Questions 1 – 5 pertain to the Case Study

1. (6 points) LifeCo’s management would like to apply fair value accounting principles to a new group medical insurance policy with the following characteristics:

- The term of the policy is one year.
- The expected year-end claims and associated expenses is $750.
- The risk-free rate is 5%.
- The tax rate is 35%.
- Assume the total return on assets supporting LifeCo’s group business is equal to the book yield on those assets.
- Information on LifeCo’s key competitors is given below:

<table>
<thead>
<tr>
<th>Competitor</th>
<th>Total Return on Assets</th>
<th>Return on Equity</th>
<th>Ratio of Equities to Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6.00%</td>
<td>12%</td>
<td>15%</td>
</tr>
<tr>
<td>B</td>
<td>6.25%</td>
<td>14%</td>
<td>17%</td>
</tr>
<tr>
<td>C</td>
<td>6.75%</td>
<td>16%</td>
<td>20%</td>
</tr>
<tr>
<td>D</td>
<td>7.50%</td>
<td>20%</td>
<td>25%</td>
</tr>
<tr>
<td>Weighted Average</td>
<td>6.50%</td>
<td>15%</td>
<td>18%</td>
</tr>
</tbody>
</table>

(a) List the hierarchy of methods to determine the fair value of financial instruments and propose the most appropriate method for LifeCo’s group business.

(b) Calculate the fair value of the new group medical policy using the Cost of Capital approach.

(c) Define the term Market Value Margin (MVM) and calculate the MVM for the above policy.
Questions 1 – 5 pertain to the Case Study

2.  *6 points*  LifeCo senior management wants to rebalance its Traditional Life Products portfolio in order to achieve the following objectives:

- immunize the portfolio on an effective duration basis
- maximize return on required capital
- achieve a positive spread contribution

(a) Analyze the asset classes supporting the Traditional Life Products portfolio with respect to the rebalancing objectives.

(b) Describe the bond trading issues that may affect LifeCo’s ability to achieve its objectives.

3.  *7 points*  LifeCo’s ALM Committee is conducting its annual review of the investment strategies for the portfolios backing the Traditional Life and Non-Traditional Life liabilities. The CFO has expressed an interest in increasing the emphasis on real estate investments for the Life portfolios and has asked for additional information on market efficiency and how to create a portfolio management process. The Committee is also reviewing the various ALM guidelines and policies as part of the review process.

(a) Describe the investment risks associated with the liabilities for each of these two segments.

(b) Recommend a portfolio management process suitable to real estate investing in response to the CFO’s inquiry.

(c) Evaluate the Asset Liability Management procedures at LifeCo.
4. (5 points) LifeCo’s investment department is interested in increasing the proportion of high-yield bonds in the surplus account. However, the Board of Directors is reluctant to approve this request since:

- high yield bonds receive poor ratings through traditional credit analysis
- any restructuring involves significant costs

(a) (1 point) Assess whether LifeCo’s current investment policy needs to be modified to permit the proposed strategy change.

(b) (4 points) Contrast traditional credit analysis and dynamic credit analysis.

5. (6 points) In response to the recent review by the M&P rating agency, LifeCo’s Board has mandated implementation of a best-practices risk management framework and appointed you Chief Risk Officer.

(a) Compose a liquidity risk management program that addresses the rating agency’s concerns.

(b) Compose a credit risk management program that addresses the rating agency’s concerns.

(c) Compose an operational risk management program for LifeCo’s derivatives unit.
6. **(5 points)** Your company is selling an Equity Indexed Annuity (EIA) product with a compound annual ratchet guarantee and no life-of-contract guarantee. You are given the following information about the contract and the current pricing environment:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial premium</td>
<td>100</td>
</tr>
<tr>
<td>Term of the contract</td>
<td>7 years</td>
</tr>
<tr>
<td>Participation rate</td>
<td>50%</td>
</tr>
<tr>
<td>Risk free rate</td>
<td>6% (continuously compounding)</td>
</tr>
<tr>
<td>Dividend yield of reference equity index</td>
<td>2% (continuously compounding)</td>
</tr>
<tr>
<td>Annual volatility of reference equity index</td>
<td>20%</td>
</tr>
</tbody>
</table>

Your company is also selling a variable annuity (VA) product with the following Guaranteed Minimum Maturity Benefit rider:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Term to maturity</td>
<td>until age 75</td>
</tr>
<tr>
<td>Guarantee</td>
<td>75% of premiums, less withdrawals</td>
</tr>
<tr>
<td>Reset</td>
<td>at policyholder request until age 65, limited to twice a year</td>
</tr>
</tbody>
</table>

(a) Compare the product features and risk management for the EIA to the VA above.

(b) Define the ratchet premium EIA benefit and calculate its value using the Black-Scholes approach.
7. (6 points) You are analyzing a swaption that gives the company XYZ Re the right to pay, 5 years after issue of the swaption, a fixed rate in the following swap:

- Notional amount: $1,000,000
- Variable rate: LIBOR (continuous compounding)
- Fixed rate: 5.2% (semi-annual compounding)
- Payments: semi-annual
- Term: 1 year
- Volatility: 20%

(a) Calculate the swaption premium assuming the LIBOR yield curve is flat at 5% at the time of issue.

(b) Categorize the possible outcomes and default options to both parties during the life of this transaction.

(c) Propose how XYZ Re can hedge the risk of default by the swaption counterparty by using a credit default swap.
8. (6 points) You have been asked by the chief investment officer (CIO) of a life insurer to develop risk management strategies for a new non-par level premium whole life insurance policy. The company has already set the premium level based on current fixed income yields. The CIO is concerned about the possibility that fixed income yields will be lower in the future, in which case the product will not achieve its profit objectives.

The Marketing VP thinks that hedging is not necessary because the company has a deferred annuity product that should experience gains if interest rates fall due to the company’s ability to lower the annuity product crediting rate.

(a) Appraise the effectiveness of the deferred annuity product in providing a “natural hedge” to the whole life policy.

(b) Recommend one strategy that uses derivatives to hedge against falling rates and allows the company to earn a spread over swap rates. Describe the benefits and risks associated with your strategy.

(c) Recommend one strategy that allows the company to lock in today’s yields on future premiums. Describe the benefits and risks associated with your strategy.
9. (5 points) You are using a lognormal distribution with annual parameters $\mu$ and $\sigma$ to model stock price movements for valuing products with a Guaranteed Minimum Maturity Benefit (GMMB).

The valuation method requires the model to be calibrated based on the following accumulation factors associated with the left-tail of the distribution accumulated over specific time periods:

<table>
<thead>
<tr>
<th>Accumulation period</th>
<th>2.5% th Percentile of the accumulation factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 year</td>
<td>0.75</td>
</tr>
<tr>
<td>5 years</td>
<td>0.77</td>
</tr>
</tbody>
</table>

(a) Explain why a left-tail calibration method is appropriate when using the “actuarial” approach for valuing GMMB.

(b) Determine the parameters $\mu$ and $\sigma$ using the calibration method.

(c) Evaluate the advantages and disadvantages of using the regime-switching lognormal model compared to the calibrated lognormal model.
10. (8 points) You are the Chief Actuary of a company that is writing GICs with 2-, 4-, and 6-year maturities. One of your actuarial students has recommended the use of PACs as an asset class to back the liabilities. You will need to evaluate the appropriateness of this recommendation.

(a) Describe the features of PAC tranche CMOs.

(b) Explain how the market value of PAC tranche CMOs is affected by whether the bonds are bought at a premium or discount.

(c) Distinguish PACs from MBS passthroughs.

(d) Describe in detail prepayment behavior considerations.

(e) Describe the specific PAC features you would find desirable for minimizing risk of the GIC product line.
11. (7 points) Your company issues SPDAs and currently uses the excess spread approach to pricing.

