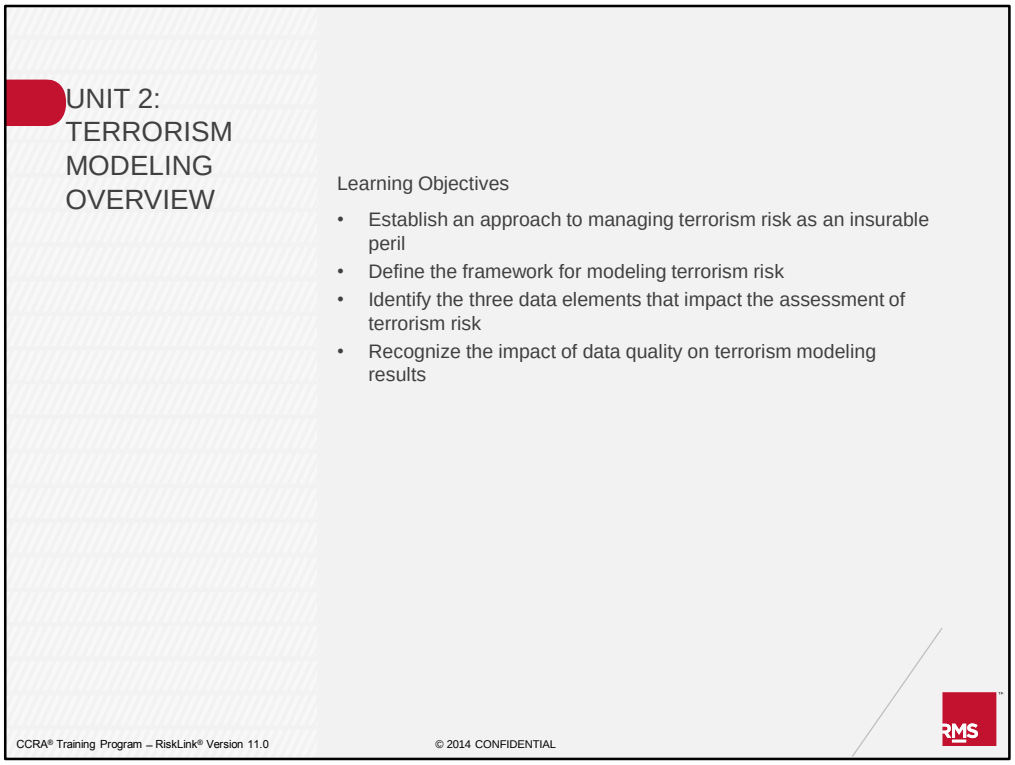
TERRORISM MODELING

UNIT 2

RMS® CCRA® Training Program

AGENDA

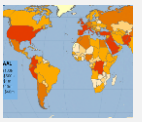
- Unit 1: Understanding Terrorism Risk
- **Unit 2: Terrorism Modeling Overview**
- Unit 3: Terrorism Hazard Module
- Unit 4: Terrorism Vulnerability Module
- Unit 5: Terrorism Financial Modeling
- Unit 6: Probabilistic Terrorism Modeling



At the end of this unit you should have a good understanding of each of the five learning objectives listed on this slide.

THREE-PRONGED APPROACH FOR MANAGING TERRORISM RISK

- Exposure management
  - Identify and manage multi-line concentrations
  - Monitor new submissions against existing exposure
- Terrorism scenario loss modeling
  - Manage losses of benchmark scenarios to “acceptable” loss levels
- Probabilistic loss modeling
  - Assist underwriters in risk selection
  - Evaluate reinsurance needs and options
  - Determine key drivers of risk



Multiple methods of risk quantification help users triangulate on the magnitude and sources of risk

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An analytical approach for the quantification and management of terrorism risk is in demand in response to insurance industry concerns post-9/11. The nature of terrorism risk is different than that of natural perils, and thus requires a different approach to risk management. There is uncertainty in the terrorist targets, the attack methods, and the frequency of events. There are anti-terrorism activities which lead to a decrease in the threat level; however, new terrorist capabilities and organizations emerge and the threat level is increased. While the management of natural catastrophe perils focuses heavily on probabilistic output, the dynamic nature of terrorism risk requires an approach that focuses on exposure management, scenario modeling, and probabilistic loss modeling. This three pronged approach can be used to analyze terrorism risk from a number of angles, allowing risk managers to triangulate on the risk.

Exposure Management

The first step in managing terrorism risk is exposure management. Insurers need to identify, understand, and control their exposure accumulations across multiple lines of business, especially in urban areas. By limiting business in over-exposed areas or flagging possible non-renewal accounts, companies are able to maintain acceptable levels of risk.

