RMS® CCRA® Training Program

Earthquake Modeling Exercise: Comparing Earthquake Severity and Frequency

ANSWER KEY

Learning Objectives:

The purpose of this exercise is to compare and contrast the exposure, losses, and events that underlie the EP curves for two portfolios; one in California (CA EQ Commercial) and one in the Pacific Northwest covering the states of Washington and Oregon (PNW EQ Commercial). At the end of the exercise you will have learned:

- How to assess the distribution of average annual loss (pure premium) based on earthquake magnitude and source types within the event set.
- How to characterize sources driving excess losses at the tail of the EP curve.
- How differences in the frequency and severity of seismic activity in different regions affects EP results.

You have been provided with the following files:

- RiskLink® Post-Import Summary Report for each portfolio
- Excel workbook (Earthquake Modeling Exercise.xls)
- The Excel workbook includes mean losses for all events in the Event Loss Table for each portfolio (see Results tabs), and tables showing losses by magnitude range and source type (see Analysis tabs).

Exposure Data Summary

	CA EQ Commercial Book	PNW EQ Commercial Book
# Accts/ locations	81 accounts 320 locations	87 accounts 1614 locations
Total Value	$1,643,367,400	$8,880,155,600
Geocoding level(s) as % of TIV	89.4% Street 5.9% ZIP Code 4.8% County	63.4% Street 36.6% ZIP Code
Line(s) of business	Commercial	Commercial
Primary characteristics modeled	Construction Occupancy Number of Stories (17% unknown; 76% 1-story) Year Built (80% unknown)	Construction Occupancy Number of Stories (99.8% known; 85% 1-story) Year Built (65% unknown)
Typical deductibles or attachment points	Primary and XS policies Avg. site deductible = 5% Various policy deductibles	Excess policies Avg. site deductible = 3% Various policy deductibles

Insured Limits: Top 5 Counties

County, State	Insured Limits ($)	% Total Portfolio Limits
1. King, WA	656,624,582	48% PNW Portfolio
2. Multnomah, OR	157,114,115	11% PNW Portfolio
3. Washington, OR	92,143,748	7% PNW Portfolio
4. Snohomish, WA	83,979,949	6% PNW Portfolio
5. Los Angeles, CA	83,405,822	29% CA Portfolio

Summary Gross AEP Loss Results

Critical Probability	Return Period	California Book $	Pacific NW Book $	Total Group $
0.02%	5,000	31,805,577	182,933,155	188,446,731
0.10%	1,000	22,100,838	47,557,234	50,642,695
0.20%	500	17,989,396	19,263,191	27,614,074
0.40%	250	14,060,842	7,098,386	18,499,462
1.00%	100	9,288,252	1,004,437	11,127,824
2.00%	50	6,047,558	34,447	7,026,289
Pure Premium		412,215	196,761	608,976
Standard Deviation		1,858,886	4,584,601	5,102,993
CV		4.5095	23.0035	8.3796

Gross AAL: Top 5 Counties

County, State	Gross AAL ($)
1. Los Angeles, CA	123,314
2. Santa Clara, CA	96,233
3. King, WA	73,690
4. Sonoma, CA	53,066
5. Multnomah, OR	45,583

1. Use the Excel workbook to compare the risk of the CA EQ Commercial book with the PNW EQ Commercial book. This information was compiled using the following data sources:

    - The event table of the RMS_EVENTINFO database
    - The rdm_anlsevent and rdm_port tables from the RDM for each portfolio
    - Source types based on Event ID number; check with RMS for more information

a. What is the distribution of Gross AAL by magnitude and source type? Use the tables in the Analysis tabs of the spreadsheet to compile your results.

Answer: *Refer to the Analysis tabs for each region in the Earthquake Modeling Exercise.xls spreadsheet for the answers.*

Table 1

Gross AAL Distribution by Magnitude and Source Type								
	California Book (%)				Pacific NW Book (%)			
Source Type	Fault	Back-ground	Interface	Intraslab	Fault	Back-ground	Interface	Intraslab
5.0-5.9	-	3.9	-	-	0.0	1.9	-	0.0
6.0-6.9	37.7	8.6	-	0.0	7.8	6.1	-	6.9
7.0-7.9	45.1	0.2	-	0.0	4.9	0.4	-	4.7
8.0-8.9	2.4	-	0.8	-	-	-	18.8	-
9.0+	-	-	1.2	-	-	-	48.5	-

Table 2

Gross AAL Distribution by Magnitude and Source Type					
	CA and PNW Grouped Results (%)				Total Group (%)
Source Type	Fault	Background	Interface	Intraslab	All source types
5.0-5.9	0.0	3.3	-	0.0	3.3
6.0-6.9	28.1	7.8	-	2.2	38.1
7.0-7.9	32.1	0.2	-	1.5	33.9
8.0-8.9	1.6	-	6.6	-	8.3
9.0+	-	-	16.5	-	16.5

b. For the California portfolio, what magnitude range in the table above dominates the portfolio loss as measured by percent contribution to the gross average annual losses (pure premium)?

Answer: *Magnitude 6.0 to 6.9 events make up 46.3% of the AAL for California. Loss is due to faults (37.7% of total AAL) and background sources (8.6% of total AAL) in this magnitude range.*

As a comparison, which magnitude range dominates for the Pacific NW portfolio?