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount/Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contract size</td>
<td>$10,000</td>
</tr>
<tr>
<td>Upfront expense per contract</td>
<td>$1,000</td>
</tr>
<tr>
<td>Crediting strategy and renewal expense</td>
<td>30bp</td>
</tr>
<tr>
<td>Average life of the liability</td>
<td>10 years</td>
</tr>
</tbody>
</table>

Your company is using Corporate A bonds yielding 110bp above Treasuries to support the liability assuming the asset related costs are 25bp.

(a) Describe the excess spread approach to pricing.

(b) Calculate the Required Spread on Assets (RSA).

(c) Calculate and interpret the excess spread.

A Co-op student has suggested that the excess spread approach may have some limitations. The student suggests using either interest rate caps and floors or a swap.

(d) Criticize the excess spread approach.

(e) Describe how interest rate caps and floors could be used to price SPDAs.

(f) Describe how an interest rate swap could be used to price SPDAs.
12. *(6 points)* You are using the contingent claim approach to evaluate a block of French “with profits” policies. The current liability of the block is valued at $95 million with supporting assets of $100 million.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to maturity</td>
<td>5 years</td>
</tr>
<tr>
<td>Guaranteed fixed interest rate</td>
<td>4% (continuously compounding)</td>
</tr>
<tr>
<td>Participation level</td>
<td>85% of net profits</td>
</tr>
<tr>
<td>Total volatility of assets</td>
<td>20%</td>
</tr>
<tr>
<td>Default-free 5 year zero-coupon bond price $P(0,5)$</td>
<td>0.8</td>
</tr>
</tbody>
</table>

(a) Describe the embedded options for both the company and the policyholders.

(b) Calculate the current value of the embedded options and hence the shareholders’ equity.

(c) Solve for the participation level that would avoid any subsidy between the company and policyholders.
13. (6 points) Your company’s liabilities consist of single premium fixed deferred annuities. In the past, your portfolio manager has been directed to match the modified duration of the liabilities. A recent study of Key Rate Durations was conducted for the liabilities, and the asset Key Rate Durations have been provided by your portfolio manager. Assets and liabilities are both valued at $1,000,000. You have the following information:

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Liability Key Rate Duration</th>
<th>Asset Key Rate Duration</th>
<th>Current Spot Curve</th>
<th>Scenario 1 Parallel Shift Up 100 bps</th>
<th>Scenario 2 Steepening Spot Curve</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 month</td>
<td></td>
<td></td>
<td>4.75%</td>
<td>5.75%</td>
<td>4.75%</td>
</tr>
<tr>
<td>1 year</td>
<td></td>
<td></td>
<td>4.80%</td>
<td>5.80%</td>
<td>5.00%</td>
</tr>
<tr>
<td>2 year</td>
<td></td>
<td></td>
<td>4.85%</td>
<td>5.85%</td>
<td>5.25%</td>
</tr>
<tr>
<td>3 year</td>
<td>2.00</td>
<td></td>
<td>4.90%</td>
<td>5.90%</td>
<td>5.50%</td>
</tr>
<tr>
<td>5 year</td>
<td>1.50</td>
<td>6.50</td>
<td>4.95%</td>
<td>5.95%</td>
<td>5.75%</td>
</tr>
<tr>
<td>7 year</td>
<td>2.00</td>
<td></td>
<td>5.00%</td>
<td>6.00%</td>
<td>6.00%</td>
</tr>
<tr>
<td>10 year</td>
<td>1.00</td>
<td></td>
<td>5.05%</td>
<td>6.05%</td>
<td>6.25%</td>
</tr>
<tr>
<td>15 year</td>
<td></td>
<td></td>
<td>5.10%</td>
<td>6.10%</td>
<td>6.50%</td>
</tr>
<tr>
<td>20 year</td>
<td></td>
<td></td>
<td>5.15%</td>
<td>6.15%</td>
<td>6.75%</td>
</tr>
<tr>
<td>25 year</td>
<td></td>
<td></td>
<td>5.20%</td>
<td>6.20%</td>
<td>7.00%</td>
</tr>
<tr>
<td>30 year</td>
<td></td>
<td></td>
<td>5.25%</td>
<td>6.25%</td>
<td>7.25%</td>
</tr>
</tbody>
</table>

(a) Calculate the change in net present value under Scenarios 1 and 2.

(b) Construct a portfolio of zero-coupon Treasury bonds that immunizes the liabilities on a Key Rate Duration basis.

(c) Explain whether the portfolio in (b) completely eliminates all exposure to interest rate risk.
14. (6 points) ExposedCo Inc. is an international manufacturing business headquartered in the United States. Its balance sheet and income statement are exposed to changes in foreign exchange rates. ExposedCo wishes to analyze its current foreign exchange rate risk exposure and formulate a suitable hedging strategy.

ExposedCo’s operations are located as follows:

- Headquarters: United States
- Research Facility: Canada
- Manufacturing: China
- Sales: Europe

ExposedCo’s objectives are to minimize:

- gains/(losses) from changes in foreign exchange rates
- the cost of implementing a hedging strategy

Sales related expenses are equal to 20% of revenue.

(a) (1 point) Identify ExposedCo’s foreign exchange rate risk exposures.

(b) (5 points) Describe how you would use the Merck model to develop a hedging strategy for ExposedCo’s foreign exchange rate risk exposures.
15.  (6 points) You are consulting to the trustees of a large corporate defined benefit pension fund regarding the expected long-term rate of return on the plan’s fixed income investments. The trustees are worried that the expected return assumption used to determine annual contributions is too high and should be lowered. The company’s chief financial officer (CFO) tells you that she believes that interest rates are temporarily low due to Federal Reserve policy and expects them to rise toward their long-term average. She points to the upward sloping yield curve as evidence, stating that, “forward rates are telling us that future yields will be higher.”

You are given the following current economic data and assumptions.

<table>
<thead>
<tr>
<th>Economic Data/Assumptions</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forecast for long-run growth in labor productivity</td>
<td>2.50%</td>
</tr>
<tr>
<td>Forecast for long-run growth in labor force</td>
<td>0.90%</td>
</tr>
<tr>
<td>Current yield on 10-year treasury bond</td>
<td>4.50%</td>
</tr>
<tr>
<td>Current yield on 10-year inflation-indexed treasury bond</td>
<td>1.80%</td>
</tr>
<tr>
<td>Estimate of inflation risk premium</td>
<td>0.30%</td>
</tr>
<tr>
<td>Estimate of equilibrium excess return of aggregate portfolio over 10-year treasury bonds</td>
<td>0.35%</td>
</tr>
<tr>
<td>Long-term average yield on aggregate fixed income portfolio</td>
<td>7.50%</td>
</tr>
<tr>
<td>Current assumption for expected long-term return on the fixed income assets used to determine plan contributions</td>
<td>7.50%</td>
</tr>
</tbody>
</table>

(a)  (3 points) Project the equilibrium yield on the plan’s aggregate fixed income portfolio.

(b)  (1 point) Describe the particular theory of the term structure of interest rates that would support the CFO’s comment regarding future yields.

(c)  (1 point) Assess whether the empirical evidence supports or rejects the theory.

