SOCIETY OF ACTUARIES®

Enterprise Risk Management – Retirement Benefits Extension

Exam ERM-RET

Date: Friday, May 3, 2019
Time: 8:30 a.m. – 12:45 p.m.

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-R.

6. Be sure your written-answer envelope is signed because if it is not, your examination will not be graded.

Recognized by the Canadian Institute of Actuaries.

Tournez le cahier d’examen pour la version française.

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Exam ERM-R Front Cover

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. (*8 points*) CYP is a small Canadian life insurance company. CYP is currently exploring whether it should create its first offshore captive and cede one of its capital intensive products to the captive.

CYP does not have its own actuarial staff, instead relying on a consulting firm to perform the necessary actuarial services.

(a) (*1 point*) Explain why this captive would qualify as an Alternative Risk Transfer (ART) program.

(b) (*3 points*) CYP's CFO has proposed creating an offshore Pure Captive with the following characteristics:

- The captive cannot pursue its own external reinsurance business.
- The offshore location has similar capital requirements but a lower tax rate.
- Two accountants and an administrative assistant will be hired to run the captive from the offshore location.

(i) Explain why a Pure Captive might be preferred over other types of captives for CYP.

(ii) Critique the characteristics of the proposed Pure Captive.

(iii) Describe two additional key actions that need to be completed with respect to establishing the Pure Captive.

(c) (*4 points*) You are employed by the consulting firm that CYP has hired to perform its actuarial services. CYP's CEO has asked you to offer an opinion on whether CYP should retain this business or cede it to a captive.

(i) Evaluate the three key elements that distinguish a captive from a commercial insurer for CYP.

(ii) Recommend whether CYP should use a captive. Justify your answer.

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2. (*9 points*) Orange, an insurance company, writes worldwide property and casualty business with three lines of products. The company is looking to incorporate its risk appetite statement into its business planning.

You are provided the following financial results for business written in 2018 as of December 31, 2018.

Product Line	**Premiums Collected**	**Under writing Profit**	**Profit Margin**	**Required Economic Capital***	**PV of Required Economic Capital***	**PV of After-tax earnings****
Specialty	10	0.9	9%	5	5	1.0
Home owners	30	3.0	10%	20	40	6.0
CAT	60	9.0	15%	150	450	27.0

* Allocated to each risk; no diversification benefit allocated
** Equivalent to risk-adjusted earnings

(a) (*3.5 points*) You are given the following correlation matrix for the three product lines in 2018.

	Specialty	**Homeowners**	**CAT**
Specialty	1.0	0.2	0.2
Homeowners	0.2	1.0	0.2
CAT	0.2	0.2	1.0

(i) Calculate the Risk Adjusted Return on Capital (RAROC) for each product line and the company in total. Show all work.

(ii) Analyze the profitability of the product line with the lowest RAROC.

(b) (*1.5 points*) Orange has developed the following risk appetite statement.

Orange has a long-term aggregate RAROC target of 10%. The company will earn at least 6% RAROC with a probability of 98% in each year.

(i) Assess Orange's compliance with its risk appetite statement.

(ii) Analyze Orange's business mix with respect to the company's RAROC.

2. **Continued**

(c) (*4 points*) There will be no rate increases in 2019. The 2019 business mix plan needs to address the following requirements.

I. Collected premiums for each product line must be at least 90% and at most 150% of those in 2018.

II. For product lines with sales increase in 2019, collected premiums must be proportional to the collected premiums for those product lines in 2018.

III. The required economic capital for the business written in 2019 needs to be lower than the expected available economic capital of $150 million.

Assume the following:

- The diversification between product lines results in a 30% reduction in required capital for business written in 2019.

- The ratio of the required capital to collected premiums in any year for each product line is constant.

(i) Calculate the maximum total premium increase from 2018 to 2019 if Orange aims to maximize overall RAROC, subject to requirements I through III. Show your work.

(ii) Orange has added a requirement that the aggregate RAROC target of 10% needs to be met by the business written in 2019.

Verify that a total premium increase of $12 million from 2018 to 2019 satisfies this requirement. Show your work.

3. (*10 points*) You are an actuary at ABC Life. Your manager would like your help in applying ALM and Strategic Asset Allocation (SAA) processes at your company.

(a) (*4 points*) ABC Life sells a simple investment product which guarantees payouts at the end of each year for five years. You have been provided the following payouts and annual effective interest rates for this business.