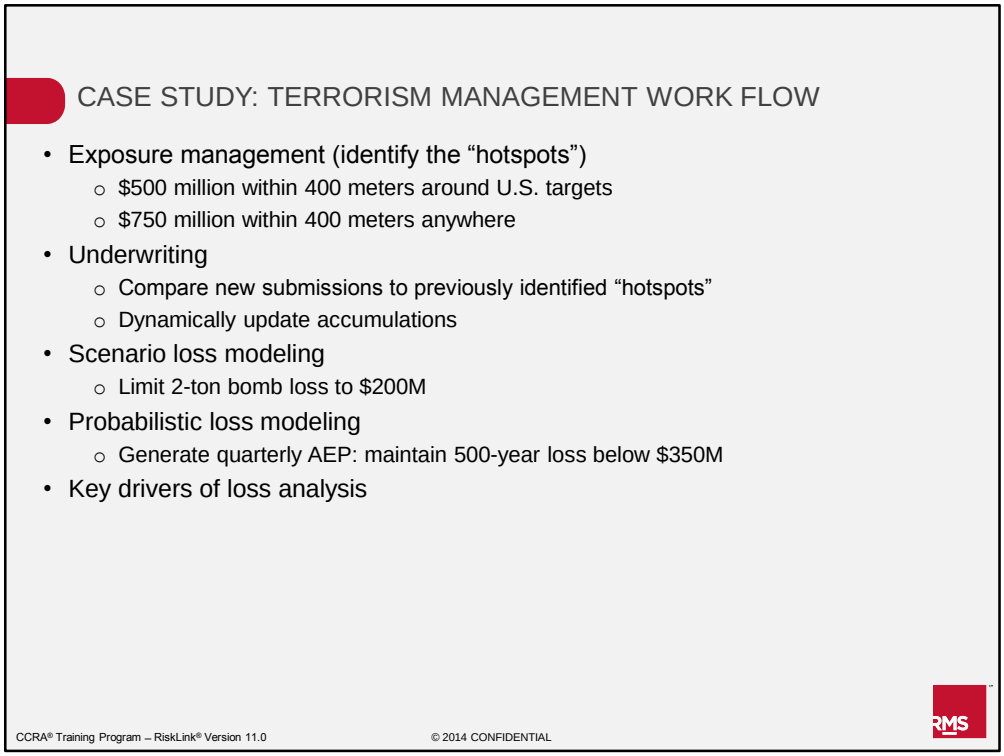
Scenario Modeling

A deterministic approach can be used to quantify loss due to potential attack scenarios. Typically, companies select a benchmark event in order to manage losses to an acceptable loss threshold. A major conventional attack, such as a 2-ton or 5-ton truck bomb, is typically selected given that this type of attack mode is relatively likely to occur and will produce a significant amount of loss.

Probabilistic Loss Modeling

While these first two methods can help control a company’s absolute exposure to terrorism risk, one also needs to factor in the relative likelihood of an attack mode and target location. This is accomplished through use of the Probabilistic Terrorism Model (PTM). While some are skeptical of the ability to model terrorism risk probabilistically, the RMS model was built by working closely with some of the world’s leading terrorism experts, incorporating their insights along with an exhaustive research of terrorist attacks and tendencies around the globe.

The challenge in managing terrorism as an insurable peril stems from the high level of uncertainty in estimating terrorism risk to a portfolio. Risk models play an integral role in helping companies make informed decisions about terrorism threat to their business.



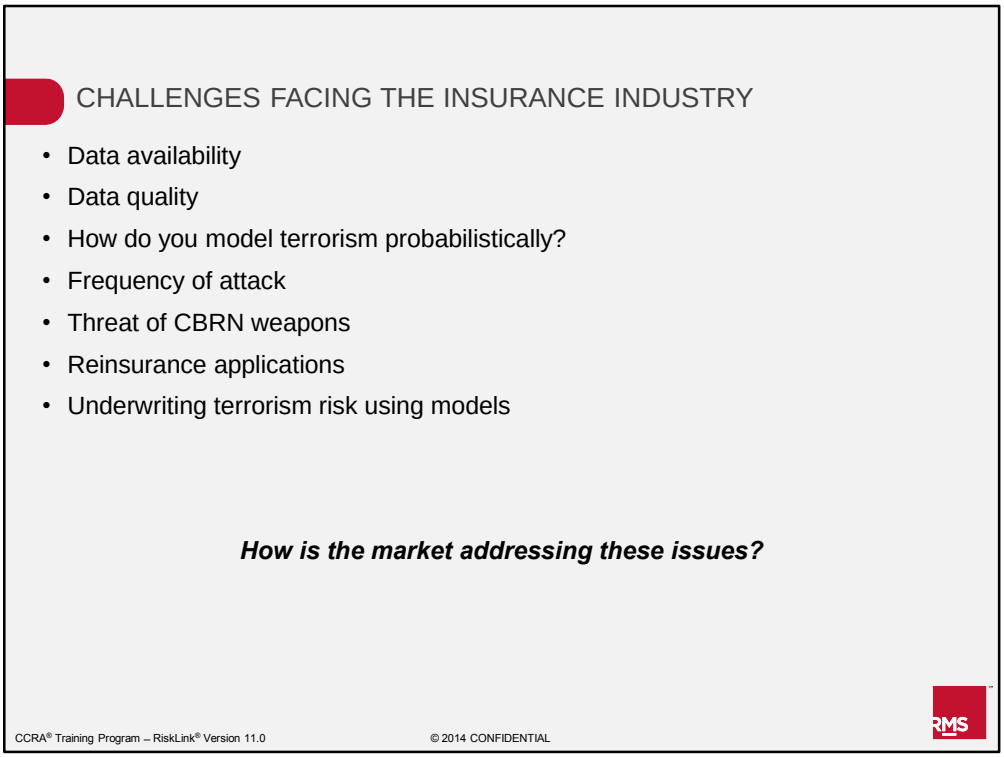
Standard industry practices for terrorism risk management are still being defined. Outlined here are a set of guidelines similar to what we see in the market today. We will step though an example of how a company would manage its terrorism exposures, given these management established guidelines.

The first step in managing terrorism risk is to identify areas of high exposure concentrations. RMS recommends a 400 meter radius circle to manage exposure accumulations since the majority of structural damage around a truck bomb is confined to the first 400 meters and conventional bombs are currently the most likely attack mode. In this example, management has selected a 400 meter exposure threshold of $750 million except around trophy buildings where the exposure threshold is $500 million.