(d)  (1 point) Formulate a recommendation for the trustees.
16. \textit{(5 points)} Consider a 3 year down-and-out put option on S&P total return Index where:

\begin{center}
\begin{tabular}{|l|c|}
\hline
S&P index & 1300 \\
\hline
Strike price & 1300 \\
\hline
Barrier & 1200 \\
\hline
Risk free rate & 5\% effective annual \\
\hline
Volatility & 22\% per annum \\
\hline
Time Step & Annual \\
\hline
\end{tabular}
\end{center}

You are given the following European put option prices on the S&P index, total return basis:

\begin{center}
\begin{tabular}{|c|c|c|c|c|}
\hline
Put Option & Index level & Strike & Term (Year) & Price \\
\hline
A & 1200 & 1200 & 1 & 75.91 \\
\hline
B & 1200 & 1200 & 2 & 91.36 \\
\hline
C & 1200 & 1200 & 3 & 97.84 \\
\hline
D & 1200 & 1300 & 1 & 126.00 \\
\hline
E & 1200 & 1300 & 2 & 135.33 \\
\hline
F & 1200 & 1300 & 3 & 137.57 \\
\hline
G & 1300 & 1200 & 1 & 45.71 \\
\hline
H & 1300 & 1200 & 2 & 64.12 \\
\hline
I & 1300 & 1200 & 3 & 73.31 \\
\hline
J & 1300 & 1300 & 1 & 82.23 \\
\hline
K & 1300 & 1300 & 2 & 98.97 \\
\hline
L & 1300 & 1300 & 3 & 105.99 \\
\hline
\end{tabular}
\end{center}

Construct the replicating portfolio for the down-and-out option from the above options. Provide details of the put options selected and number of units used. Assume that option contracts are infinitely divisible.
17. (6 points) You are given the following information about an at-the-money European put option on a dividend paying stock.

Annual volatility 20%
Risk free rate 5% (continuously compounding)
Current stock price $50
Dividend $0.25 per quarter
Term of option 1 year (immediately after the 4\textsuperscript{th} dividend)

(a) (2 points) List and criticize the assumptions underlying the original Black-Scholes option pricing formula.

(b) (3 points) Calculate the price of the put option assuming that the first dividend is paid 3 months from now.

(c) (1 point) Define and explain the following volatility concepts associated with the Black-Scholes pricing framework for equity options.

(i) Implied volatility
(ii) Volatility smile
(iii) Volatility surface
18. * (7 points) A gold mining company is considering investing $30 million in a project to open a new mine. You are given the following information about the project:

- The mine will yield 50,000 ounces of gold per year for the next 2 years.
- Expenses for the proposed mine are $5 million per year and $50 per ounce of gold extracted.
- At the end of year 1, the Company has the option to improve the efficiency of its extraction process for the second year to extract 20% more gold by investing $4 million at the end of year 1. The expense per ounce extracted would increase to $60 with that new technology.
- Assume year-end cash flows once the mine is in operation.
- The continuously compounded risk free rate is 5% for all maturities.

The following trinominal tree displays the spot price of gold (per ounce) over the next 2 years.

The table below shows the probability of moving up, down or staying level for each node listed.

<table>
<thead>
<tr>
<th>Node</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prob up</td>
<td>0.333</td>
<td>0.167</td>
<td>0.333</td>
<td>0.5</td>
</tr>
<tr>
<td>Prob medium</td>
<td>0.333</td>
<td>0.333</td>
<td>0.333</td>
<td>0.333</td>
</tr>
<tr>
<td>Prob down</td>
<td>0.333</td>
<td>0.5</td>
<td>0.333</td>
<td>0.167</td>
</tr>
</tbody>
</table>

(a) * (1 point) Describe options embedded in projects, in general, and compare them to American and European calls and puts.
18. Continued

(b) \((4 \text{ points})\) Evaluate the project to start the new mine and recommend whether or not the company should undertake it.

(c) \((2 \text{ points})\) Explain why the company’s actual decision might differ from your recommendation in (b).

19. \((5 \text{ points})\) You are using Monte Carlo simulation to calculate the value of a 1-year at-the-money European call option on a portfolio of two stocks that pay no dividends. You are given the following information regarding the two underlying stocks:

<table>
<thead>
<tr>
<th>Stock</th>
<th>Number of stocks in portfolio</th>
<th>Current price of the stock</th>
<th>Expected 1-year log-return</th>
<th>Expected 1-year volatility</th>
<th>Correlation of log-returns with stock 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>$100</td>
<td>5%</td>
<td>10%</td>
<td>1.00</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>$50</td>
<td>8%</td>
<td>20%</td>
<td>0.80</td>
</tr>
</tbody>
</table>

You use a lognormal process for stock prices with 1-year time steps. Assume that the composition of the portfolio does not change during the year. The risk-free rate is 4% compounded continuously.

(a) Describe the calculation of the call price using Monte Carlo simulation.

(b) Calculate a sample payoff of the call option at the end of the year that you would use to price the option. Use the following realizations from a standardized univariate normal distribution.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Normal Random Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>2</td>
<td>0.7</td>
</tr>
</tbody>
</table>

(c) Describe the antithetic variable technique for variance reduction.
20. (6 points)

(a) (1 point) Define the following Greeks:
(i) Delta
(ii) Gamma
(iii) Rho
(iv) Vega

(b) (2 points) Sketch the curve of each of the above Greeks as a function of time to maturity for an at-the-money put option on a non-dividend paying stock.

(c) (3 points) Explain the reasons for the shapes of the curves in (b).
Solution 1

(a) Hierarchy of models:

- If the liability exists as a traded instrument, use the market price of the instrument as the fair value
- If the liability is not an actively-traded instrument but there exists a similar instrument that is traded, use the price of this similar instrument, then adjust for differences between the two to get the fair value
- If neither the first two apply, determine the fair value of the liability as the risk-adjusted present value of future liability cash flows.

As group medical insurance is not actively traded, and there is no similar instrument that is traded, LifeCo should use the third method.

(b) Using the cost of capital approach, we first calculate the valuation interest rate \( r_L \), then use this to discount the cash flows:

\[
\frac{A}{E} = r_L (1-t) - r_A
\]

Where:
- \( r_L \) = valuation interest rate
- \( r_A \) = total return on risky assets
- \( e \) = ratio of capital to liabilities
- \( r_E \) = market's required return on capital
- \( t \) = tax rate

From the case study, \( r_A \) equals 6.75% based on the book yield of the assets in LifeCo’s group business.

From the case study, \( r_A \) equals 6.75% based on the book yield of the assets in LifeCo’s group business.
Solution 1 (continued)

We assume C is the most similar competitor due to its return on assets. Hence, we will use \( e \) and \( r_E \) from competitor C.

\[
r_E = 0.0675 - \left( 0.20 \times \frac{0.16}{1 - 0.35} - 0.0675 \right) = 3.18\%
\]

The fair value of the group medical policy is \( 750 / (1.0318) = $726.91 \)

(c) Market Value Margin (MVM) is an adjustment made to the expected cash flow that accounts for the risk of the cashflows and allows discounting at the risk-free rate.

In other words, MVM is the value that makes:

\[
\frac{C + MVM}{1 + r_f} = \frac{C}{1 + r_L}
\]

Where:

- \( C = \) liability cashflows
- \( r_L = \) valuation interest rate
- \( r_f = \) risk-free rate

In this case, we have

\[
\frac{750 + MVM}{1 + 0.05} = \frac{750}{1 + 0.0318}
\]

\[
MVM = 763.26 - 750 = 13.26
\]
Solution 2

(a)

Traditional Life segment has:

1. Government bonds – long duration, low required capital, reasonable yield. Good Choice
2. Public investment grade bonds – very long duration, low required capital, high yield. Excellent choice
3. Public high yield bonds – Short duration, high required capital, high yield. Not a good option
4. Private investment grade bonds – long duration (but not as long as liability) medium required capital, high yield. Decent but not excellent
5. Private high yield bonds – Short duration, high required capital, high yield. Not a good option
7. CMOs – Same as pass-throughs
8. Cash & short term – very short duration, low required capital, low yield – need more to keep LifeCo away from a liquidity crisis but don’t want too much
9. Commercial Mortgages – short duration, high required capital high yield not suitable for this product
10. Equities – short duration, high required capital, low yield, three strikes, it is out
11. Real estate – short duration, high required capital, high yield, Yield is great but does not meet other objectives

Given our objectives, the best investment would be the public investment grade corporate bonds. Government bonds or private investment grade bonds are also good choices. Too much is invested in equities. This money would be better invested in these bond classes. Reducing the amount invested in high yield bonds and commercial mortgages, and moving this money into public investment grade bonds would also be advised.
Solution 2 (continued)

((b)

Trading bonds is considerably more difficult than trading stocks. Bonds are thinly traded, even the most liquid bonds are hard to move. LifeCo would have to contact a bond specialist to see if it could buy these bonds. Then the specialist would have to contact other bond dealers to effect a trade. It may take weeks to find a suitable trade partner. Also, since bonds are rarely traded, there is no set market price; the specialist likely has had to apply a sophisticated regression model to estimate the bond’s price based on credit quality, coupon, time to maturity, etc. Often, though actual prices differ from model-produced prices.