Year	**1**	**2**	**3**	**4**	**5**
Payout (End of Year)	600	200	800	1,000	400
Spot Rate	0.50%	0.80%	1.20%	2.00%	3.00%

ABC Life measures key rate durations at years 1, 2, 3, and 5 using a +0.1% shift and linear interpolation to approximate the shift along the maturity range. Some of the key rate durations are shown below:

Year	**Liability Key Rate Duration**
1	0.21
2	0.14
3	?
5	1.23

(i) Compare and contrast the use of key rate durations and effective duration for quantifying interest rate risk.

(ii) Verify that the missing key rate duration is 1.44. Show your work.

(iii) Verify, using the effective duration, that the key rate durations have been calculated correctly. Show your work.

3. Continued

(b) (*2 points*) ABC Life evaluates ALM solutions using a "bottom-up" approach and asset-only volatility as their risk measure.

The Chief Investment Officer (CIO) has recommended using surplus volatility as the only risk measure instead because it covers both asset and liabilities.

(i) Compare and contrast the "bottom-up" and holistic ALM/SAA approaches.

(ii) Explain how ABC Life's approach would need to change in order to use surplus volatility instead of asset-only volatility as the risk measure.

(iii) Critique the CIO's recommendation.

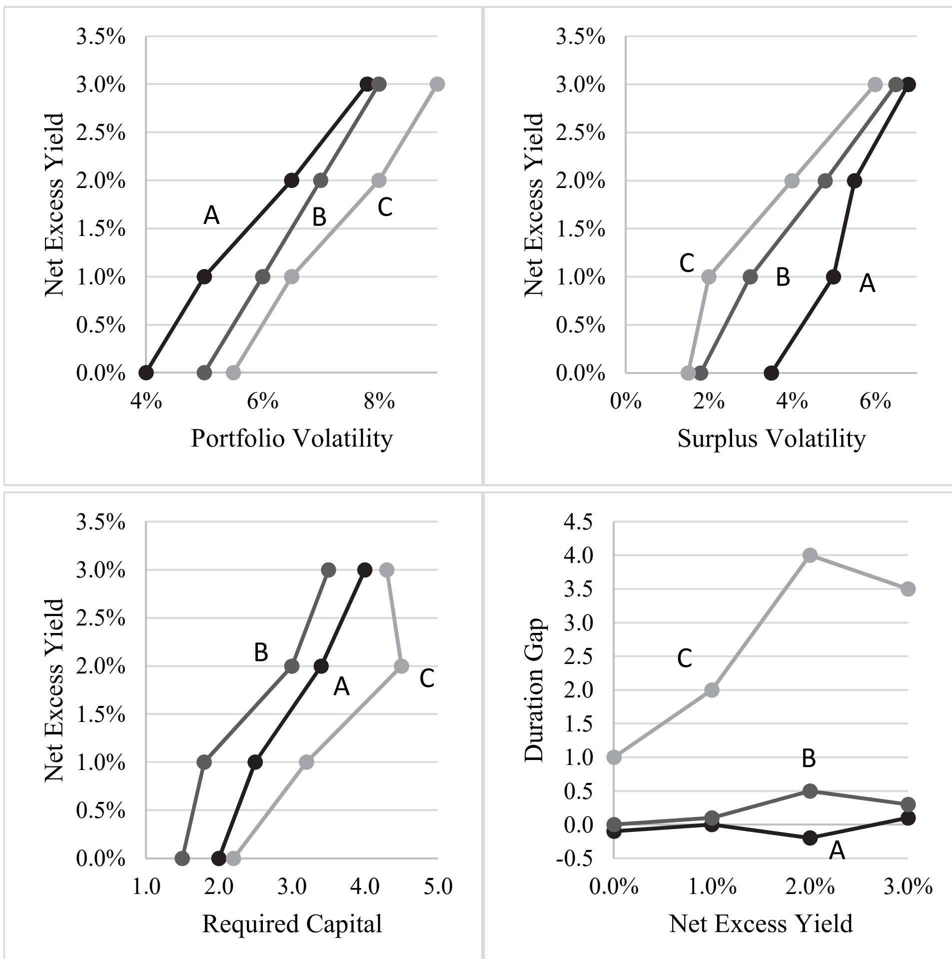
Question 3 continued on the next page

3. Continued

(c) (*4 points*) You are assessing three different risk minimization approaches:

1. Minimize economic surplus risk while relaxing the asset-liability duration gap.
2. Minimize asset-only risk while constraining the asset-liability duration gap.
3. Minimize economic surplus risk while constraining the asset-liability duration gap.

