- Weapon Damage and Injury Models

Loss Estimation
- Event Loss
- Probabilistic Loss Estimate

Exposure Information
Policy Conditions
Loss Estimates Made for Specific Event Scenarios

- **Scenario**
  - Targets high-profile U.S. bank headquarters in Chicago
  - Van loaded with explosives
    - Oklahoma City - type

- **Modeled losses**
  - $1.9 billion property
  - $450 million workers’ compensation
Sample Exposure Portfolio
Analysis Conducted For Events At Each Landmark
Probability of Loss Curve Results
Terrorism Model Components

Hazard
- Weapons
- Targets/Landmarks
- Frequency Estimate

Terrorism Events

Engineering
- Weapon Damage and Injury Models
- Policy Conditions

Loss Estimation
- Event Loss
- Probabilistic Loss Estimate

Exposure Information
AIR Models Possible Future Attacks Where They Could Occur

- Commercial facilities
  - Prominent buildings
  - Corporate headquarters
  - Transportation
    - Airports
    - Rail; Bus
    - Bridges; Ports
  - Chemical plants
  - Energy facilities
  - Retail centers and malls
  - Hotels and casinos
  - Amusement parks and sports venues

- Government facilities
  - Federal office buildings and courthouses
  - Embassies
  - State capitols

- Educational, medical, and religious institutions, etc.
Example: the Energy Sector

- Refineries
- Nuclear power plants
- Tank farms
- Natural gas production plants
- Natural gas compressor stations
- Fossil-based electric power plants
Consistent with Homeland Security Department – Critical Infrastructures and Key Assets

- Critical Infrastructures
  - Agriculture and Food
  - Water
  - Public Health
  - Emergency Services
  - Defense Industrial Base
  - Telecommunications
  - Energy
  - Transportation
  - Banking and Finance
  - Chemicals and Hazardous Materials
  - Postal and Shipping

- Key Assets
  - National Monuments and Icons
  - Nuclear Power Plants
  - Dams
  - Government Facilities
  - Commercial Key Assets
    - Commercial Centers
    - Office Buildings
    - Sports Stadiums
    - Theme Parks
    - Other Commercial and Recreational Sites

*The National Strategy for the Physical Protection of Critical Infrastructures and Key Assets February 2003*
Terrorism Model Components

Hazard

- Weapons
- Targets/Landmarks
- Frequency Estimate

- Terrorism Events

Engineering

- Weapon Damage and Injury Models
- Policy Conditions

Loss Estimation

- Event Loss
- Probabilistic Loss Estimate
Types of Attacks Modeled by AIR

CONVENTIONAL
- Bombs
  - Portable
  - Car
  - Van
  - Delivery Truck
  - Large Truck
- Airplane crash
  - General aviation
  - Large commercial airliner

CBRN
- Chemical*
  - Sarin (GB)
  - VX Nerve
- Biological*
  - Anthrax
  - Small pox
- Radiological
  - Cesium 137
  - Cobalt 60
- Nuclear
  - Suitcase type
  - Medium
  - Large

* Includes small, medium, and large
Conventional Damage Estimates Consider Multiple Effects on the Target and Surrounding Buildings

- Kinetic Energy
- Explosion
- Fire & Smoke
- Pressure Wave
- Shock Wave

Target Building
- Falling Debris
- Projectiles
- Falling Structures
- Dust

Surrounding Buildings

Damage, Casualties

Mean Damage Ratio vs. Distance (ft)

© 2005 AIR Worldwide Corporation
CONFIDENTIAL
Exposure Density Strongly Influences Commercial Property Losses

Scenario: Large Truck Bomb Placed in Washington DC vs. Northern Virginia Area
Building Physical Damage Distribution Mapped to Damage States

1 - Slight Damage
2 - Moderate Damage
3 - Extensive Damage
4 - Complete Damage
   - collapse
   - no collapse
Components of AIR’s Injuries and Fatalities Model -- Workers’ Compensation, Life, Disability

Location Information → Damage Ratio Distribution → Damage State → Injury Severity Levels

Engineering

Loss Estimation

- Number of People
- Costs of Injuries
- Loss Calculation

Terrorism Event

© 2005 AIR Worldwide Corporation
CBRN Events Modeled Using Department of Defense Standard Model