Risk transfer options for terrorism are not as abundant as the options available for natural catastrophe risk. As a result, risk selection and underwriting are very important in maintaining an acceptable level of risk as well as being able to identify areas where a business can grow.

In addition to managing exposure concentrations, most companies utilize a benchmark scenario to manage terrorism risk. A 2-ton bomb or 5-ton bomb is commonly used in the industry due to their likelihood of occurrence. There are a range of analyses that can be performed; however, the two most commonly used are (1) attack scenarios at RMS target locations and (2) attack scenarios utilizing the spider analysis. The spider analysis identifies those areas that would generate the worst case losses from a specified attack for an entire portfolio worldwide, not just looking at targets. Here, management has chosen to limit loss to $200 million from a 2-ton bomb across all lines of business.

It is also possible to evaluate the exceedance probability of loss to a terrorism portfolio. The probabilistic model supports decisions such as risk selection, reinsurance needs, analysis of key drivers of loss, and pricing.

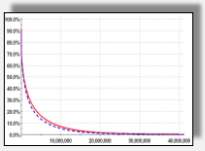


There are many challenges and questions that face the insurance industry when it comes to modeling terrorism. Some of these include:

- Data availability
- Data quality
- How to model terrorism probabilistically
- What is the frequency of attack and how does it change over time?
- What is the threat CBRN weapons?
- Reinsurance applications
- How to underwrite terrorism risk using models

FRAMEWORK FOR TERRORISM MODELING



Exposure at Risk	Quantify Hazard	Assess Vulnerability	Probabilistic Analysis

• Property exposed
• Population exposed
• Geocoding
• Building Attributes
	• Pressure waves
	• Contaminant dispersal
	• Debris
	• Fire
		• Distance vs. Damage
		• Impact of hazard on the building environment
		  ○ Building Damage
		  ○ Nature of injuries
			• Relative likelihood of scenarios
			• Multiplicity of attacks
			• Frequency of attacks

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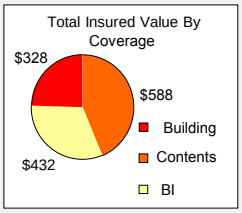
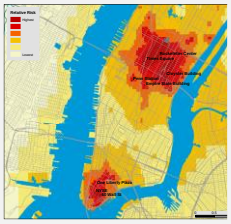
Terrorism models are based on the concepts used to model natural catastrophes. The framework for terrorism modeling begins with the identification of the exposure at risk, followed by quantifying the hazard associated with potential attack modes, assessing the vulnerability of building structures and the nature of injuries resulting from different levels of hazard, and, finally, assessing the loss to insured property and people. We will focus on the exposure at risk in this unit.

EXPOSURE DATA AND RELEVANCE TO TERRORISM MODELING

- The assessment of terrorism risk requires understanding of three main topics



1. How much is insured?



2. Where are the insured assets and/or individuals located?

3. In what type of structure are the insureds located?

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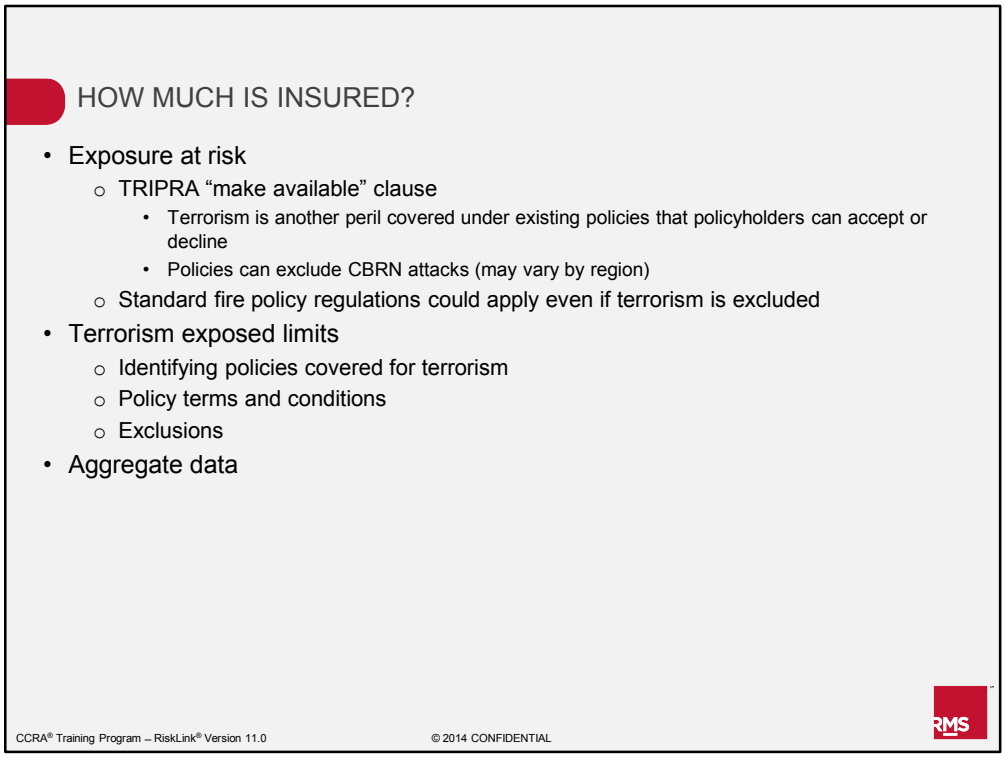
The assessment of exposure at risk requires the understanding of three main topics.

1. How much is insured?
2. Where are the insured assets and/or individuals located?
3. In what types of structures are the insureds located?