The following efficient frontier results have been provided.



(i) Match labels A, B, and C to the approaches listed above. Justify your answer.

(ii) Recommend which approach to use. Justify your answer.

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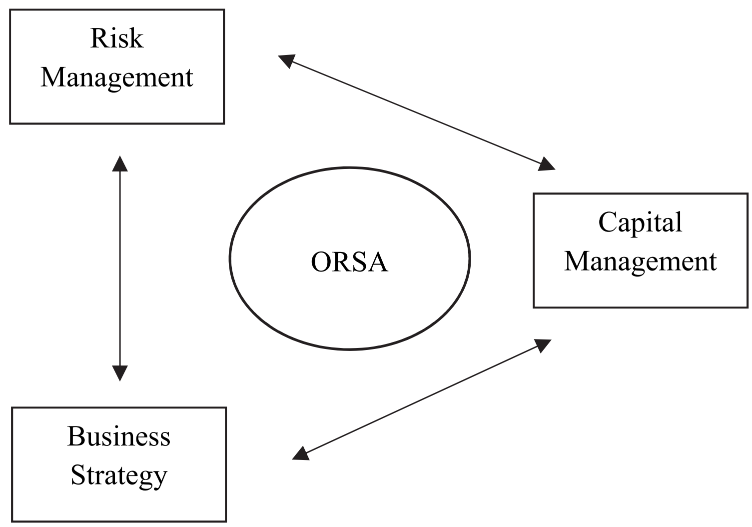
4. (*12 points*) You are an ERM actuary working at XYZ, a life insurance company. XYZ envisions an international expansion into one of three new regions. Your task is to assist the Board of Directors (BoD) with implementing ERM best practices in evaluating these strategic options.

(a) (*1 point*) XYZ's CRO is proposing that XYZ use the ORSA framework, as shown below, to assist the BoD in evaluating each strategic option and its underlying risks:



Assess the appropriateness of the CRO's proposal.

4. Continued

(b) (*3 points*) You have identified some specific external threats and opportunities. The following list summarizes some of the key challenges:

- Existing and potential customer challenges
  - Facing new challenges: longevity risk and changing traditional family patterns and needs.
- High-tech challenges
  - Artificial intelligence and technological advances in insurance (InsuranceTech) are on the horizon.
  - Big data and predictive modeling are opportunities, but new regulations about individual privacy rights are unknown.
- Financial challenges
  - Internationally, long-term interest rates are low by historical standards.
  - New internationally-enforced capital regulations are in effect as a result of the 2008 financial crisis.
- Competitive challenges
  - Intense international competition from online insurance companies.
- Other challenges
  - Environmental climate changes and their impact on investments.
  - The long-term sustainability of social governmental programs.
  - Demographic changes and migration patterns are unknown.

The CRO proposes that you use the PESTEL method to perform a preliminary strategic risk identification analysis.

(i) Describe advantages and disadvantages of the PESTEL method for XYZ.

(ii) Identify, using the PESTEL method, the strategic risks that XYZ may face.

(iii) Propose an alternative risk identification method that may improve XYZ's assessment. Justify your response.

Question 4 continued on the next page

4. Continued

(c) (*2 points*) A colleague outlined a series of qualitative scenarios in order to assess the impact of three of the threats and opportunities identified. The analysis is summarized below:

	Threats / Opportunities		
Strategic Decision	**Artificial Intelligence**	**InsuranceTech**	**Climate Change**
European Expansion	Little impact in the short-term	High potential positive impact in the short-term	Will generate opportunities
Asian Expansion	Potential for a medium threat in the longer term	High potential negative impact medium term	Will impact capitalization and risk
African Expansion	Little impact in the short-term	Highly negative in the short-term	Negative impact: already happening

Describe four shortcomings of the assessment methodology used for this analysis.

4. Continued

(d) (*6 points*) XYZ's ERM group estimated the amount of required economic capital for the threat associated with climate change, which the BoD considers the current primary threat.

You are provided the following financial information (in $ million):

XYZ's Balance Sheet, economic basis

Assets		Liabilities and Equity	
Long-Term Traded Securities	400	Long-Term Insurance Liabilities	75
Non-Traded Investments	150	Long-Term Financial Debt Instruments	25
Non-Traditional Investments	50		
Total Assets	600	Available Capital	500

XYZ's equity on an accounting basis is 200.
Tax rate is equal to 0%.