Illiquidity may also have an impact on LifeCo’s ability to sell some bonds. It may need to take a loss to move them.
Solution 3

(a) Trad segment
   • Term and whole life insurance
   • Long duration
   • Guaranteed interest rates
   • Maximum loan rates

Non Trad segment
   • All universal life
   • Minimum guaranteed rate
   • Fund transfer risk
   • Cashflows that vary with interest rates

(b) Market efficiency is either assumed to be high or low
   • If we assume high then we need a passive PM approach. Create index to match.
   • If we assume low then we need an active PM approach. Find underpriced assets.
   • Real estate market data is harder to get
   • I recommend an active approach for real estate

So we use an active approach
   • Top-down – look at national level, then regional, then local
   • Bottom-up – look at individual property

To select actual properties we could use
   • Technical analysis
   • or Fundamental analysis
I recommend Fundamental analysis for real estate

(c) Best Practices are
1. Secure Sr Management commitment
   - management must understand ALM
2. clear assignment of roles and responsibilities
3. leverage cashflow testing platform
4. select appropriate metrics
   - must be relevant and actionable measures
5. responsive and effective mitigation
Solution 3 (continued)

Life Co follows these practices

- ALM committee has CEO, CFO, etc involved
- ALM policy is reviewed by Board annually
- ALM committee has functional area reps (investment, pricing, etc)
- Have ALM procedure manual
- Don’t know about cf platform so this could be area for improvement
- LifeCo uses many measures (duration, key rates) and has various guidelines on them
- LifeCo has regular meetings with annuities weekly
Solution 4

(a) Life Co follows these practices
   ALM committee has CEO, CFO, etc involved
   ALM policy is reviewed by Board annually
   ALM committee has functional area reps (investment, pricing, etc)
   Have ALM procedure manual

(b) Traditional Credit Analysis
   This is similar to insurance; it collects premium for the (yield spread above treasuries) to insure against defaults
   Bondholders have been compensated for taking credit risk.
   The drawbacks of this approach
   Most investors can’t diversify to get the average return.
   Want to outperform the historical market averages
   Most can’t absorb short term losses.

Dynamic Credit analysis
   Equivalent to classic equity analysis; but focus on different factors
   Look at improvement in
     Debt service coverage
     Debt as a multiple of cash flow
     Debt as a percentage of capital
   Analysts look at covenant protections carefully; they analyze event risk carefully
   Liquidity analysis and analyzing default likelihood as specific event is important, as in equity analysis

Private Company Valuation
Three main dynamic credit analysis procedures
   1) CreditMetrics: uses transition probability matrix
   2) KMV Approach: Similar to Merton model for default risk
   3) Credit Risk +: Uses the compound Poisson model for loss distribution for the entire portfolio
Solution 5

(a) Objective – Codify plan to manage/address/understand liquidity issues given liability constraints and specify action in time of crisis

Management Oversight
- Management should select those responsible for monitoring liquidity position
- Management should assign a crisis team

Liquidity Measures and Monitoring Reports
- Specify content and frequency of reporting

Constraints
- Specify assets to be retained
- Maximum realized capital loss that can be tolerated

Establish Plan
- Create an action plan to respond to liquidity needs

(b) Internal controls on assessment of credit risk before the transaction

Internal controls on continued monitoring of credit quality

Documentation of provisions to reduce credit risk and enforcement of transaction

Credit enhancement structures

(c) Gain commitment of senior management

Set up system of checks and balances throughout transaction

Make sure back office has required expertise and hardware to perform required accounting

Set up risk committee in charge of overseeing derivative transactions, setting risk limits, monitoring transaction

Independent internal audits to ensure practices adhere to policies

Thorough documentation of all policies and practices
Solution 6

(a) EIA are relatively short-term compared with VA.

The reference index in EIA is normally price index without dividend being reinvested. VA GMMB tied to account value which get the benefits of dividend.

EIA benefit is like owning a call option. Policyholders of VA own put option.

The EIA option is usually in-the-money at maturity, while the VA GMMB option is less likely to be in-the-money at maturity.

Sellers of EIA contracts normally expect the guarantee would mature in-the-money. And they normally pass the equity risk to a third party by buying call options.

Sellers of VA may expect the contract mature out-of-the-money and the insurer may decide to run the risk without hedging.

Hedging VA guarantee is more complex than hedging EIA and may involve dynamic hedging.

(b) The ratchet premium without life-of-contract guarantee is

\[ RP = P \prod_{t=1}^{n} \{1 + \max(\alpha(S_{t} - 1), 0)\} \]

The expected value of RP is, under the iid Q-measure,

\[ H = \mathbb{E}_Q[e^{-rn}(RP)] \]

\[ H = P(e^{-r} + \alpha(e^{-d_1} \Phi(d_1) - e^{-d_2} \Phi(d_2)))^n \]

\[ d_1 = (r-d+ \sigma^2/2)/\sigma \]

\[ d_2 = d_1 - \sigma \]

\[ d_1 = (.06-.02+ .2^2/2)/.2 = .3 \]

\[ d_2 = .3 - .2 = .1 \]

\[ \Phi(d_1) = \Phi(.3) = .6179 \]

\[ \Phi(d_2) = \Phi(.1) = .5398 \]

\[ H = 100 \{e^{-.06} + .5 * (e^{-02} * .6179 - e^{-06} * .5398)\}^7 \]

\[ H = 100*(.941765+ .5*.048643)^7=93.48 \]
Solution 7

(a)

value of pay fixed swaption is

\[ LA[s_0N(d1) - s_kN(d2)] \]

\[ A = \frac{1}{m} \sum_{i=1}^{m} P(0, T_i) \]

\[ d_1 = \frac{\ln \left( \frac{s_0}{s_k} \right) + \frac{1}{2} \sigma^2 T}{\sigma \sqrt{T}}; d_2 = d_1 - \sigma \sqrt{T} \]

\[ L = 1,000,000 \]

\[ s_0 = [\sqrt{\exp(0.05)}-1] \times 2 = 5.06\% \text{ semi-annual compounding} \]

\[ s_k = 5.2\% \]

\[ T = 5 \]

\[ \sigma = 0.2 \]

\[ A = \frac{1}{2} \left[ \exp(-0.05 \times 5.5) + \exp(-0.05 \times 6) \right] = 0.75020 \]

\[ d1 = 0.16391 \]

\[ N(d1)=0.565101 \]

\[ d2 = -0.28329 \]

\[ N(d2)=0.388474 \]

Swaption premium = \[ LA[s_0N(d1) - s_kN(d2)] = 6,309.56 \]

(b) If the option has not been exercised

XYZ is long an option

Counterparty is short an option

XYZ holds an asset that it can lose if the counterparty becomes bankrupt

If the option has been exercised

XYZ may have an asset or liability depending on the swap value

XYZ maximum loss is the swap replacement value if it is positive

XYZ loss amount can be less if collateralization, netting provisions or downgrade triggers
Solution 7 (continued)

(c) Credit default swap is typically used to protect a bond holder against default by the issuer (reference entity) in case the issuer defaults (credit event).
Periodic payments are paid by the CDS buyer to the CDS seller during CDS term.
Payments are made until the CDS term ends or the occurrence of the credit event.
If credit event occurs the payment by the issuer is made in cash or by delivering a bond.

