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**SOCIETY OF ACTUARIES**  
**Enterprise Risk Management – Individual Life & Annuities Extension**

# Exam ERM-ILA

**Date:** Tuesday, November 1, 2016

**Time:** 8:30 a.m. – 12:45 p.m.

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## INSTRUCTIONS TO CANDIDATES

### General Instructions

1. This examination has a total of 80 points.

This exam consists of 8 questions, numbered 1 through 8.

The points for each question are indicated at the beginning of the question. Questions 7 and 8 pertain to the extension readings and/or the Case Study, which is enclosed inside the front cover of this exam booklet.

2. Failure to stop writing after time is called will result in the disqualification of your answers or further disciplinary action.
3. While every attempt is made to avoid defective questions, sometimes they do occur. If you believe a question is defective, the supervisor or proctor cannot give you any guidance beyond the instructions on the exam booklet.

### Written-Answer Instructions

1. Write your candidate number at the top of each sheet. Your name must not appear.
2. Write on only one side of a sheet. Start each question on a fresh sheet. On each sheet, write the number of the question that you are answering. Do not answer more than one question on a single sheet.
3. The answer should be confined to the question as set.
4. When you are asked to calculate, show all your work including any applicable formulas.
5. When you finish, insert all your written-answer sheets into the Essay Answer Envelope. Be sure to hand in all your answer sheets because they cannot be accepted later. Seal the envelope and write your candidate number in the space provided on the outside of the envelope. Check the appropriate box to indicate Exam ERM-ILA.
6. Be sure your written-answer envelope is signed because if it is not, your examination will not be graded.

Tournez le cahier d'examen pour la version française.



## **CASE STUDY INSTRUCTIONS**

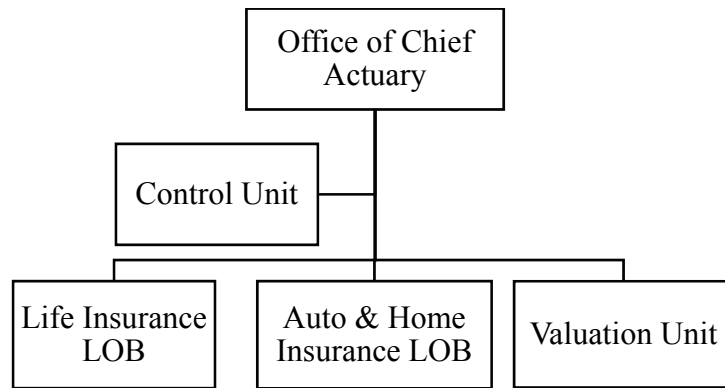
**The case study will be used as a basis for some examination questions. Be sure to answer the question asked by referring to the case study. For example, when asked for advantages of a particular plan design to a company referenced in the case study, your response should be limited to that company. Other advantages should not be listed, as they are extraneous to the question and will result in no additional credit. Further, if they conflict with the applicable advantages, no credit will be given.**

**\*\*BEGINNING OF EXAMINATION\*\***

**1.** (7 points) You are a Risk Management actuary for ABC, a multi-line life insurance company with both life and annuity business. ABC is acquiring XYZ which has two lines of business (LOB):

- Life insurance
- Auto and homeowner's insurance

You have gathered the following information about XYZ's risk management structure before the acquisition:



- Each LOB is responsible for its own product pricing, assumptions setting and profit projections.
- Valuation Unit calculates reserves using pricing assumptions provided by LOBs.
- Control Unit calculates Economic Capital based on the pricing model and assumptions.
- Control Unit also conducts periodic reviews of LOBs and Valuation Unit which are provided to Chief Actuary.

(a) (3 points) ABC considers adoption of the three lines of defense approach as the risk governance and internal controls system.

- (i) Compare XYZ's risk management structure to the three lines of defense framework.
- (ii) Recommend improvements to enhance risk governance.