Climate change threat data

Expansion	Revenue	Costs	Expected Losses	Available Economic Capital	Required Economic Capital
European	15	5	1	100	54
Asian	60	10	5	120	127
African	5	15	5	75	9

(i) Compare and contrast the following performance measures in terms of their use in strategic decision making. Justify your analysis by performing appropriate calculations.

- ROE
- RAROC
- RARORAC

(ii) Recommend to the Board which strategic expansion should be pursued based on your financial analysis. Justify your recommendation.

5. (*13 points*) You work in the warranty department for Pleasant Air, a heater manufacturer with a current market that is limited to only two cities: NorthPole and SouthPole.

You want to determine the amount of capital needed in order to support the warranties on Pleasant Air's products. For the warranties, Pleasant Air would use liquid assets equal to the 96% daily absolute VaR of the warranty costs. Warranty claims are dependent on the weather experienced each day.

You are given the following information:

Weather Type	**Probability**	**Aggregate Daily Claims Distribution**	
		NorthPole	**SouthPole**
Non-Extreme	95%	U($0, $1,000)*	U($0, $2,000)
Extreme	5%	U($3,000, $5,000)	U($4,000, $7,000)

* U indicates a uniform distribution

(a) (*3 points*) VaR is calculated independently for NorthPole and SouthPole. It is your task to aggregate VaR at the enterprise level.

(i) Determine the 96% daily absolute VaR of aggregate claims for each city. Show your work.

(ii) Determine the theoretical range of the aggregate 96% daily absolute VaR based on the VarCovar method. Show your work.

(iii) Assume claim amounts in NorthPole and SouthPole have a correlation of $\rho = 0.8$.

Determine the 96% daily VaR of aggregate claims for both cities combined using the VarCovar method.

(iv) Discuss the appropriateness of the VarCovar method for calculating enterprise capital.

5. Continued

(b) (*5 points*) Your manager asks you to perform a simulation exercise to estimate warranty claims for NorthPole and SouthPole. He suggests using Monte Carlo simulation with correlated uniform random variables for this task.

(i) Explain how you would apply Cholesky factorization to address your manager's request.

(ii) Calculate the Cholesky factors using the correlation coefficient from part (a). Show your work.

You have partially populated the following table using the Cholesky factors from part (b)(ii). Z1 and Z2 represent random draws from a N(0,1) distribution. Your manager said to initially induce correlation on these variables, producing Z3 and Z4, before translating them to U(0,1) variables.

Claim Amount Simulation from 1,000 replications
Ordered from lowest aggregate claims to highest aggregate claims

Simulation Number	**Z1**	**Z2**	**Z3**	**Z4**	**U1 = F(Z3) is U(0,1)**	**U2 = F(Z4) is U(0,1)**	**Aggregate NorthPole Claims from U1**	**Aggregate SouthPole Claims from U2**	**Total Aggregate Claims**
959	1.08	1.99	1.08	2.06	0.86	0.98	905	5,800	6,705
960	1.52	1.39							
961	0.13	3.53	0.13	2.22	0.55	0.99	579	6,400	6,979

(iii) Determine the absolute VaR using your manager's suggested method by completing the above table. Show your work.

While the simulated random variables have a correlation of $\rho = 0.8$, the simulated claim amounts are correlated with $\rho = 0.7$. Your manager suggests the correlation discrepancy may be due to the choice of dependency measure and recommends using Spearman's rho.

(iv) Explain your manager's feedback.

Question 5 continued on the next page.

5. **Continued**

(c) (*3 points*) After rerunning the analysis in part (b) using Spearman's rho, your manager explains that this method is equivalent to simulation using a Gaussian copula. You are evaluating the following options:

- Monte Carlo Simulation using a Gaussian Copula
- Monte Carlo Simulation using an Archimedean Copula
- Copula methods should not be used

(i) Describe the pros and cons of the two copulas listed.

(ii) Identify three key considerations for determining the most appropriate option.

(d) (*2 points*) Pleasant Air is expanding to several additional locations and you need to determine the best way to estimate the VaR for the entire company.

Describe one key advantage and one key disadvantage for each of the following methods as they pertain to Pleasant Air's analysis:

I. VarCovar
II. Simulation using Cholesky factorization / Gaussian Copula
III. Simulation using Archimedean copula

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6. (*8 points*) You have recently been hired as CRO for PQR, an insurance company started by a hedge fund, in country XEN. Even though PQR has no business yet, you want to develop the risk management function for the company to comply with rating agency and regulatory capital requirements. Standard & Poor's (S&P) Rating Services will be assessing the ERM framework of PQR.