Identifying exposed limits is the first step in determining how much a company has exposed to terrorism risk. Within the U.S., the placement of TRIPRA has required insurance companies to provide terrorism coverage to its policyholders; however, coverage for chemical, biological, radiological, and nuclear (CBRN) attacks may be excluded from property coverage. Coverage can then be accepted or declined by the insured. Even if coverage is declined, standard fire policy regulations require coverage for fire regardless of peril. This means that even if terrorism is excluded from a policy, the fire caused by the terrorist attack may still be covered.

Since terrorism is just another peril covered under existing policies, it is important to identify which policies are covered for terrorism and which are not. It is also important to identify if the terms of the policy vary by region. Are there any policy exclusions?

There has been a lot of discussion in previous courses around the affect of aggregate data on exposure data quality. Due to the geographically focused nature of terrorist events, it is imperative to acquire high resolution data to understand exposure at risk.

WHERE ARE THE INSURED ASSETS LOCATED?

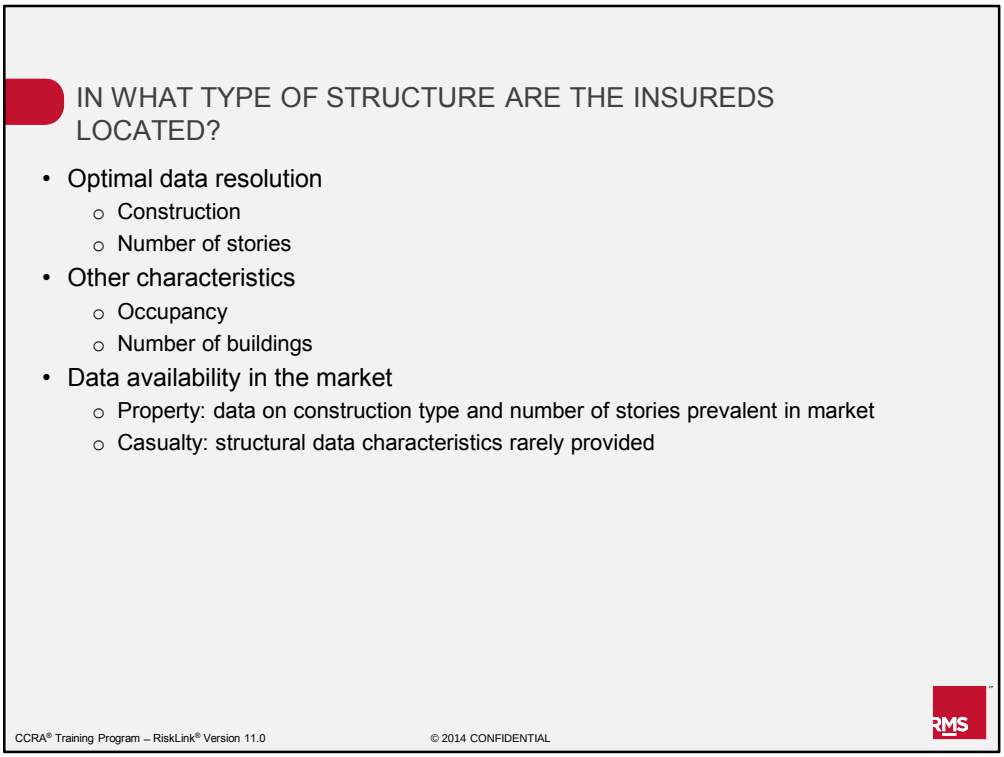
Line of Business	Optimal Data Resolution	Data Availability in the Market
Property	Geocoding to high resolution (coordinate, ESDB* building ID, street)	High resolution data prevalent ZIP Code supported in models, but not recommended
Workers Comp	Employee information: • # of people by location • Shift information	Number of employees by location/satellite office RMS & Brokers report that 85% of data is hi-res and remaining is ZIP Code Reinsurers seeing lower quality data (i.e. 25% hi-res, 50% ZIP Code, 25% state)
Other Casualty	Work and/or home address	Generally available at ZIP Code level

*ESDB building ID ("4-wall geocoding") available in major U.S. cities.
Users with a latitude/longitude coordinate can use accumulation management functionality anywhere in the world.

High resolution data begins with an understanding of where insured assets are located. Optimal data resolution includes address information geocoded to coordinate, building, or street level. This type of information is prevalent in the market for property exposure and becoming more prevalent for workers compensation exposure. An informal survey performed by RMS reports that approximately 85% of workers compensation exposure is available at street level and the remaining at ZIP Code level, although reinsurers are not seeing this high of resolution. Due to the mobility of workers compensation exposure, it is a challenge to accurately reflect the location of individuals and the time of day that individuals are at work. Information such as shift data helps to estimate occupancy levels throughout the day.

