RMS® CCRA® Training Program
Terrorism Modeling Exercise

ANSWER KEY

Learning Objectives:

The purpose of this exercise is to gain hands-on experience with the interpretation of both scenario and probabilistic terrorism loss results. At the end of the exercise you will have learned how to:

- Interpret terrorism model results, including the key drivers of average annual loss (AAL), and AAL by attack type/region/target type
- Understand differences between the drivers of terrorism loss results vs. the drivers of exposure accumulation

You have been provided with an MS Excel workbook file (Terrorism Modeling Exercise Data.xls) which contains data extracted from terrorism analyses.

Overview

Assume that you are a catastrophe risk analyst for the large commercial division of a primary insurance company. Your company's approach to the management of terrorism risk is based on three measures: (a) exposure concentrations, (b) scenario loss results, and (c) probabilistic loss modeling. Exposure accumulations and probabilistic analyses have been performed and the results have been extracted for your review.

Using the data in the MS Excel file, answer the following questions.

Analysis Results Questions:

1. Management would like to limit gross exposure within 200 meters of an RMS Target building to $200 million and limit exposure within any 200 meter ring to $400 million.

    a. Using worksheet "2. Accumulations RMS_Targets," how many accumulations exceed $200 million, and which portfolio drives these results (e.g. property or workers compensation)?

    # of Accumulations: *14*   Predominant Portfolio: *Property*

    b. Explain how the dollar loss for workers compensation is calculated for an exposure accumulation analysis. How does knowledge of this process affect your view of the results?

    Answer: The associated dollar loss for workers comp exposure is based on the injury distribution that has been selected and the assumed payout rates. Given a different injury distribution, or a different assumption about payouts, the workers comp losses could be higher or lower and would likely change the accumulations that exceed the management established guidelines.

    c. Management has established criteria around RMS Target buildings, yet you notice there is significant exposure in non-RMS target locations based on the results in worksheet "4. Building Level Accumulations."

Compare these results to the accumulations within 200 meters of RMS Target locations (worksheet 2). What observations do you have? How might you incorporate this new information into your risk management strategies?

Answer: If you compare these results to the building level accumulations, you will notice that only two buildings have gross exposure in excess of $200m. Since these buildings are not RMS Target locations, they did not appear on the RMS target accumulation list. However, since terrorist attacks could occur anywhere, we recommend examining accumulations not only around RMS target locations, but also in individual buildings. It is also important to note that few of the top 14 RMS target accumulations coincide with the building level accumulations, which means the insured location is not located in the RMS target building, yet does reside within 200-meters of the RMS target building.

Recommendations: While it is important to look at exposure concentrations that are close in proximity to RMS targets, it is also useful to examine exposure accumulations within a single building to avoid an over concentration of exposure to any peril. One might consider evaluating distance to target and geocoding resolution of all locations that comprise an accumulation to identify false accumulations.

While it is important to review top concentrations of exposure based on an area accumulation, such as a 200 meter ring analysis, one should also consider identifying top concentrations of potential loss, say from a 2-ton bomb or other conventional attack. Although you may have a large amount of exposure in an accumulation area, this may not be significant from a loss standpoint. This is because the relative risk drops off significantly the farther you are away from the attack centroid.

d. List at least two exposure data issues that could change how you view these results.

- *Geocoding resolution*
- *The use of aggregate data*
- *Missing exposure data values (i.e. not capturing all locations/people covered under a policy)*
- *Accuracy of address information (e.g. does the address on a workers compensation policy reflect where the individual works?)*

2. Management has selected the 2-ton bomb as a benchmark scenario for managing exposure to terrorist attacks. This loss threshold is set to $200 million.

a. Identify those attacks that would generate gross loss in excess of $200 million to the combined property and workers compensation books, given a successful 2-ton bomb attack has occurred. Fill in the table provided using the results in the "5. GR 2ton Bomb Loss" worksheet.