This is complicated contingent payoff so simulation should be used for valuation.
Solution 8

(a)  
- Gain from deferred annuity line would help offset term product losses if portfolio is duration-matched in the aggregate  
- Duration-matching is a good strategy for dealing with the risk of interest rate fluctuation.  
- Can only lower crediting rate to guaranteed minimum rate in policy.  
- Marketing consideration / early surrender high lapses  
- Regulation issue  
- Temporary natural hedging only

(b)  
- Today - Enter into a series of forward-starting interest rate swaps (pay LIBOR, receive fixed)  
- At the times of each premium payment - enter into an offsetting swap; (pay fixed and receive LIBOR), and invest the premium in fixed rate  
- Company earns swap rate plus spread  
- Risks:  
  - Counterparty credit exposure  
  - Can’t lock in today’s credit spreads Rebalancing  
  - Cost of derivatives  
  - Accounting issue of using derivatives  
  - Swap market may not offer all needed tenor

(c)  
- Securitizing the premium flow  
  - Expected premiums are packaged and sold to the capital markets for cash  
  - Benefits  
    - Can invest cash today at current yields  
    - Increased earnings  
    - Reduced interest rate risk  
    - Increased assets under management  
  - Risks  
    - Deviation in lapse/mortality experience  
    - Level premium term is lapse-supported; if lapses lower than expected, must set higher reserve
Solution 8 (continued)

OR

- Sell a structured liability
  - sell into the market a liability with cash flows that match the product’s cash flows
  - Benefits
    - cash flows are matched
    - lock in profit margin
    - increase assets under management
    - minimizes use of derivatives and FAS 133 implications
  - Risks: expected cash flows may not match actual cash flows
Solution 9

a) The GMMB is vulnerable to poor market returns over the term, using the “actuarial method
   o Poor market returns are represented by the left tail of the stock price distribution
   o Many models when calibrated by standard technique, such as maximum likelihood, tend to be too thin tailed on the left side. This is because MLE is heavily weighted to the centre of the distribution rather then the tails.

b) \[
\frac{S_t}{S_{t-1}} \sim \log N\left(\mu, \sigma^2\right)
\]

\[\Rightarrow P_t\left[\frac{S_t}{S_0} < 0.75\right] = 0.25\]

\[\Leftrightarrow \Phi\left(\frac{\log 0.75 - \mu}{\sigma}\right) = 0.25\]

\[\Leftrightarrow \frac{\log 0.75 - \mu}{\sigma} = -1.96 \Rightarrow \mu = \ldots\]

Similarly \[
\frac{S_t}{S_{t-5}} \sim \log N\left(5\mu, 5\sigma^2\right)
\]

\[\Rightarrow \left(\frac{\log 0.77 - 5\mu}{\sqrt{5}\sigma}\right) = -1.96\]

So we have:
1) \[\mu = 1.96\sigma + \log 0.75\]

and 2) \[5\mu = 1.96\sqrt{5}\sigma + \log 0.77 \Rightarrow \mu = \frac{1.96}{\sqrt{5}} \sigma + \frac{\log 0.77}{5}\]

Equate 10 and 2) gives

\[1.96\left(1 - \frac{1}{\sqrt{5}}\right)\sigma = \frac{\log 0.77}{5} - \log 0.75 \Rightarrow \sigma = 0.2173\]

Substitute in 1) \[\Rightarrow \mu = 0.1382\]
Solution 9 (continued)

c)  
  o  RSLN fits the whole data distribution better  
    (Adv) - Calibrated logN is fitted to the left tail, may be a poor fit to  
    the centre and right tail

  o  RSLN captures dynamic process better  
    (Adv) - volatility bunching  
    - association of volatility and low returns

  o  LgN is simpler, and is consistent with black Scholes framework.  
    (Disadv) -
Solution 10

(a) Collar - range of prepayment speeds which PAC principal repayments do not vary
   Narrower collar = weak protection
   Prepayments faster than top collar accelerate payments and reduce future collar
   Prepayments slower than bottom collar reduce payments, increase future collar and provide extension protection for longer tranches
   Prepayments within collar typically widen future collar

   Window – Interval over which scheduled prepayments are made
   Tighter window = better guaranteed return of CF (more bullet-like), better rolldown of yield curve, experience greater avg. life variability when prepayments outside collar
   Wider window likely to outperform tight windows due to wider spread
   Shorter window = fewer and larger repayments

   Lockout - feature of companion where PAC bonds locked out for period where principal is paid to companions (typically 12-24 months)
   Companions absorb all principal in excess of scheduled payments
   Lockout reduces call and extension risk

(b) Top collar = better call protection on current coupon over premium coupon
   Greater avg. life variability on premium coupon vs. current coupon
   Discount coupons greatest stability
   Upper collar broken, discount coupon benefits, premium coupon hurt
   Lower collar broken, discount coupon hurt, premium coupon benefits

(c) CFs certain as long as prepayments stay within range
   MBS shorten as rates fall, lengthen as rates rise. PAC bonds behave more like corporates
   PAC bonds provide more call/extension protection than MBS bonds
(d) Total prepayments = relocations – assumptions + curtailments + refinancings
Relocations – default, cash paydowns, or equity refinancings
   Affected by economic considerations: home equity levels, mortgage rates, tax deductibility
   Affected by non-economic decisions: age of loan, yearly seasonal cycle, multi-year housing cycle
Assumptions – mortgages assumed by buyer rather than prepaid
   Easier to qualify, minimal transaction costs, no judgment on interest rate timing
   Incentive to assume when current market rates higher than existing mortgage and LTV ratio high
Curtailments – partial prepayments of mortgage
   Small effect at beginning of mortgage, large cumulative effect as pool seasons
Refinancing – interest rate related payment
   Path dependent, need lower lows in mortgage rates to encourage new refinancing
   Burnout – sizable short-term fluctuations in prepayment speeds around a gradual declining trend once a full refinancing has occurred
   Are home owners ready, willing, and able?
   Does pool have experienced refinancers?

(e) Need wider collars
   Prefer discount bonds
   Prefer presence of companions
   Tighter windows
   Include lockout
Solution 11

a) 1. RSA uses known quantity, the MV of assets
2. RSA = constant spread, when added to treasures, makes PV (liab + expense)=MVCA)
3. Steps
   1. Calculate market value (A)
   2. Calculate treasury forward rates on same day
   3. for interest-sensitive liabilities, develop set of treasury rate paths
   4. calculate liability + expense CF along each path

b) \[ RSA = \frac{\$1,000}{\$10,000 - \frac{1}{2} \times \$1,000} = 105bp - 30bp \]
   10 years = 75bp
   - need to consider p/h interest sensitive lapses
   - could cost more or less

c) excess spread = asset spread – total target spread
   = asset spread – (RSA + credit spread + expenses)
   = 110bp – (75bp + 25bp)
   excess spread = 10bp
   ➢ this means assets are earning 10 bps over what is spread is required
   – barely positive means may need to look for higher yielding assets

d) RSA measures are limited in the sense that the highest RSA may not always be the best
1. different OAS’s may not be available at different sales volume – or for both assets and liabs
2. profit goal may be to maximize total excess spread

e) SPDA’s are contrasts that take single premium and accumulate at give rate and then annuitize
   ➢ The book value cash out embedded option is analogous to an interest rate cap (loss to insurer if p/h lapses when rates rise after issue
   ➢ The minimum guaranteed floor in SPDA’s are analogous to interest rate floors
Solution 11 (continued)

- by pricing an interest rate cap to mimic the BV adjustment in the SPDA, the effect of this option can be quantified instead of using RSA
- Similarly, by pricing an interest rate flow whose state = min guaranteed rate, the option under the SPDA can be priced
- The embedded options within the SPDA make it the hardest to price
- RSA simply adds a spread to the liabilities ⇒ cap/flow actually replicate inner-workings of SPDA

f) Swap = long cap + short floor
Similar to prior reasoning, swap can be decomposed into 1) cap and 2) flow to price embedded options with SPDA
Solution 12