PQR has already hired several actuaries with strong life insurance background. PQR will utilize the parent hedge fund as the investment advisor.

PQR's CEO has identified several blocks of business available for purchase. The CEO is exploring using the U.S. Risk Based Capital (RBC) framework to evaluate each block.

A consultant provided the following data regarding the blocks of business available for purchase. Due to confidentiality agreements, the consultant was unable to disclose any additional information about Blocks A, B, or C.

RBC Components and Purchase Price by block, in $ thousand

RBC Component	Block A	Block B	Block C
C0	0	0	0
C1	380	1,060	120
C2	440	40	650
C3	310	300	150
C4	80	40	110
Authorized Control Level	820	1,360	710
Purchase Price	3,500	1,500	3,200
RBC Ratio			

(a) (*3 points*) The CEO has asked you to evaluate the three blocks. PQR has $5 million of seed money available for the acquisition and capital support.

(i) Describe the risks associated with each RBC component identified above.

(ii) PQR evaluates each block separately. For example, when evaluating block A, blocks B and C are ignored.

Populate the missing RBC Ratio values in the table. Show all work.

(iii) Evaluate the pros and cons of each block for PQR.

6. **Continued**

(b) (*5 points*) Several years have passed and you are provided the following facts about PQR's current Enterprise Risk Management (ERM) program.

- Main sources of material risks are identified and monitored.
- Risk appetite framework is directly linked with risk limits.
- Model limitations are documented and understood within the organization.
- Key risk exposures are managed within specific risk tolerances.
- A formal and comprehensive risk limit system exists and is enforced.
- Risks are managed within the business units.
- A strict model governance process has been implemented.
- The Board of Directors' participation in the ERM process is infrequent.
- Material risks are modeled both deterministically and stochastically.
- Model results are used to support senior business leaders in making decisions.

(i) You anticipate that PQR's Emerging Risk Management and Strategic Risk Management subfactors will be scored as Negative by S&P.

Assess each of the remaining three ERM score subfactors for PQR. Justify your answer.

(ii) Determine PQR's expected overall ERM score. Justify your answer.

(iii) Recommend two improvements to PQR's ERM program to increase the overall ERM score to the next level. Justify your recommendation.

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

7. (*11 points*) AHA decided to proceed with acquiring Eureka and has recently completed the acquisition. AHA plans to leave Eureka's current leadership in place and expects that the company will continue to operate independently from AHA.

AHA has noted that Eureka does not have a retirement program and plans to implement a cash balance plan for the new company. The plan provisions will be identical to AHA's plan except for the level of the minimum interest crediting rate.

You have been asked to help develop the new Eureka plan.

(a) (*3 points*) You use a Monte Carlo model to simulate the NPV of the guarantee (amounts in 000s) under alternative minimum interest crediting rate scenarios. 10,000 interest rate simulations were performed, with the following results:

	Minimum Interest Crediting Rate		
Select Ranked Observations	4.00%	4.50%	5.00%
8,500	92,333	95,000	99,750
9,000	95,941	98,809	101,745
9,500	97,850	102,743	106,832

	Minimum Interest Crediting Rate		
Average of Ranked Observations	4.00%	4.50%	5.00%
8,501-9,000	95,000	97,850	102,743
9,001-9,500	96,900	100,786	104,797
9,501-10,000	99,807	105,825	110,037

Eureka intends to invest an amount based on the simulated guarantee NPVs in risk-free assets and the remainder of the available assets in other investments.

AHA's CFO, B.G. Bucks, has two goals:

1) Invest the assets such that the expected annual return exceeds 4.00%.

2) Set the minimum interest crediting rate at the highest possible level while still being able to fund the 90% VaR level in risk-free assets.

7. Continued

In your calculations, you assume the following:

- Annualized Risk-Free Rate of Return: 2.00%
- Annualized Rate of Return of Other Investments: 8.00%
- Total Assets Available for the Trust: 150,000,000

(i) Determine the minimum interest crediting rate that meets Bucks' goals. Show your work.

(ii) The Investment Officer, Steve Marlin, is more sensitive to the potential severity of failing to fund the NPV of the guarantee and would prefer to be able to fund the 90% CTE level in risk-free assets. Marlin accepts Bucks' expected annual return objective of exceeding 4.00%.

Determine the minimum interest crediting rate that meets Marlin's goals. Show your work.

(b) (*1 point*) Eureka's VP of HR is concerned that the salary scale assumed in the simulation is significantly lower than the actual average rate of salary increase the company has observed.