**1. Continued**

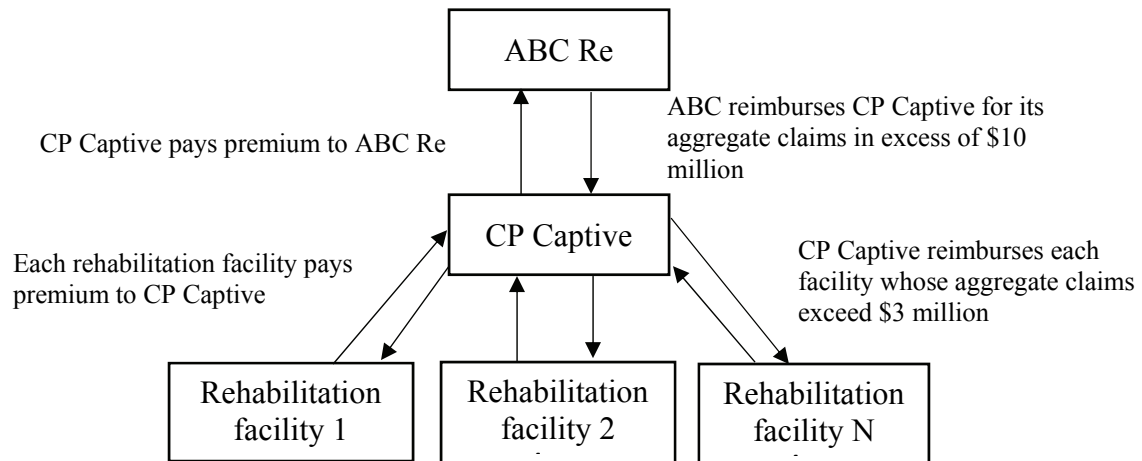
- (b) (2 points) Assess XYZ's existing Economic Capital modeling considerations in light of the acquisition.
- (c) (2 points) You prepared the Own Risk and Solvency Assessment (ORSA) for ABC before the acquisition.

Describe the potential issues, excluding XYZ's Economic Capital modeling considerations from part (b), to address when preparing the ORSA for the combined company after the acquisition.

2. (13 points) You are the CRO of ABC Re, a U.S. group benefits reinsurance company that assumes medical stop-loss business.

A group of rehabilitation facilities has formed a captive insurance company, CP Captive. CP Captive enables each facility to participate in the collective experience. CP Captive is a large enough group to apply for stop-loss coverage.

The chart below illustrates the reinsurance arrangement.



- (a) (4 points)
- Describe the essential elements of captive insurance.
  - Determine whether CP Captive qualifies as a captive insurance company. Justify your response.
  - Determine what type of captive CP Captive most resembles. Justify your response.

## 2. Continued

(b) (4 points) You identified the following top four risks for ABC Re in this captive arrangement:

- Reinsurance treaty negotiation
- Insurance
- Legal and regulatory
- Operational

Describe approaches for ABC Re to manage each of these risks.

(c) (5 points) As a means to manage capital efficiently, ABC Re proposes ceding a portion of the assumed risks from CP Captive to an offshore affiliate in the Cayman Islands called Retro Life.

- (i) Describe key advantages and disadvantages of entering into a reinsurance agreement between ABC Re and Retro Life.
- (ii) Recommend a course of action with regard to this proposal. Justify your response.

- 3.** (12 points) DirectComp is an insurer that sells an annuity product with benefits linked to the S&P 500 index. The product has a very long liability-duration profile. Premiums are collected in the first two policy years, and most benefit payments occur after fifteen years.

DirectComp's economic reserve is calculated using the CTE70 measure of the accumulated deficiency via Monte Carlo simulation. The accumulated deficiency is defined as present value of future benefits minus present value of future premiums.

In 2006, DirectComp and Reinsurer entered into a 90% quota share coinsurance agreement whereby the Reinsurer would receive the annuity premiums from DirectComp and pay benefits when they occur. In addition, the Reinsurer was required to hold collateral equal to DirectComp's economic reserve in a trust account.