(a) Company:
Long a call on assets $A_t$ to walk away (default)
with maturity in 5 years and strike price $L_5^*$, the guaranteed payment
Short a call on asset $A_t$ to share the profit
with maturity in 5 years and strike price $L_5^* / \alpha$,
where $\alpha$ is the current ratio of liabilities to assets
Equity at time $t = C_E(A_t, L_5^*) - \delta \alpha C_E(A_t, L_5^* / \alpha)$,
where $\delta$ is the participation (bonus) level

Policyholder:
Short a put (or call) on assets $A_t$ to default
with maturity in 5 years and strike price $L_5^*$, the guaranteed payment
Long a call on asset $A_t$ to share the profit
with maturity in 5 years and strike price $L_5^* / \alpha$
Liabilities at time $t = L_T^* P(t, 5) - P_t(A_t, L_5^*) + \delta \alpha C_E(A_t, L_5^* / \alpha)$

(b) Formulas:
\[
E_t = \frac{A_t (N(d_1) - \delta \alpha N(d_3)) - P(t, T) L_T^* (N(d_2) - \delta N(d_4))}{- \delta \alpha C_E(A_t, L_T^*)} \\
\text{or } C_E(A_t, L_T^*) = \frac{\ln(A_t/(P(t, T) L_T^*)) + \sigma^2 (T - t)/2}{\sigma \sqrt{T-t}} - \frac{\ln(\alpha A_t/(P(t, T) L_T^*)) + \sigma^2 (T - t)/2}{\sigma \sqrt{T-t}}
\]
\[
d_1 = \frac{\ln(A_t/(P(t, T) L_T^*)) + \sigma^2 (T - t)/2}{\sigma \sqrt{T-t}} \\
d_2 = \frac{\ln(\alpha A_t/(P(t, T) L_T^*)) + \sigma^2 (T - t)/2}{\sigma \sqrt{T-t}}
\]
\[
L_T^* = L_0 \exp(r^* T)
\]

Inputs:
\[
t = 0, T = 5, r^* = 0.04, \delta = 0.85, \alpha = 0.95, \sigma = 0.2, L_0 = 95, A_0 = 100, \ P(0,5) = 0.8
\]

Calculations:
\[
L_T^* = 116.03 \\
d_1 = 0.39005, \quad N(d_1) = 0.6518 \\
d_2 = -0.05716, \quad N(d_2) = 0.4772 \\
d_3 = 0.27536, \quad N(d_3) = 0.6085 \\
d_4 = -0.17186, \quad N(d_4) = 0.4318
\]

Answer:
\[
E_t = 5.81
\]
Solution 12 (continued)

(c) To avoid subsidy
\[
\delta = \left( C_E(A_t, L_T^*) - (1- \alpha) A_0 \right) / \left( \alpha C_E(A_t, L_T^*/\alpha) \right)
\]
\[
C_E(A_t, L_T^*) = A_t N(d_1) - P(t, T) L_T^* N(d_2)
\]
\[
C_E(A_t, L_T^*/\alpha) = A_t N(d_3) - P(t, T) L_T^*/\alpha N(d_4)
\]

\[
C_E(A_t, L_T^*) = 20.88, \quad C_E(A_t, L_T^*/\alpha) = 18.66
\]

\[\delta = 89.58\%\]
Solution 13

(a) 
\[ P = 1 \text{ million} \]
\[ (P^* - P) / P = \text{Sum}[-D(i) \times d(i)] \]

Scenario 1. \( \Delta \text{Liab} = -(2+1.5+2+1) \times 1\% \times 1 \text{ mil} = -$65,000 \)
\[ \Delta \text{Asset} = -6.5 \times 1\% \times 1 \text{ mil} = -$65,000 \]
\[ \text{Change in NPV} = \Delta \text{Asset} - \Delta \text{Liab} = -65,000 - (-65,000) = 0 \]

Scenario 2. \( \Delta \text{Liab} = -(2 \times 0.6\%+1.5 \times 0.8\%+2 \times 1\%+1 \times 1.2\%) \times 1 \text{ mil} = -$56,000 \)
\[ \Delta \text{Asset} = -6.5 \times 0.8\% \times 1 \text{ mil} = -$52,000 \]
\[ \text{Change in NPV} = \Delta \text{Asset} - \Delta \text{Liab} = -52,000 - (-56,000) = 4,000 \]

(b) 
\[ W(i) = D(i) / T(i) \]
\[ W(0) = 1 - \text{Sum}[W(i)] \]

\[ W(3) = 2/3 = $666,667 \text{ in 3-year zero} \]
\[ W(5) = 1.5/5 = $300,000 \text{ in 5-year zero} \]
\[ W(7) = 2/7 = $285,714 \text{ in 7-year zero} \]
\[ W(10) = 1/10 = $100,000 \text{ in 10-year zero} \]
\[ W(0) = 1,000,000 - 666,667 - 300,000 - 285,714 - 100,000 = -$352,381 \]
\[ \text{i.e. borrowing } $352,381 \text{ in cash} \]

(c) 
No
Portfolio (b) is not cash flow matching
Convexity risk remains
Need to rebalance continuously
Liability cash flow very sensitive to assumption change, e.g. lapse
Solution 14

(a) ExposedCo receives revenues in Euros, pays expenses in C$, Yuan, Euros and US$. Reporting is in US$.

So risk exposures are: strengthening of C$ or Yuan and weakening of Euro (versus US$).

(b) Merck model applied to ExposedCo:

I Assess potential future fx movements / volatility
   Determine likely ranges of fx rates
   Consider factors affecting fx rates
   Impact of government policies
   Consider outside expert forecasts

II Examine impact of fx movements on strategic plans
   impact on financial results under various scenarios

III Determine whether to hedge
   External considerations
      Impact on share price
      Investor / clientele behavior
      Impact on dividends
   Internal considerations
      Impact on financial plans

IV Determine appropriate instrument
   Options, futures, swaps could be used
   ExposedCo wants to minimize gains AND losses from fx
   Also wants to minimize cost
   Swaps or futures most appropriate since no upfront cost and lock in rates
   (no gains or losses if fully hedged)

V Implement hedging program
   Determine term and amount of instruments
   Develop simulation model
   monitor effectiveness of hedge and rebalance as needed
Solution 15

(a) Long-run real GDP growth = labor growth + productivity growth
   = 2.50% + 0.90% = 3.40%

   Equilibrium real interest rate = long-run real GDP growth = 3.40%

   Expected inflation = Nominal bond yield – inflation-indexed bond yield –
   inflation risk premium = 4.50% - 1.80% - 0.30% = 2.40%

   Equilibrium nominal GDP growth = 3.40% + 2.40% = 5.80%

   Equilibrium Fed Funds rate = equilibrium nominal GDP growth = 5.80%

   Equilibrium 10-year treasury yield = Fed Funds rate + inflation risk
   premium
   = 5.80% + 0.30% = 6.10%

   Equilibrium yield on aggregate portfolio = equilibrium 10-year treasury
   yield plus 0.35% = 6.45%

(b) Unbiased expectations theory (UEH) – forward rates are unbiased
    predictors of future spot rates

(c) Empirical evidence mostly rejects the UEH – when yield curve is rising,
    short rates tend to rise but yields on long bonds tend to fall over their
    remaining lives. Forward rates usually overestimate actual future rates.
    The term premium, which is composed of the risk premium and the
    convexity premium, is not zero: the two premiums do not net to zero.

(d) The trustees should lower the assumption for the long-term expected
    return on fixed income from 7.50% to 6.45%. The UEH does not hold
    empirically
Solution 16

The values of the option on the boundary are given by
\[ f(S, 3) = \max(1300 - S, 0) \text{ when } S > 1200 \]
\[ f(1200, t) = 0 \text{ when } 0 \leq t \leq 3 \]
Use one unit of Option L to match the first boundary.