2-Ton Bomb Attacks Generating > $200 M Gross Loss

City	Target	Event ID	Cond. Probability	WC Gross Loss	Property Gross Loss	Total Gross Loss
Chicago	Newberry Plaza	692753	0.0000441	-	$297.9	$297.9
Chicago	Chicago CBD (37)	692626	0.0000238	-	$294.8	$294.8
New York	Lefcourt Colonial Building	693682	0.0000440	$57.8	$211.0	$268.8
New York	Lincoln Building	692727	0.0000696	$47.8	$210.6	$258.4
Chicago	Chicago CBD (36)	692625	0.0000238	-	$249.9	$249.9
New York	Altria Group	693103	0.0000175	$36.9	$198.8	$235.7
Los Angeles	1100 Wilshire Building	693651	0.0000279	-	$203.9	$203.9

b. Identify those targets that have the highest likelihood of attack, given a successful 2-ton bomb attack has occurred. Fill in the table provided using the results in the "5. GR 2ton Bomb Loss" worksheet.

Top 5 Targets by Highest Likelihood of Attack (2-Ton Bomb)

City	Target	Event ID	Cond. Probability	WC Gross Loss	Property Gross Loss	Total Gross Loss
New York	Empire State Bldg	692643	0.000128	$26.8	$45.4	$72.3
New York	Federal Reserve Bank of New York	783758	0.00011	$33.2	$0.1	$33.3
New York	New York City Hall	692870	0.00011	$16.9	$0.0	$16.9
New York	FBI New York Field Office	919672	0.00011	$10.3	$0.4	$10.6
New York	US Court of Appeals for the Second Circuit	692843	0.00011	$7.9	$1.0	$9.0

c. What is the benefit of examining loss to those targets that have the highest likelihood of occurrence?

Answer: By looking at those targets with the greatest likelihood of occurrence, we are zoning in on events that will potentially contribute substantially to our average annual loss.

3. Your management does not understand the term "Attack Loss Table" (ALT). Explain the difference between an Event Loss Table (ELT) for natural catastrophe analyses and an ALT for terrorism analyses. Include the definition of terrorism event and terrorism attack likelihood in your answer.

Answer: In the ALT, a terrorist attack is defined as a single attack at a specific target. A terrorist event, however, could be made up of one or more attacks (swarm) occurring in a coordinated offensive at one or more targets.

RMS uses a similar framework to generate a terrorism ALT as it does to generate a natural peril ELT (i.e. both loss tables include results from the hazard, vulnerability, and financial model components).

However, there are fundamental differences that must be taken into account when using the ALT to generate EP curves, including:
1. *Terrorist attacks in the stochastic set are <u>not</u> independent.*
2. *Frequency distributions for terrorism events do not follow a Poisson process as in other perils.*
3. *'Swarm attacks' – or the possibility that multiple attacks could make up a single event – are modeled in the EP generation process even though they are not reflected in the ALT.*

4. Various magnitudes of each attack mode are modeled in order to capture the potential range of losses that the insurance industry could face and to understand each attack mode's likelihood of occurrence.

Your company has asked you to review losses by attack mode magnitude in order to determine the worst case conventional attack for each attack mode. The following table identifies the maximum loss scenario by attack mode magnitude for a bomb based on the combined Property and Workers Comp books. The information is from the results in the "6. GR All Bomb Loss" worksheet.

City	Target	Event ID	Cond. Probability	Attack Mode	WC Gross Loss	Property Gross Loss	Total Gross Loss
Chicago	Chicago CBD (37)	666028	0.00000752	Bomb-10 Ton	$0.0	$581.8	$581.8
Chicago	Chicago CBD (37)	666027	0.0000132	Bomb-5 Ton	$0.0	$465.5	$465.5
Chicago	Newberry Plaza	692753	0.0000441	Bomb-2 Ton	$0.0	$297.9	$297.9
New York	Lefcourt Colonial	675033	0.0000956	Bomb-1 Ton	$37.5	$177.9	$215.4
New York	Lincoln Building	666779	0.000501	Bomb–600 lb	$8.6	$112.9	$121.5

Management has asked you whether it is more appropriate to select a 5-ton bomb or a 10-ton bomb as the benchmark scenario. Using the information from the previous questions, what recommendation would you make? Include a discussion of the relative likelihood of an attack occurring vs. the potential for loss in your answer.

Answer: Given the uncertainty in terrorist capabilities, it is useful to look at the maximum loss that could be generated by each attack mode magnitude. By comparing the likelihood of these attacks vs. the potential for loss, consideration can be made to the most appropriate attack mode that should be selected as a benchmark scenario. Looking specifically at bomb attacks, a 10-ton bomb is considerably less likely to occur than a 5-ton bomb and does not produce loss that much higher than the 5-ton bomb. Therefore, it would not be sensible to select a 10-ton bomb attack as a benchmark scenario.