- (a) (1 point) Describe the steps to compute DirectComp's economic reserve requirement using Monte Carlo simulation.
- (b) (2 points) Explain the advantages and disadvantages of using Monte Carlo simulation to determine DirectComp's economic reserve.
- (c) (1 point) Determine whether a risk-neutral or real world model is more appropriate when performing DirectComp's economic reserve calculation. Justify your response.



### 3. Continued

- (d) (5 points) In 2016, Reinsurer is performing a retrospective analysis of this reinsurance arrangement as a case study.

At pricing (in 2006), DirectComp conducted the following stress test for Reinsurer and showed that the biggest increase in CTE70 was 25%, which Reinsurer considered to be within its tolerance.

Account Value Shock	CTE70 (Million)	% of Baseline
Baseline	100	
-10%	104	104%
-20%	110	110%
-30%	125	125%

When it received the 2008 annual reinsurance report in early 2009, Reinsurer observed that its collateral asset requirement had increased by 80% during the 2008 financial crisis.

- (i) Analyze the adequacy of the provided stress test.
- (ii) Evaluate whether the collateral asset increase is reasonable.
- (iii) Identify the risks DirectComp is exposed to from the reinsurance arrangement.
- (iv) Recommend actions DirectComp could have taken in advance to mitigate risks from the reinsurance arrangement that you identified in (iii).

*Question 3 continued on next page*

### 3. Continued

- (e) (3 points) Following the increase in the collateral requirement in 2009, Reinsurer became skeptical about the reserve amount quoted by DirectComp and requested annual validation of the model DirectComp uses to calculate the reserve.

The following steps were taken by DirectComp to complete the annual model validation:

- DirectComp’s chief actuary assigned the writing of the report for Reinsurer to the department that developed the model.
  - The annual validation report was included in the department’s “critical date” list so that whoever could work it into his/her work load around the time it was due would complete the task.
  - The report writer worked from audit reports, results of tests that were run to check on certain calculations performed in the model, or any other existing documentation that had been created throughout the year.
- (i) Evaluate the adherence of DirectComp’s model validation process to key model validation principles.
- (ii) Recommend any changes or enhancements that DirectComp should make to this process.

4. (8 points) You are a portfolio manager and are responsible for making investment decisions on behalf of one of your company's biggest clients – Mr. Jackson. Mr. Jackson currently has \$5 million invested entirely in Fund A and he wishes to invest an additional \$3 million into either Fund B or Fund C in order to reduce portfolio volatility. Characteristics for each fund are listed in the table below.

Fund	Fund Variance	Correlation Coefficient – Relative to Fund A
A	1.00%	1.0
B	4.00%	-0.3
C	2.25%	-0.2

- (a) (2 points) Demonstrate that investing the \$3 million in Fund C results in a lower 95% VaR for the aggregate portfolio than investing in Fund B. Show your work.

Mr. Jackson's aggregate portfolio now includes \$5 million in Fund A and \$3 million in Fund C.

- (b) (1 point) Calculate the diversification benefit for Mr. Jackson's aggregate portfolio.
- (c) (1 point) Describe two factors, besides the diversification effect, that an investor should consider when adding funds to a portfolio.
- (d) (4 points) At the end of the following month, Mr. Jackson plans on making an additional contribution in the amount of \$100,000 to either Fund A or Fund C.
- (i) Calculate  $\beta$  for each of these two funds before the additional contribution.
  - (ii) Estimate, for each of the two funds, the marginal impact to the 95% VaR of investing \$100,000.
  - (iii) Discuss the limitations of using the calculated  $\beta$  to estimate marginal VaR.
  - (iv) Recommend an alternative method to estimate marginal VaR .

5. (11 points) Bank XYZ is concerned about its vulnerability to losses due to cyberliability risk. Such losses may result from fraud, settlement with account owners, or government fines after a hacking event.