Then match at \( t=2 \).
Choose a regular 3-year European put option with a strike price of 1200 (Option I).
It is worth 75.91 at the 2-year point when \( S=1200 \).
The position in option L is worth 126.00 at this point.
The position we require in option I is therefore \(-126/75.91=-1.66\).
Next to match the second boundary condition at \( t=1 \).
Use Option H.
It is worth 75.91.
Our position in Option I and L is worth \(-16.32\) at this point.
We require a position in option H \( 16.32/75.91=0.22 \).

At \( t=0 \), use option G.
It is worth 75.91. Our position in Option H, I and L is worth \(-5.19\) at this point.
We require a position in option G \(-5.19/75.91=0.07 \).
Solution 17

a) The stock pays no dividends. Stocks do pay dividends. Adjustments to the formula can now account for dividends.

An investor’s trades do not affect the taxes paid. Different investors pay taxes at different rates.

Investor pays no transaction costs. Trading costs make it hard for an investor to create an option-like payoff by trading in the underlying stock. It becomes harder to take a gain from the arbitrage.

Volatility is known and doesn’t change. In reality the volatility is only an estimate and can change over the life of the option (called volatility of volatility).

Interest rates remain constant. Interest rates may change over time and it is unknown how they will change.

Stock price changes smoothly. Stocks actually can jump up or down quickly when major news is released.

Unrestricted borrowing and lending at a single rate. Borrowing rates will be higher than lending rates for an individual investor.

No penalties or costs associated with short selling a stock. In reality you can only short sell after an up tick in the stock. Investor must go thru the expense of borrowing the stock before he can sell it, may require collateral.

Exercise occurs only at maturity. (Option is European.) Most of options are American options.

No takeovers or other event to end the life of the option early.
Solution 17 (continued)

b) Present Value of dividends is \( \sum_i dividend \cdot e^{-r \cdot t} \)
\[
= 0.25e^{-0.25 \cdot 5\%} + 0.25e^{0.5 \cdot 5\%} + 0.25e^{-0.75 \cdot 5\%} + 0.25e^{-1.5 \cdot 5\%} = 0.9693
\]
Reduce the current stock price by the present value of dividends.
\[ S = 50 - 0.9693 = 49.0307 \]
\[ K = 50, r = 5\%, \sigma = 20\%, T = 1 \]
\[
d_1 = \frac{\ln \left( \frac{S_0}{K} \right) + \left( \frac{r + \sigma^2}{2} \right) T}{\sigma \sqrt{T}} = \frac{\ln \left( \frac{49.0307}{50} \right) + \left( \frac{0.05 + \frac{0.2^2}{2}}{2} \right) \cdot 1}{0.2 \cdot \sqrt{1}} = .25
\]
\[
d_2 = d_1 - \sigma \sqrt{T} = .25 - 0.2 \sqrt{1} = .05
\]
\[ N(-0.25) = 0.4013, \; N(-0.05) = 0.4801 \]
Put Price = \( K \cdot e^{-r \cdot T} \cdot N(-d_2) - S \cdot N(-d_1) \)
\[ \text{Put Price} = 50 \cdot 0.4801 - 49.0307 \cdot 0.4013 = 3.1582 \]

\[ c) \quad \text{Implied volatility} \]
    In actual markets, option prices are determined by supply and demand. Implied volatility is the volatility that is implied by option prices observed in the market by iteratively solving for the volatility that equates the BS value to the market value of the options.

Volatility Smile of Equity Options
Volatility smile is a description of implied volatilities at different strike prices.

Implied volatility usually decreases as strike price increases.
Implied distribution has a heavier left tail and a thinner right tail than a lognormal distribution. Possible explanations include equity leverage of a company or “Crashaphobia”

Volatility surface
Volatility surface as two dimensions: Strike price and time to maturity.
Solution 18

(a) Options in Projects:
Option to abandon:
Can end the project at any time.
Similar to an American put option on the value of the project with
a strike price equal to the project value less liquidation costs.

Option to expand:
Can make further investment in project if conditions are good.
Similar to an American call option on value of additional capacity
with
a strike price equal to cost of expansion.

Option to contract:
Can reduce the scale of the project’s operation.
Similar to an American put value on the lost capacity with a strike
price equal to the costs saved by contracting the project.

Option to extend:
At end of the project’s life you have the option to extend the life of
the
project by paying a fixed amount.
Similar to a European call option on the project’s future value.

Option to defer:
The option to defer the project to a later date.
Similar to an American call option on the value of the project.

(b) First calculate the value of the option to expand the project at the end of
year 1.

Node E = Additional Gold Revenue – Expense on Additional Gold
Extracted – Expense on Original Gold extracted
Node E = (650-60)*10,000-10*50,000 = 5,400,000
Node F = (570-60)*10,000-10*50,000 = 4,600,000
Node G = (520-60)*10,000-10*50,000 = 4,100,000
Node H = (430-60)*10,000-10*50,000 = 3,200,000
Node I = (360-60)*10,000-10*50,000 = 2,500,000

Option Vale at Node B:
=Exp(-.05)*[(.167)*( 5,400,000) + (.333)* 4,600,000 + (.5)* 4,100,000] –
4,000,000
=264,932
Therefore the option would be exercised at node B.
Solution 18 (continued)

Option Value at Node C:
\[=\exp(-.05) \left( \frac{1}{3} \right) \left[ 4,600,000 + 4,100,000 + 3,200,000 \right] - 4,000,000 \]
\[= -226,790 \]
Negative so the option will not be exercised at node C

Option Value at Node D:
\[=\exp(-.05) \left[ .5 \times 4,100,000 + .333 \times 3,200,000 + .167 \times 2,500,000 \right] - 4,000,000 \]
\[= -639,211 \]
Negative so the option will not be exercised at node D

After determining the point of exercise now calculate the total project:

Value at Node B = PV of Nodes E, F, G + Value at node B + value of the option
\[=\exp(-.05) \left[ .167 \times (650-50) + .333 \times (570-50) + .5 \times (520-50) \right] \times 50,000 - 5,000,000 \]
\[+ (550-50) \times 50,000 - 5,000,000 + 264,932 \]
\[= 39,687,134 \]

Value at Node C
\[=\exp(-.05) \left[ \frac{1}{3} \times \left[ (570-50) + (520-50) + (430-50) \right] \times 50,000 - 5,000,000 \]
\[+ (510-50) \times 50,000 - 5,000,000 \]
\[= 34,963,591 \]

Value at Node D
\[=\exp(-.05) \left[ .5 \times (520-50) + .333 \times (430-50) + .167 \times (360-50) \right] \times 50,000 - 5,000,000 \]
\[+ (420-50) \times 50,000 - 5,000,000 \]
\[= 28,401,485 \]

Value at Node A
\[=\exp(-.05) \left( \frac{1}{3} \right) \left[ 39,687,134 + 34,963,591 + 28,401,485 \right] \]
\[= 32,675,431 \]

This is greater than the initial investment of 30,000,000 so recommend opening the mine.

(c) May not open the mine after all due to loss aversion as people view losses looming larger than gains.