Describe qualitatively how the selected minimum interest crediting rate in (a)(i) would change if the simulation were redone to reflect the company's actual average rate of salary increase.

(c) (*2.5 points*) Assume that AHA implemented the Eureka plan on January 1, 2020. You are provided with the following excerpts from the Eureka's most recent accounting report as of January 1, 2025 (amounts in 000s).

Operating Assets	500,000
Pension Assets	205,000
Total Assets	705,000
Liabilities	200,000
Pension Liability	205,000
Total Liabilities	405,000

Pension Assets:	Market Value	Beta
Debt	100,000	0
Equity	105,000	1
Total	205,000	

Market Risk Premium	4.00%
Risk-Free Rate	3.00%

Question 7 continued on the next page.

7. Continued

Eureka has stated that its Weighted Average Cost of Capital (WACC), ignoring the pension plan, is 8.00%.

Eureka's CEO is planning to undertake a project that will require an investment of 50,000,000 today and will pay off 105,000,000 at the end of 10 years.

(i) Calculate the company's equity beta prior to the investment, assuming that the beta for liabilities is 0. Show your work.

(ii) Recommend whether or not the CEO should undertake the project based on a WACC approach. Justify your answer.

(d) (*2.5 points*) Eureka's CEO has heard a lot about offering lump sum windows as a method of de-risking a pension plan. He has stated at a recent strategy meeting that the company would not benefit from doing so.

(i) Critique the CEO's statement.

(ii) Propose one alternative strategy that the company could implement under each of the following categories to de-risk the plan:

- Plan Design
- Funding/Investment Policy
- Liability Management

(e) (*2 points*) AHA was provided with Eureka's January 1, 2025 funding report which included the following disclosures to comply with ASOP 51.

- A decrease in interest rates would significantly erode the funded status of a traditional defined benefit plan.
- Enclosed in the appendix are the numerical results of scenario tests, sensitivity tests, and stochastic modeling to evaluate the impact of varying inflation rates on the funded status.
- The company has approved the use of an 11% discount rate for use in determining the pension liability.
- The financial results shown exclude the impact of the intended acquisition of BKT, a major competitor of Eureka, which will be announced at the end of next fiscal year.

Critique each of the statements included in the disclosure with respect to its compliance with ASOP 51.

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Each question should be answered independently

8. (*9 points*) You are the lead retirement consultant for the SLIC Salaried Pension Plan ("Plan"). SLIC has decided to execute a group annuity buy-out for pensioners on December 31, 2019 to de-risk the pension plan. SLIC's December 31, 2019 forecasted accounting results are provided in Stella Kitty's memo in Section 3.14.3 of the Case Study.

- Based on the Plan's estimated 2019 funding valuation results, there will be no variable PBGC premium due.
- The present value of fixed costs associated with administering the Plan for the pensioner group as of December 31, 2019 is \$8.5 million.

An insurance company, RBA, provided SLIC with a group annuity quote of \$525 million for the pensioners.

You believe that RBA used a mortality assumption that is more conservative (i.e., assumes longer expected lifespans) than that used for accounting and estimate that the Economic Liability (EL) will be 4% higher than the Projected Benefit Obligation (PBO).

You realize that there is also a difference between the discount rate used for the PBO and the group annuity contract. You decide to use the duration-adjusted method to estimate the impact of the interest rate difference.

The December 31, 2019 annuity interest rates are assumed to be:

Immediate annuity (7-year duration)	3.50%
Immediate annuity (9-year duration)	3.65%
Deferred annuity (15-year duration)	3.57%

(a) (*2 points*) Explain the differences between the PBO, EL, and the cost of purchasing group annuity contracts.

(b) (*2.5 points*) Pierre LeGrouse asks for your opinion regarding the group annuity cost of \$525 million for the pensioners.

(i) Calculate the EL of the pensioners. Show your work.

(ii) Assess whether or not the group annuity cost is beneficial for SLIC. Justify your answer.

8. **Continued**

(c) (*3 points*) SLIC needs to issue additional debt in 2020 to fund a new product. LeGrouse is concerned that a group annuity buy-out for pensioners will increase the company's cost of capital.

Calculate the change in the company's debt-to-equity ratio due to the group annuity buy-out for the pensioners. Show your work.

(d) (*1.5 points*) Describe three alternative pension risk transfer techniques that SLIC could implement.

****END OF EXAMINATION****

USE THIS PAGE FOR YOUR SCRATCH WORK