- Full spectrum of NBC weapons
- Accurately predicts the effects of hazardous material releases
  - Contamination
  - Injuries and fatalities
- Embedded climatology and historical weather data
- Terrain data and supporting wind-flow models calculate the local windfield

Surface Dosage
ANTH at 01-Sep-02 15:00Z (1.00 hrs)

Contour area at indicated level (sq Km)

NOTE: Exposures based only on the displayed portion of the plume
Distribution of Source Locations by CMSA/MSA
Terrorism Model Components

Hazard
- Weapons
- Targets/Landmarks
- Frequency Estimate

Terrorism Events

Exposure Information

Engineering
- Weapon Damage and Injury Models
- Policy Conditions

Loss Estimation
- Event Loss
- Probabilistic Loss Estimate
Frequency Estimates Based on Operational Assessment of Each Terrorist Group

- **Objectives**
  - Mass casualties?
  - Economic impact?
  - Symbolic?
  - Punish a group, industry, company, government?

- **Capabilities and Resources**
  - Weapon availability
  - CBRN efforts
  - Coordinated attacks
  - Manufacture vs. buy
  - Financial
  - Technical
  - Operational skills

- **Deployment**
  - Locales with presence
  - Financial vs. operational
  - Local target surveillance opportunity
  - Local support

- **Historical attacks**
  - Targets
  - Weapons
  - Locales

- **Impact of Security**
  - Federal
  - State
  - Local
  - Private
Frequency and Severity Update

- Group Attack Frequency
  - Target Types: Com’l Bldgs, Fed Bldgs, Airports...
- Group Threat Index
  - Target type
  - Weapon/attack type
  - Locale
- Locales
- Weapon/attack Types

- Delphi Method
- Terrorist Groups
- Objectives Resources History Countermeasures
Terrorism Model Components

Hazard
- Weapons
- Targets/Landmarks
- Frequency Estimate

Engineering
- Terrorism Events
- Weapon Damage and Injury Models

Loss Estimation
- Exposure Information
- Policy Conditions
- Event Loss
- Probabilistic Loss Estimate
Complete National Exposure Database Used to Quantify Event Outcomes for the Industry

- Locations, values, construction, and occupancy database
- Commercial property, residential property, workers, automobiles
- Used throughout AIR’s history for all catastrophe models
ISO Specific Property Information Database

- 2.5 million commercial properties
- 600 field inspectors
- Complete building data
  - Construction
  - Occupancy
  - Square feet
  - Number of stories
  - ...
- 50 years legacy
- Up-to-date
Terrorism Model Components

Hazard
- Weapons
- Targets/Landmarks
- Frequency Estimate
- Terrorism Events

Engineering
- Weapon Damage and Injury Models
- Policy Conditions

Loss Estimation
- Event Loss
- Probabilistic Loss Estimate

Exposure Information
Generation of Loss Probabilities

- Frequency estimation process results in expected frequency of each event (landmark attack vector element)
  - Frequently updated to reflect current threat
- Occurrence of each event is modeled as a Poisson process
- Catalog of 500,000 years of replications is generated
  - Catalog is delivered to customers within AIR software
- Results in calculation of probabilistic loss distribution
  - Distribution tail is of utmost importance in catastrophe risk management
ISO Used AIR Model to Develop New Filings

Proposed ISO 2005 Advisory Loss Costs

© 2005 AIR Worldwide Corporation
ISO Used AIR Model to Develop New Filings

Proposed ISO 2005 Advisory Loss Costs
Underwriting
- Measure and limit maximum loss exposure

Transfer risk
- Terrorism Risk Insurance Act of 2002 (TRIA)
- Private reinsurance market

Loss reserves
Terrorism Risk Measures Being Used

- Maximum Possible Loss (to the portfolio)
  - Single location
  - Ring concentration
  - Aggregate exposure
  - Deterministic loss scenario

- Maximum Landmark Risk
  - Landmark exposure – in the landmark
  - Landmark ring concentration
  - Landmark event loss scenario

- Probabilistic Loss Distribution
  - Portfolio
  - Policy
Multiple Tools for Measuring Terrorism Risk

- Exposure concentration analysis
  - Single location
  - Insured location
  - Ring
  - Landmark

- Deterministic loss analysis
  - Insured location
  - Landmark

- Probabilistic loss analysis
Include Concentrations Across Lines of Business

Workers Compensation

Property
Identify Concentrations Around Targets
### Largest Ring Concentration Report