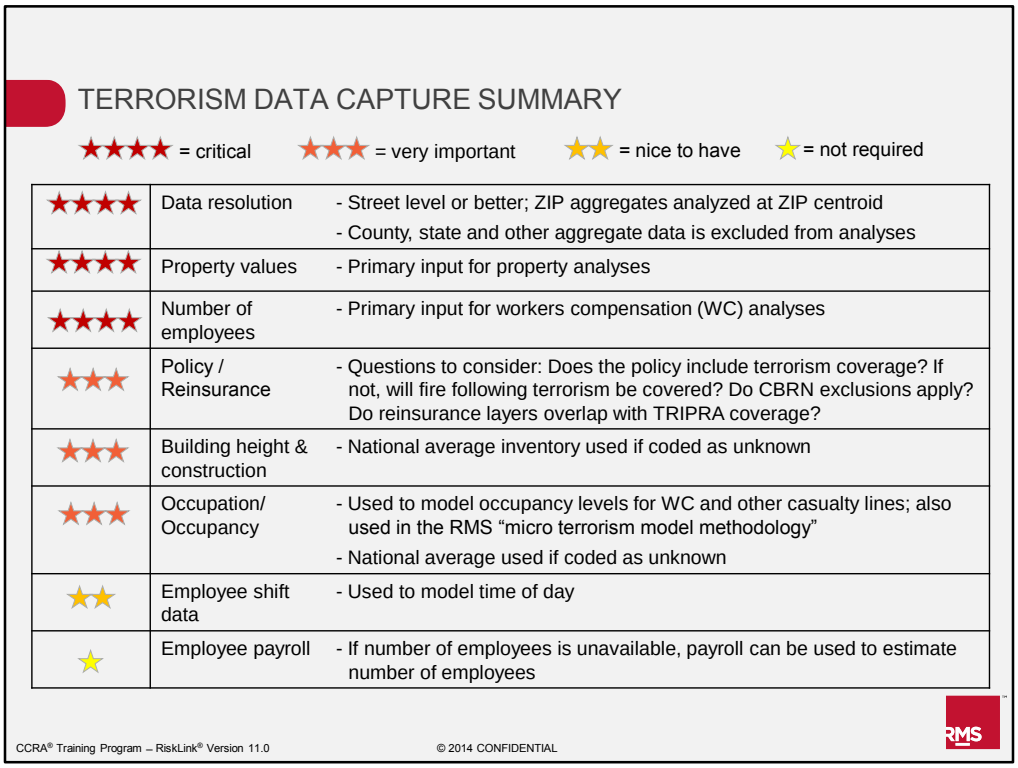
Other casualty lines, such as life and personal accident, are generally available at the ZIP Code level. Since these lines of business are generally covered 24 hours a day, having both work and home addresses is optimal.

While ZIP Code level data is supported in the RMS terrorism models, it is not recommended due to the misrepresentation of exposure.



The type of structure in which the insured assets are located significantly impacts the amount of damage and extent of injuries sustained. The vulnerability model incorporated in the RMS terrorism models is dependent on both construction and height. Therefore, the presence of those building characteristics is important. Other characteristics, such as occupancy, is also used to determine the amount of exposure exposed to an event for workers compensation (WC) and other casualty lines of business.

Construction and building height information are generally available for property exposures; however, they are rarely provided for casualty lines of business.



This chart summarizes various data elements and indicates their relative importance. Critical to the quantification of terrorism risk are high resolution geocoding data, property values, and number of employees. A few questions to consider when determining issued limits or reinsurance participation include:

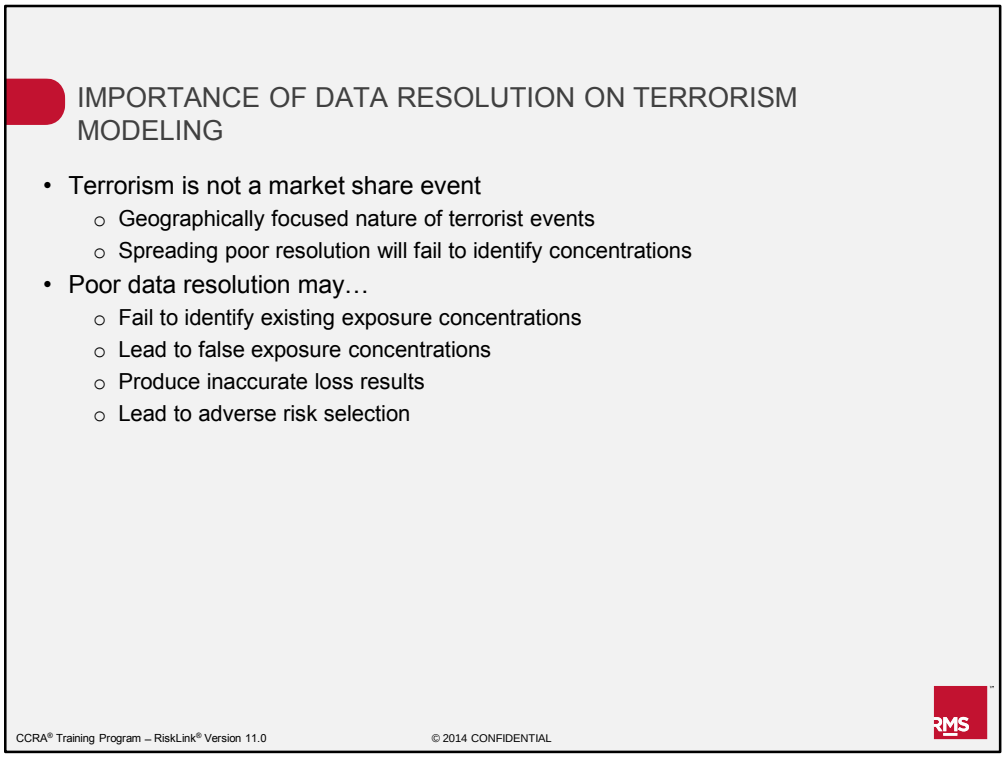
1. Does the policy include terrorism coverage. If not, will fire following terrorism be covered?
2. Do CBRN exclusions apply?
3. Do reinsurance layers overlap with TRIPRA coverage?

Building height and construction class are the key building attributes that determine vulnerability in the RMS terrorism models and, therefore, are considered very important data fields. In the absence of this data, RMS uses a composite vulnerability curve based on a national average.

Occupancy is an important field when modeling casualty lines of business because the occupancy, or occupation of employees, will determine the percentage of employees subject to risk for each event.