5. It is helpful to examine average annual loss by various metrics to assess drivers of terrorism risk. Calculate the average annual loss to the property and workers compensation books using the data on worksheet "7. GR ALT Conventional." Fill in columns P, Q, and R and provide the totals below.

Property Average Annual Loss: *$5,681,004*

Workers Comp Average Annual Loss: *$2,868,250*

Combined Average Annual Loss: *$8,549,254*

6. Analyzing annual average loss by attack mode magnitude is a useful method to evaluate the drivers of risk to a portfolio. The following table shows the contribution of average annual loss by attack mode magnitude and by portfolio for all conventional attacks. Management has asked you to comment on how the nature of the portfolio impacts the expected loss between a 2-ton and a 5-ton bomb.

Attack Mode Magnitude	WC	Property	Combined
Bomb - 600 lb.	17%	29%	25%
Bomb - 1 Ton	19%	20%	20%
Aircraft Impact	15%	16%	16%
Bomb - 5 Ton	19%	11%	14%
Bomb - 2 Ton	15%	13%	13%
Bomb - 10 Ton	14%	7%	9%
Conflagration	2%	4%	3%
Sabotage - Industrial - Explosion – Large	0%	0%	0%
Sabotage - Industrial - Explosion – Medium	0%	0%	0%
Sabotage - Industrial - Explosion – Small	0%	0%	0%

a. Compare the expected loss from the 2-ton bomb vs. 5-ton bomb for the property portfolio. What observations do you make? Provide an explanation for the results that you see.

Answer: The expected property losses are higher for a 2-ton bomb than for a 5-ton bomb scenario, which is generally expected. A 2-ton bomb attack is more likely to occur than a 5-ton bomb attack, so we should see a greater contribution to overall AAL from these events.

b. Compare the expected loss from the 2-ton bomb vs. 5-ton bomb for the workers compensation portfolio. What observations do you make? Provide an explanation for the results that you see (hint: consider the potential distribution of injuries).

Answer: The expected loss for the 5-ton bomb is higher than the 2-ton bomb for the workers compensation portfolio. There are many factors that could lead to this conclusion: The nature of injuries resulting from the attacks, the cost of those injuries, the likelihood of different attacks at the targets impacting the portfolio, the time of day distributions, etc. If a portfolio is dominated by locations in a target-rich area such as NY, it is likely that the distance between insured locations and targets will be closer.

7. The terrorism EP curve takes into consideration both the frequency and severity of events, and is a commonly used metric for managing terrorism risk.

a. The 250-year return period is used as a common risk management metric for natural catastrophe exposed books of business. For corporate catastrophe treaties that include natural as well as terrorism perils, grouping and managing these portfolios against a common exceedance probability metric is possible. Referring to the worksheet "8. GR EP results", what is the 250-year return period loss for the Property book, the Workers' Comp book and the combined book?

Property 250-year Loss: *$139.8M*

Workers Comp 250-year Loss: *$84.6M*

Combined 250-year Loss: *$217.6M*

b. Management has asked you to comment on how the 2-ton bomb attack scenario loss, which is currently used as the benchmark scenario, compares to the 250-year return period loss.

Answer: The AEP curves are based on event losses (one or more attack losses). Thus comparing a single 2-ton bomb loss to the EP curve is not appropriate. Attack multiplicity should be taken into account when comparing AEP with attack losses.

c. Discuss the pros and cons of managing to a specific attack mode.

Answer: There are many events other than the 2-ton bomb that can contribute to the 250-year return period. In addition, the 2-ton bomb attack modes that cause the highest losses are much more likely than the 0.004 AEP loss (i.e. 1-in-250 year). This highlights that managing to a single event is not a good proxy to managing to a specific probabilistic return period or loss threshold.

8. Answer the following using the information in spreadsheet "9. PTM ALT " assuming that an event has occurred,

a. What is the conditional likelihood that the event will be a 2-ton bomb event? *0.0523*

b. Identify which conventional attack mode is **most likely**? *600 lb. bomb*

Note: Conventional attacks are defined as non-CBRN attacks and include bombs, aircraft impact, conflagration and explosion-only industrial sabotage attacks.