#### Location Ring Analysis Report
- **Business Unit:** Terrorism Treaty
- **Book:** ABC Insurance Co
- **Exposure:** Policy Exposure
- **Ring Value:** .5 Miles

<table>
<thead>
<tr>
<th>Policy ID</th>
<th>Location ID</th>
<th>Latitude</th>
<th>Longitude</th>
<th>City</th>
<th>State</th>
<th>Exposure (Policy Exposure)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policy_003</td>
<td>13</td>
<td>38.89883</td>
<td>-77.03947</td>
<td>Washington</td>
<td>DC</td>
<td>116,838,845 R</td>
</tr>
<tr>
<td>Policy_003</td>
<td>2</td>
<td>38.89914</td>
<td>-77.0391</td>
<td>Washington</td>
<td>DC</td>
<td>116,838,845 R</td>
</tr>
<tr>
<td>Policy_005</td>
<td>6</td>
<td>38.90275</td>
<td>-77.03427</td>
<td>Washington</td>
<td>DC</td>
<td>116,838,845 R</td>
</tr>
<tr>
<td>Policy_002</td>
<td>2</td>
<td>40.75481</td>
<td>-73.98804</td>
<td>New York</td>
<td>NY</td>
<td>91,816,235 R</td>
</tr>
<tr>
<td>Policy_004</td>
<td>24</td>
<td>40.7564</td>
<td>-73.98764</td>
<td>New York</td>
<td>NY</td>
<td>91,816,235 R</td>
</tr>
<tr>
<td>Policy_007</td>
<td>393</td>
<td>40.72762</td>
<td>-74.00067</td>
<td>New York</td>
<td>NY</td>
<td>61,875,867 R</td>
</tr>
<tr>
<td>Policy_004</td>
<td>6</td>
<td>38.90335</td>
<td>-77.03972</td>
<td>Washington</td>
<td>DC</td>
<td>60,099,426 R</td>
</tr>
<tr>
<td>Policy_002</td>
<td>11</td>
<td>40.75201</td>
<td>-73.97597</td>
<td>New York</td>
<td>NY</td>
<td>56,955,200 R</td>
</tr>
<tr>
<td>Policy_007</td>
<td>661</td>
<td>41.68725</td>
<td>-87.95251</td>
<td>Lemont</td>
<td>IL</td>
<td>49,031,644 R</td>
</tr>
<tr>
<td>Policy_007</td>
<td>662</td>
<td>41.68733</td>
<td>-87.95226</td>
<td>Lemont</td>
<td>IL</td>
<td>49,031,644 R</td>
</tr>
<tr>
<td>Policy_007</td>
<td>113</td>
<td>29.45563</td>
<td>-98.4965</td>
<td>San Antonio</td>
<td>TX</td>
<td>42,527,707 R</td>
</tr>
<tr>
<td>Policy_005</td>
<td>13</td>
<td>42.35445</td>
<td>-71.05943</td>
<td>Boston</td>
<td>MA</td>
<td>42,137,285 R</td>
</tr>
<tr>
<td>Policy_003</td>
<td>16</td>
<td>42.35548</td>
<td>-71.06059</td>
<td>Boston</td>
<td>MA</td>
<td>42,137,285 R</td>
</tr>
<tr>
<td>Policy_002</td>
<td>3</td>
<td>41.88453</td>
<td>-87.62914</td>
<td>Chicago</td>
<td>IL</td>
<td>40,502,521 R</td>
</tr>
<tr>
<td>Policy_004</td>
<td>4</td>
<td>41.88201</td>
<td>-87.63107</td>
<td>Chicago</td>
<td>IL</td>
<td>40,502,521 R</td>
</tr>
</tbody>
</table>
Look at Potential Losses (Deterministic)

![Image of Location Ring Analysis Report]

**View Location Ring Analysis Report**

Location Ring Analysis Report created 6/29/2004 2:44:17 PM

- **Business Unit:** Terrorism Treaty
- **Book:** ABC Insurance Co
- **Exposure:** Policy Exposure
- **Ring Value:** .6 Miles