You are developing a model for quantifying cyberliability risk for Bank XYZ. Below is a table of losses for known hacking events at companies of similar size over the past five years. All these cyber loss events were reported in major news media when they occurred.

Company Hacked	Loss Amount from Individual Hacking Event Millions of \$
A	45
A	276
B	102
C	330
C	700
D	19
E	557

(a) (3 points)

- (i) Describe challenges that you would encounter in developing a cyberliability risk model for Bank XYZ.
- (ii) Explain how you would address these challenges.

You decide to model the cyberliability loss distribution using a two-parameter generalized Pareto distribution as below:

$$F(x) = 1 - \left( 1 + \xi \frac{x-u}{\beta} \right)^{-\frac{1}{\xi}}, x \geq u$$

## 5. Continued

- (b) (1 point) Explain why this distribution may be appropriate for fitting these data.
- (c) (1 point) Explain the considerations in setting the threshold parameter.

Assume:

- The threshold has been set at \$100 million
- The probability of exceeding the threshold is 5%
- Shape parameter equals 1
- The most extreme data point falls between the 98<sup>th</sup> and 99.5<sup>th</sup> percentiles of the full loss distribution.

- (d) (5 points)
- (i) Calculate the range for beta under these assumptions. Show your work.
- (ii) Calculate the range for the 99<sup>th</sup> percentile of the loss distribution under these assumptions. Show your work.
- (e) (1 point) Recommend two methods to validate inputs for the cyberliability model.

6. (9 points) You work as a financial analyst for ABC. During a recent review, one rating agency expressed concern over increased exposure to credit risk due to the prevalence of below investment grade bonds in the company's investment portfolio.

- (a) (1 point) Describe three components of credit risk.
- (b) (1 point) Your manager states that because VaR and CTE are used extensively in ABC's risk management activities, these are appropriate risk measures for credit risk analysis.

Critique your manager's statement.

(c) (2 points) The CFO recommends that ABC establish a special purpose vehicle (SPV) into which many of the below investment grade bonds would be transferred. The CFO claims that this arrangement would move these risks off ABC's balance sheet.

- (i) Explain bankruptcy remoteness and off-balance sheet accounting as they relate to the CFO's proposal.
- (ii) Recommend alternatives for managing ABC's credit risk.

(d) (3 points) The CFO has provided the following details:

- ABC is subject to IFRS rules.
- The SPV would be established as a U.S. limited liability corporation.
- The SPV would only act on behalf of ABC.
- ABC would be the sole investor in the SPV.

The CFO doesn't want the SPV to be considered "controlled" under IFRS.

- (i) Describe the term "controlled" in the context of SPV accounting under IFRS
- (ii) Explain why the SPV is considered "controlled" under IFRS
- (iii) Propose changes to the SPV so that it will not be considered "controlled" under IFRS.
- (e) (2 points) The CFO states that an SPV will address the concerns expressed by the rating agency.

Critique this statement.

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**Questions 7 and 8 pertain to the Case Study and/or extension readings.  
Each question should be answered independently.**

- 7.** (9 points) SLIC has evaluated its economic capital position and has determined it has extra capital which can be put to use.

To utilize the additional capital, SLIC is considering the acquisition of a block of Single Premium Deferred Annuities (SPDAs) using reinsurance.

- (a) (2 points) SLIC is considering using YRT or Coinsurance to acquire the SPDA block.
- (i) Contrast the use of YRT and Coinsurance in this situation.
- (ii) Recommend which reinsurance structure would be more appropriate. Justify your recommendation.

You are given the following:

- SLIC's current total required economic capital is \$454.518 million.
  - Management has determined that it would be willing to let SLIC's total required economic capital level increase up to \$525 million as a result of this acquisition.
  - SLIC has determined the required economic capital on the SPDA block to be \$200 million.
  - The correlation between the SPDA block and SLIC's current products is 0.6.
- (b) (2 points) Evaluate SLIC's ability to acquire the SPDA block. Show your work.
- (c) (1.5 points) SLIC's management has expressed the following two concerns regarding the acquisition of the SPDA block:
- I. As indicated above, management does not want to increase SLIC's total required economic capital above \$525 million.
- II. Management is worried about the reaction of external stakeholders to whether SLIC can appropriately price a new product acquisition.