If available, employee shift data is used to determine occupancy by time of day. While this data is be beneficial to have, it is rarely provided.

Employee payroll is not a required field for the RMS casualty model. However, if number of employees is not available, payroll can be used to estimate number of employees. Payroll information may also be useful as a way to check for data accuracy. For example, if you are provided with five employees at a location with a total annual payroll of $5 million, that would imply an average salary of $1 million, which may be correct; however, it should raise a red flag.



Next we will talk about the importance of data resolution as it relates to terrorism modeling.

Terrorism is not a market share event. Terrorist attacks are geographically focused in nature and certain attacks may only impact one building. What that means is that terrorism does not lend itself to “market-share” analyses. High resolution address information is required to accurately manage terrorism risk.

Poor data resolution may lead to false exposure concentrations. In the accumulation management module we discussed how aggregate data could lead to the identification of a large exposure concentration; in reality, those exposures could be dispersed and actually contribute to other accumulation zones.

Poor data resolution may also produce inaccurate loss results. Insured losses to terrorism are binary. You are either at or close to the attack centroid and experience a large amount of loss or far enough away that you experience little or no loss. Accurate placement of a location within the damage footprint is crucial.

Losses are very sensitive to building attributes. For instance, a 50-story steel frame building will experience much less damage from a 2-ton bomb than an eight story reinforced masonry building. Having detailed data is critical in the analysis of terrorism risk, even more so than natural peril risk.

Poor data resolution may also lead to adverse risk selection.

MULTIPLE BUILDING ADDRESSES ISSUE

- Company ABC writes nine property and workers compensation accounts in the Empire State Building, each coded under a different address.

350 5th Ave
350 5th Ave, 14th floor
1 West 33rd St
17 West 33rd St
25 West 33rd St
25 W 33rd St
20 West 34th St
Empire State Bldg, 11th floor
Empire State Bldg, suite 5901

- ESDB building ID geocoding data can identify multiple addresses coded for a single location.

A common issue for the insurance industry is identifying exposure concentrations in a single building. Looking at the list of addresses on this slide, it is not obvious which locations are located in the Empire State Building (ESB). The primary address of the ESB is 350 5th Ave, so looking at this list we would say there are four accounts located in this building. However, the ESB has a very large building footprint and in actuality, all these locations are in the ESB. Sanborn geocoding data can be used to identify multiple addresses coded for a single location.

IMPACT OF GEOCODING DATA

Target: Empire State Building located at 350 5th Ave, NY 10118

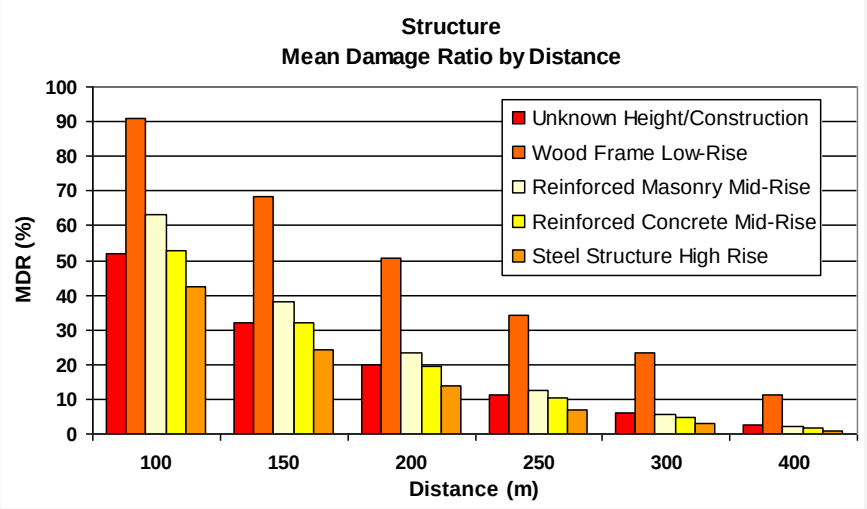
Loss per million

Attack Method	Building Level Geocode	ZIP Code Level Geocode
Bomb - 600 lb	$380,936	$180,062
Bomb - 1 Ton	$610,064	$391,444
Bomb - 2 Ton	$686,231	$523,143
Bomb - 5 Ton	$831,738	$739,842
Bomb - 10 Ton	$896,596	$826,438
Aircraft Impact	$999,307	$596,074
Conflagration	$784,676	$535,461

The impact of poor data resolution will vary depending upon the size of the attack footprint and the geographic region.

The impact of geocoding resolution on loss estimates will vary depending upon the size of the attack footprint, the geographic region, and the concentration of exposures. The chart on this slide shows that losses will vary considerably even in a region that has a relatively small ZIP Code. This impact is magnified for attacks with small damage footprints. Looking at the 1-ton bomb, losses are less than half if the location is geocoded to the ZIP Code centroid compared to the attack centroid. Since the damage footprint of the 10-ton bomb is larger and more severe, you will notice less variation in damage. Again, the impact will vary depending upon footprint size and geographic region.

IMPACT OF CONSTRUCTION AND BUILDING HEIGHT



The above example shows how damage to a building's structure due to a 2-ton bomb will vary depending upon the construction and height of the building, as well as the distance from the center of the attack. At 100 meters from the center of the attack, there is a large variation in the building damage depending upon construction and building height. A high-rise steel frame structure will sustain less damage than a mid-rise reinforced masonry structure. You will notice that by coding data with unknown building height and construction, you may be overestimating your losses, especially in a region that is characterized by steel frame skyscrapers such as New York City.

Similarly, damage will vary as a location is farther away from the center. At 100 meters, the mean damage ratio for a steel frame structure is approximately 42%. At 150 meters, the mean damage falls to around 22%.