<table>
<thead>
<tr>
<th>Policy ID</th>
<th>Location ID</th>
<th>Latitude</th>
<th>Longitude</th>
<th>City</th>
<th>State</th>
<th>Exposure (Policy Exposure)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policy_003</td>
<td>13</td>
<td>38.89883</td>
<td>-77.03947</td>
<td>WASHINGTON</td>
<td>DC</td>
<td>116,838,845 R</td>
</tr>
<tr>
<td>Policy_003</td>
<td>2</td>
<td>38.89914</td>
<td>-77.0391</td>
<td>WASHINGTON</td>
<td>DC</td>
<td>116,838,845 R</td>
</tr>
<tr>
<td>Policy_005</td>
<td>6</td>
<td>38.90278</td>
<td>-77.03427</td>
<td>WASHINGTON</td>
<td>DC</td>
<td>116,838,845 R</td>
</tr>
<tr>
<td>Policy_002</td>
<td>2</td>
<td>40.75468</td>
<td>-73.98804</td>
<td>NEW YORK</td>
<td>NY</td>
<td>91,816,235 R</td>
</tr>
<tr>
<td>Policy_004</td>
<td>24</td>
<td>40.7564</td>
<td>-73.98764</td>
<td>NEW YORK</td>
<td>NY</td>
<td>91,816,235 R</td>
</tr>
<tr>
<td>Policy_007</td>
<td>393</td>
<td>40.72762</td>
<td>-74.00067</td>
<td>NEW YORK</td>
<td>NY</td>
<td>61,875,867 R</td>
</tr>
<tr>
<td>Policy_004</td>
<td>6</td>
<td>38.90335</td>
<td>-77.03972</td>
<td>WASHINGTON</td>
<td>DC</td>
<td>60,099,426 R</td>
</tr>
<tr>
<td>Policy_002</td>
<td>11</td>
<td>40.75201</td>
<td>-73.97597</td>
<td>NEW YORK</td>
<td>NY</td>
<td>56,955,200 R</td>
</tr>
<tr>
<td>Policy_007</td>
<td>661</td>
<td>41.68725</td>
<td>-87.95251</td>
<td>LEMONT</td>
<td>IL</td>
<td>49,031,644 R</td>
</tr>
<tr>
<td>Policy_007</td>
<td>662</td>
<td>41.68733</td>
<td>-87.95226</td>
<td>LEMONT</td>
<td>IL</td>
<td>49,031,644 R</td>
</tr>
<tr>
<td>Policy_007</td>
<td>113</td>
<td>29.45563</td>
<td>-98.4965</td>
<td>SAN ANTONIO</td>
<td>TX</td>
<td>42,527,707 R</td>
</tr>
<tr>
<td>Policy_005</td>
<td>13</td>
<td>42.35445</td>
<td>-71.05943</td>
<td>BOSTON</td>
<td>MA</td>
<td>42,137,285 R</td>
</tr>
<tr>
<td>Policy_003</td>
<td>16</td>
<td>42.35548</td>
<td>-71.06059</td>
<td>BOSTON</td>
<td>MA</td>
<td>42,137,285 R</td>
</tr>
<tr>
<td>Policy_002</td>
<td>3</td>
<td>41.88453</td>
<td>-87.62914</td>
<td>CHICAGO</td>
<td>IL</td>
<td>40,502,521 R</td>
</tr>
<tr>
<td>Policy_004</td>
<td>4</td>
<td>41.88201</td>
<td>-87.63107</td>
<td>CHICAGO</td>
<td>IL</td>
<td>40,502,521 R</td>
</tr>
</tbody>
</table>
Deterministic Loss Analysis at Largest Concentration
Deterministic Loss Analysis
Support for Rating Agency Reporting

A.M. Best Supplementary Rating Questionnaire

- Single location exposure
- Location ring exposure
- Deterministic modeled loss
Summary

- **Terrorism Loss Estimation Model**
  - Comprehensive landmark database
  - National exposure database
  - Conventional and CBRN weapons
  - Weapons effects modeling
  - Credible process for event likelihood estimation

- **Risk measurement**
  - Potential loss at insured locations and landmarks
    - Single location exposure
    - Ring accumulation
    - Deterministic (modeled) event loss
  - Probabilistic loss analysis

- **Risk control**
  - Underwriting
  - Risk transfer
  - Risk reserves/surplus/capital
Thank you

Jack Seaquist
AIR Worldwide Corporation
131 Dartmouth Street
Boston, MA 02116
617-267-6645
Jseaquist@air-worldwide.com