Answer: *Events with a magnitude 9.0 and above dominate the gross pure premium in the Pacific Northwest portfolio. The types of earthquake sources and their contributions to the loss in this range are different from the California portfolio. Faults and background seismicity contribute no loss while the interface faults in the subducting Cascadia plate contribute 48.5% of the total AAL.*

c. For the California book, what source types in Table 1 dominate the portfolio loss as measured by percent contribution to the gross average annual losses (pure premium) by magnitude range?

Answer: *Faults identified and mapped by scientists dominate the California book between the ranges of magnitude 7.0 to 7.9. In this range, the Hayward-Rogers Crk Zone source dominates the gross pure premium.*

As a comparison, which source types dominate for the Pacific NW book?

Answer: *The presence of the Cascadia subduction zone offshore Oregon and Washington has a significant impact as a contributing source to the AAL in the Pacific Northwest portfolio in the magnitude 9.0 and greater range. In this range, the interface faults make up 100% of the AAL.*

2. Now, consider events that contribute to losses in excess of the 250-year loss level for the entire group. Note that losses shown in the ELT are mean losses for each event and do not include secondary uncertainty. The XSAAL has been calculated for you and listed in the table below. To account for secondary uncertainty, we used the XSAAL calculation described in the Model Application course.

   Note: Please refer to the RMS CCRA Training Program Study Topic Supplement: Incorporating Secondary Uncertainty into XSAAL Calculations document from the Model Applications course on this topic.

Portfolio	250-Year AEP Gross Loss	Gross XSAAL
CA EQ Commercial	$ 14,060,842	$ 73,110
Pacific NW EQ Commercial	$ 7,098,386	$ 175,804
Group (CA and Pacific NW)	$ 18,499,462	$ 201,437

a. Which earthquake region dominates the risk in excess of the 250-year EP return period (excluding secondary uncertainty) for the entire group? This can be assessed by reviewing events in the ELT with losses greater than the 250-year gross loss.

Answer: *For the combined portfolio, the Pacific Northwest book dominates with the Cascadia subduction zone and crustal faults contributing the most to losses above $18 million.*

b. What types of earthquake sources make up the bulk of the risk in this range of losses?

Answer: *Interface source types make up the majority of the events with losses above $18 million for the grouped portfolio. For the California portfolio, A-type and B-type faults contribute to almost all the events with losses above $18 million, whereas the Interface source type (Cascadia subduction zone) contributes the most to the Pacific Northwest portfolio.*

c. List at least three earthquake source names that are prominent drivers of risk in excess of the 250-year EP return period for the grouped portfolio.

List of possible answers:
Cascadia Subduction Zone
Newport-Inglewood Fault
Seattle Fault
Portland Hills Fault
Puget Sound
Santa Monica Fault
Puente Hills Fault

d. Based on your analysis, which portfolio is at higher risk to earthquake losses and why?

Answer: *The answer to this question depends on your definition of portfolio risk and the metrics you use to define it. Some common risk measures explored in this exercise include pure premium or average annual loss (AAL) and excess average annual loss (XSAAL), which assess both the frequency and severity of events over time on your portfolios. Another measure that may be used is tail conditional expectation (TCE, which assesses portfolio risk given that an event of a specified severity or greater occurs. Other measures of risk include exposure data quality, correlation of portfolio risks to other risks, exposure concentration, profitability statistics, and uncertainty around portfolio losses.*

Using the metrics explored in this exercise (AAL and excess AAL), one could make the argument that on a gross AAL basis, the California portfolio has greater risk given the higher AAL than the Pacific Northwest portfolio ($412,515 vs. $196,761). However, the Pacific Northwest portfolio has a greater level of uncertainty around losses as measured by the coefficient of variation (23.3 for PNW vs. 4.5 for the California portfolio). The potential risk could therefore be greater than that of the California portfolio. Additionally, the 250-year excess AAL is nearly two and a half times that of the California portfolio, making the Pacific Northwest portfolio riskier by this metric. If the Pacific NW has high excess layers, this would expose the portfolio to the high severity/low frequency event losses at the tail of the EP curve. Since many of these events are associated with the Cascadia subduction zone source, they have a minimal impact on the California portfolio losses.

Finally, it is worth mentioning the relative portfolio data quality. Both portfolios could benefit from better geocoding resolution, though the Pacific Northwest portfolio with only 63.4% of locations with street level geocoding is clearly at a disadvantage. Both have fairly good statistics on quality of primary characteristic information; however California fares worse in the number of locations with number of stories and year built entered as unknown as compared to the Pacific Northwest. Questionable data quality in both portfolios contributes to the uncertainty in the modeled loss results.

e. What additional information would you want to obtain before making any decisions or recommendations regarding these portfolios?

Answer:

Data Quality – As discussed above, it would be beneficial to understand if the data quality can be improved for both portfolios prior to making any business decisions based on loss results.

Policy information – An assessment of which policy layers are the greatest contributors to both loss and loss uncertainty for both portfolios would be beneficial. It may be that policy attachment points and limits could be altered to make the portfolios better risks.

Accumulation management – Assessing where the exposure is concentrated in the large metropolitan regions relative to exposure to collateral hazards (soil, liquefaction, and landslide) is helpful to determine if diversifying your exposure within the portfolio regions would lessen the risk.

Underwriting guidelines – Reviewing underwriting guidelines and assessing whether they are appropriate for the risk to the region might lead to further recommendations on your portfolios. Updating guidelines on information such as primary characteristics, secondary characteristics, and deductible data capture may change the risk characterization of your portfolio.

Market forces – Will the market bear changes in policy structures, deductibles, and premium that would reduce the risk measures for this portfolio?