IMPACT OF DATA RESOLUTION ON PRICING

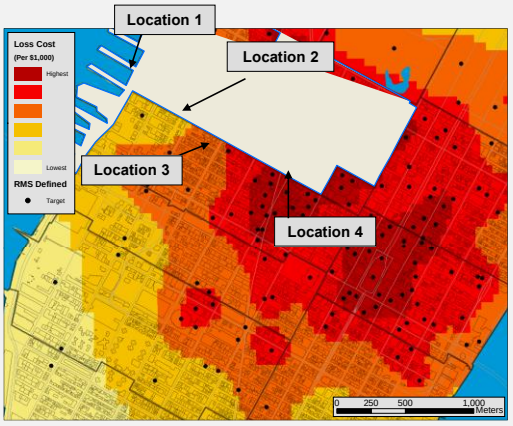
Loss Rates per $1,000

Manhattan = 1.4

Midtown = 3.1

Post Code 10019 = 4.0

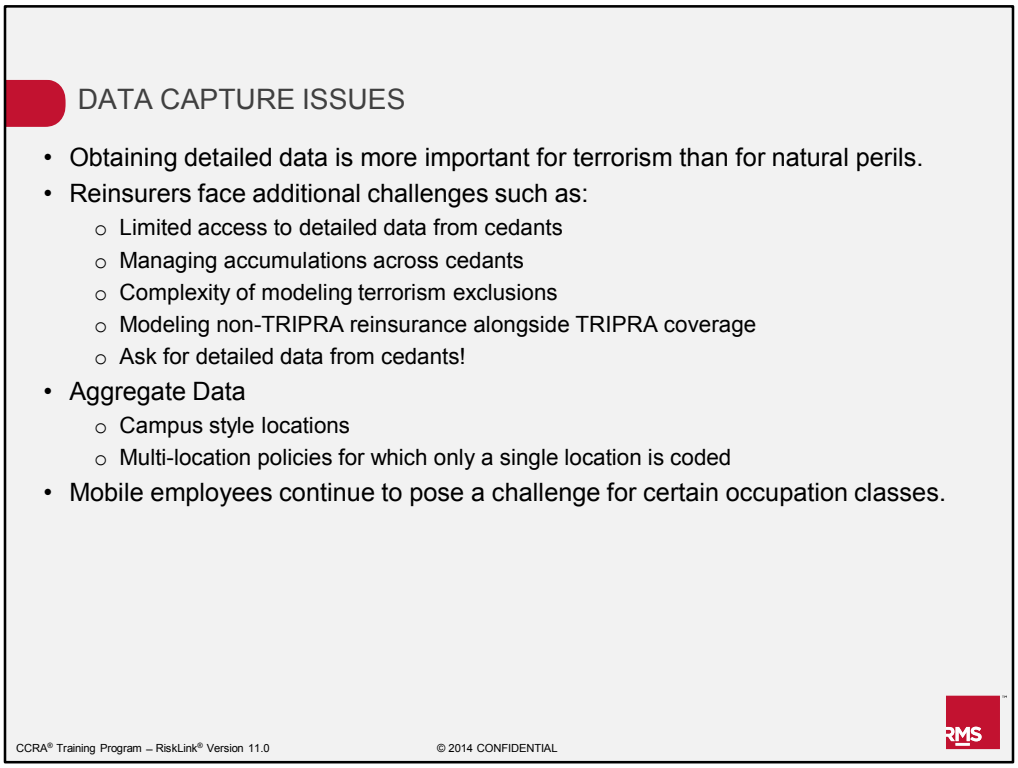
- Location 1 = 0.1
- Location 2 = 0.7
- Location 3 = 2.8
- Location 4 = 5.3



- Terrorism risk is often more variable than market pricing
- Modeling tools are invaluable for risk selection

This map shows the relative risk of four locations in midtown Manhattan. Although the pricing of terrorism risk may be relatively flat, you can see there is a large variation in risk between these four locations. Low resolution data could lead to adverse risk selection and impact pricing of terrorism risk.

Risk transfer options for terrorism are not as abundant as the options available for natural catastrophe risk. As a result, risk selection and underwriting are very important in maintaining an acceptable level of risk as well as being able to identify areas where a business can grow.



Data capture is the basis of any risk analysis and impacts the accuracy of analysis results for any peril. Due to the geographically focused nature of terrorist events, it is much more important to gather high resolution data for terrorism than for natural peril analyses.

Challenges for Reinsurers

Reinsurers face additional challenges such as limited access to detailed data from cedants and managing accumulations across multiple cedants. Most reinsurance contracts have terrorism exclusions that can be challenging to model. Modeling TRIPRA alongside a non-TRIPRA reinsurance program is complicated because TRIPRA is applied on an aggregate loss basis, but before the application of other reinsurance programs.