Describe how SLIC could partially reinsure to a retrocessionaire in order to address these concerns.



## 7. Continued

- (d) (3.5 points) SLIC has decided to proceed with the SPDA acquisition and is now negotiating the terms of the reinsurance arrangements.
- (i) Draw a diagram illustrating the key relationships that will exist once both the initial reinsurance and the retrocession arrangements are executed.
  - (ii) Recommend provisions to be included in the reinsurance agreement between SLIC and the company selling the SPDA block in order to mitigate risks to SLIC introduced by the arrangement.
  - (iii) Recommend provisions to be included in the reinsurance agreement between SLIC and the retrocessionaire in order to mitigate the risks to SLIC introduced by the arrangement.

*Questions 7 and 8 pertain to the Case Study and/or extension readings.  
Each question should be answered independently.*

- 8.** (11 points) SLIC's Variable Annuity (VA) sales growth has stagnated as new competitors have begun offering alternatives. Management has concluded that sales are being impacted by products in non-traditional distribution channels, such as the new offering by National Bank (as described in Section 3.9.2 of the case study).
- (a) (3.5 points) You consider the following categories of strategic risks to evaluate the threat to SLIC from National Bank:
- I. Industry
  - II. Technology
  - III. Brand
  - IV. Competitor
  - V. Customer
  - VI. Project
  - VII. Stagnation
- (i) Explain which three of the seven strategic risk categories, I to VII, are most applicable to this situation.
- (ii) Evaluate whether or not the two proposed VA product changes described in Danielle Wolf's e-mail address the strategic risk categories you identified in (i).
- (iii) Recommend two other strategic actions SLIC could take in order to address the strategic risks posed by National Bank and other competition in the VA market. Justify your recommendation.

To protect its market share, SLIC is considering introducing an Equity Indexed Annuity (EIA) product with the following features:

- 10-year point-to-point contract using the S&P 500 total return index (S&P TR) as the reference index. Note: the S&P TR assumes dividends earned are reinvested.
- 70% participation rate
- No yield-spread cost factor
- Growth rate cap of 6% per year compounded over the 10 year term
- No bonus credit
- Initial surrender charge of 10%, decreasing by 1% per year annually
- 2% compound guaranteed annual interest credit, available at maturity or upon surrender
- No market value adjustment

## 8. Continued

You have been asked to perform a strategic and product risk review, using SLIC's VA with GMAB rider as a benchmark.

- (b) (1.5 points) Describe advantages and disadvantages for the policyholder of the proposed EIA product compared with SLIC's existing VA with the GMAB rider.
- (c) (4 points) You next analyze the payoff profiles for:
- An Equity Indexed Annuity with features described above.
  - SLIC's VA with GMAB rider, fully investing in the S&P TR separate account.

You also assume:

- The value of the S&P TR is 1,000 as of the purchase date, and
  - The account value is over \$100,000 for both products.
- (i) Determine the range of values of the S&P TR after 10 years for which the GMAB rider will be in-the-money.
- (ii) Determine the range of values of the S&P TR after 10 years for which the EIA cap will apply.
- (iii) Determine the range of values of the S&P TR after 10 years for which the EIA floor will apply.
- (iv) Determine the range of values of the S&P TR after 10 years for which each of the two products will result in the better return for the policyholder.

Show your work.

- (d) (2 points) Compare the proposed EIA product and the existing VA with GMAB rider with respect to the following risks to SLIC:
- (i) Credit Risk
- (ii) Liquidity Risk
- (iii) Operational Risk

**\*\*END OF EXAMINATION\*\***

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