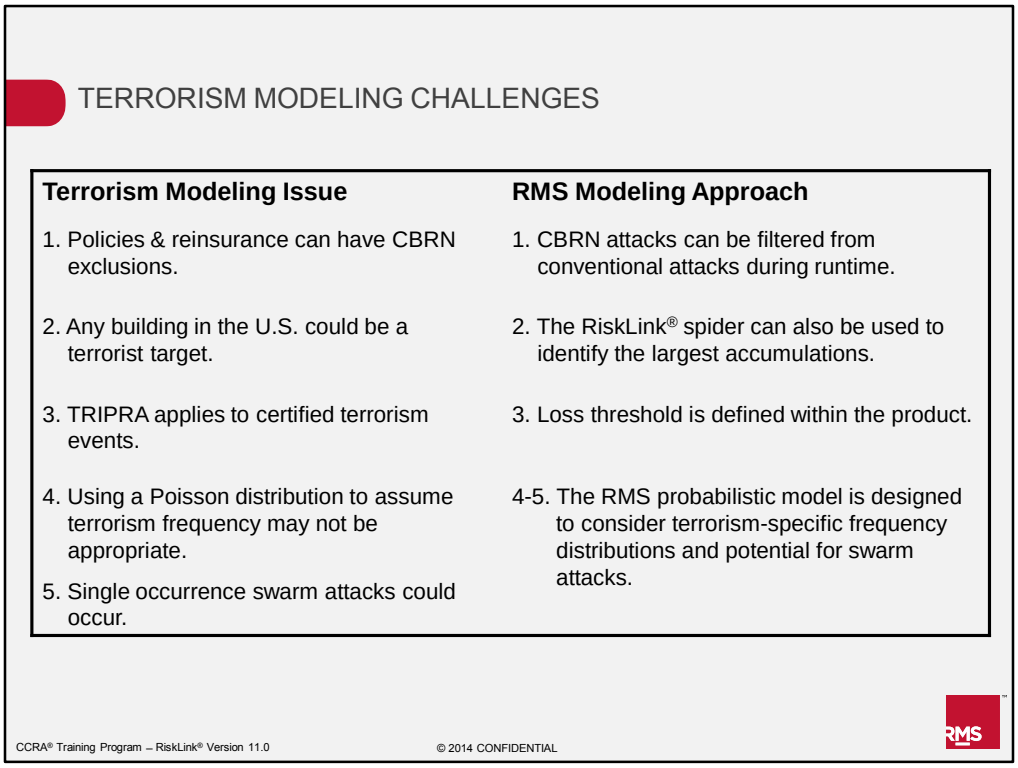
Aggregate Data

Many campus style locations may only have one address that can be geocoded. This occurs often in large corporate complexes and colleges where there are many buildings all with the same address.

More common for casualty lines, you may see multi-location policies for which only a single location is coded.

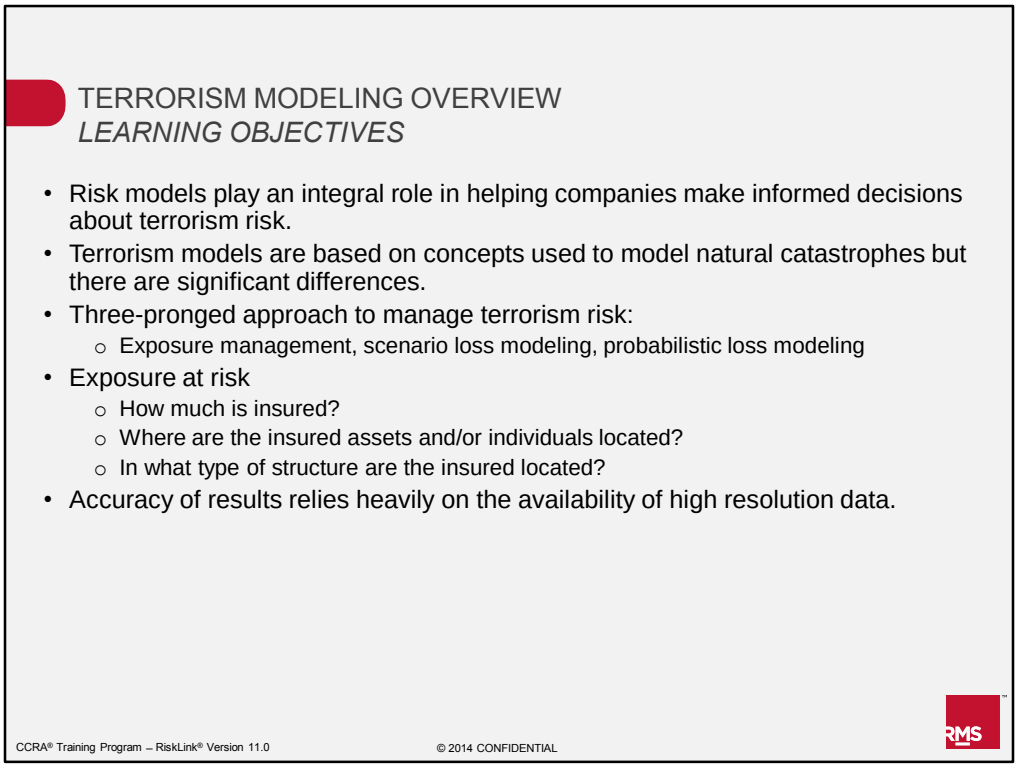
Mobile Employees

Certain employee classifications are challenging to model due to their mobility. An excellent example is construction workers, where the address provided to the insurer is not the location where the individuals work on a daily basis. Occupations of this nature need to be monitored more closely to ensure work location and address information are in sync.



Here is a list of current modeling challenges for terrorism along with RMS' modeling approach. This list is not exhaustive but addresses some of the more common questions. We will focus on Item #2. Any building in the U.S. could be a terrorist target. The RiskLink spider analysis can be used worldwide to identify those locations in your portfolio that would generate the largest loss based on criteria set by the user.

Similar to any natural peril, terrorism risk has both high risk and low risk areas. High risk areas include regions with high economic value, large populations, and symbolic value, such as New York City and Washington D.C. For these areas, RMS has compiled a target database to include those locations that are likely to be attacked. Prioritization and selection of these key buildings will be discussed in a later unit.



This slide summarizes the key points from Unit 2. If any of these points are unclear, please revisit the associated slides within the unit.