Regret avoidance
Avoidance of feeling remorse about a decision that leads to a bad outcome
Fashions and Fada
Non-Bayesian Forecasting
Instead of Bayes rule, people make their own probability predictions
Solution 19

(a)
- sample bivariate random values for S1 and S2
- adjust the random values for correlation
- project stock price at end of period using selected process and random values
- use risk-free rate instead of expected rate to project stock prices
- calculate the payoff of the call option
- repeat previous steps for a large number of times to obtain the payoff distribution
- take the average of these payoffs to get the expected payoff at maturity
- discount the expected payoff at the risk-free rate to obtain the call price

(b)
\[ e_1 = \text{Random Normal Number 1} \]
\[ e_2 = \text{Rho} \times \text{Random Normal # 1} + \text{Random Normal # 2} \times [(1 - (\text{Rho}^2))^{0.5}] \]
\[ e_1 = 0.4 \]
\[ e_2 = 0.8 \times 0.4 + 0.7 \times [(1 - (0.8^2))^{0.5}] \]
\[ e_2 = 0.74 \]

\[ S_1 = S_0 \times \exp[(\mu - 0.5 \times (\sigma^2)) \times dt + \sigma \times \text{Normal Random #}(dt^{0.5})] \]
Stock 1: \[ S_1 = 100 \times \exp[(0.04 - 0.5 \times (0.1^2)) \times 1 + 0.1 \times 0.4 \times (1^{0.5})] = 107.79 \]
Stock 2: \[ S_1 = 50 \times \exp[(0.04 - 0.5 \times (0.2^2)) \times 1 + 0.2 \times 0.74 \times (1^{0.5})] = 59.14 \]

Payoff of the option is \[ \text{MAX}[0, \text{Portfolio Value at time 1} - \text{Portfolio Value at time 0}] \]
Portfolio Value at time 1 = 107.79 + 59.14 = 166.93
Portfolio Value at time 0 = 100.00 + 50.00 = 150.00
Payoff = \[ \text{MAX}[0,166.93-150.00] = 16.93 \]

(c)
The antithetic variate technique pairs each standard normal deviate (Y) with (-Y), so an estimator \( f_1 \) using Y would be paired with an estimator \( f_2 \) using (-Y)

Estimator \( f_r \) would be the average of \( f_1 \) and \( f_2 \) (\( f_r = 0.5(f_1 + f_2) \))

This works well because when one value is above the true value, the other tends to be below.

Taking the mean of the \( f_r \)'s rather than the \( f \)'s reduces variance as each high estimator is paired with a low estimator
Solution 20

(a) Define the following Greeks:

i) Delta

Delta is the change of the option price with respect to change of the underlying stock price, \( \frac{dC}{dS} \)

ii) Gamma

Gamma is the second derivative of the option price with respect to the stock price, \( \frac{d^2C}{dS^2} \)

iii) Rho

Rho is the change of the option price with respect to change of the interest rate, \( \frac{dC}{dr} \)

iv) Vega

Vega is the change of the option price with respect to change of the volatility of the underlying stock, \( \frac{dC}{d\sigma} \)

(b) Sketch the curve of each of the above Greeks as a function of time to maturity for an at-the-money put option on a non-dividend paying stock.
Solution 20 (continued)

i) Delta

![Delta vs Time for an at-the-money put option](image1)

ii) Gamma

![Gamma vs Time for an at-the-money put option](image2)

iii) Rho

![Rho vs Time for an at-the-money put option](image3)
Solution 20 (continued)

iv) Vega

(c) Explain the reasons for the shapes of the curves in b).

i) Delta

Delta for a put option is negative.
It gets less negative as the time to maturity grows longer, because delta = N(d₁)-1, and N(d₁) increases as T increases.

ii) Gamma

Gamma is the slope of the delta graph.
Slope of the delta goes to zero, therefore, gamma tends to go to zero when the time to maturity increases.
Short life at-the-money options are highly sensitive to jumps in the stock price, they show very high gammas

iii) Rho

Rho decreases as T increases.
Rho is negative for a put.
At-the-money put options with longer maturities have a long duration (value drops significantly when interest rate increases)

iv) Vega

As volatility increases, price of puts increases.
Vega is positive.
As maturity increases, price of puts increases.
Vega is more positive as T increases.
EDUCATION AND EXAMINATION COMMITTEE
OF THE
SOCIETY OF ACTUARIES

COURSE 8 INVESTMENTS STUDY NOTE

COURSE 8 INVESTMENT CASE STUDY

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COURSE 8 - INVESTMENTS
CASE STUDY

LifeCo

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BACKGROUND AND HISTORY

LifeCo is a multinational stock life insurance company and has general account assets totaling $5 billion supporting three main lines of business: Individual Life and Annuity, Institutional Pensions and Group Benefits. Its assets are internally segmented in eleven major portfolios defined below. Each portfolio is fully integrated in the accounting databases with full income statements and balance sheets produced monthly. LifeCo has recently implemented guidelines for Asset Liability Management and is in the process of identifying strategies for mitigating its exposure to interest rate and other risks.

LINES OF BUSINESS

*Individual Life and Annuity*

- Traditional Life
- Non-Traditional Life
- Accumulation Annuity
- Equity-Linked GIC
- Separate Account for Variable Annuity and Variable UL

*Institutional Pensions*

- Payout Annuity
- GIC
- Separate Account for Institutional GICs

*Group Benefits*

- Long Term Disability
- Other A&H

*Surplus Account*

- Surplus Capital

DESCRIPTION OF LIABILITIES

*Individual Life and Annuity*

*Traditional Life* includes all non-interest-sensitive individual life products and is predominantly comprised of non-par term and whole life. Guaranteed interest on whole life policies ranges from 3% to 6%. Policyholders can take out policy loans against any cash surrender value. A maximum loan rate of 7% exists on older policies. The duration of the traditional life liability cash flows tends to be fairly long. It has been difficult to find assets with suitable characteristics to effectively match these liabilities. The liabilities in the traditional life segment are supported by $300 million of assets.

*Non-Traditional Life* consists entirely of universal life. Universal life policyholders can direct their investments into a number of interest bearing or equity-linked accounts.
Interest bearing accounts generally credit a portfolio average rate and have a minimum credited interest guarantee of 4% across the board. Because LifeCo incurs significant costs associated with the acquisition of this business, even though the present value of future fund profits exceeds the present value of all future benefits and expenses, it will not have the hard assets to invest at issue in order to match the interest rate exposure of the liabilities. This situation creates significant reinvestment rate risk. To further complicate matters, the embedded options present in universal life mean that the liability cash flows will not be fixed and will vary with interest rates. The liabilities in the non-traditional life segment are supported by $400 million of assets.

**Accumulation Annuity** contains all individual flexible and single premium deferred annuities. Assets total $1.5 billion. Most funds are available for withdrawal at a book value basis. Surrender charges decline to 0% over a 5-7 year period. Minimum guarantees are generally in the 3-4% range but there is a $500 million block of annuities that have a 5% minimum guarantee. This latter block was sold with a 6% cliff surrender charge and will be reaching the end of the surrender charge period in the next year (i.e. the surrender charge will go from 6% to 0%). There is also a $250 million block of MVA (market value adjusted) annuities included in this segment. The Accumulation Annuity portfolio has been the subject of much modeling scrutiny over the years to better understand the product profitability and risk profile. Actuaries at LifeCo have internally flagged each asset purchase in the portfolio to a particular product in order to support a more detailed level of analysis.

**Equity Linked GICs** offer the return of principal after five years, plus 75% of the percentage increase of the S&P 500 total return index over that five-year period (if positive). As of December 31st:

- assets total $55 million
- remaining term to maturity of GICs is 4.5 years
- current percentage increase of the S&P 500 total return index since issue is 6%
- volatility of the S&P 500 index equals 18%
- S&P 500 total return index is expected to grow at 15%/year

**Variable Annuities** include a guaranteed minimum death benefit, which, upon death of the policyholder, will pay the maximum of the current account value and the deposits accumulated at 5%. Upon surrender, the market value less surrender charges is paid. The benefit is reduced dollar-for-dollar on partial surrenders. For example, assume a policyholder elects to take a $10 partial surrender of the $100 Account Value when the GMDB is $110 after the surrender charge wears off. As a result of the partial withdrawal, the Account Value would be reduced by $10 to $90 and the GMDB would also be reduced by $10 to $100. Therefore, the dollar amount of the GMDB exposure in excess of the Account Value remains constant, but increases as a percentage of the Account Value.

**Separate Accounts for Variable Annuity and Variable Universal Life** assets are invested in various externally managed mutual funds. Policyholders may transfer between the funds offered, make new deposits, and withdraw money, subject to a surrender charge.
Institutional Pensions

Payout Annuity contains pension buyout annuities in both immediate and deferred status, supplementary contracts arising from life and annuity contracts, and structured settlement annuities. This segment was established to hold intermediate to long-term income payment streams that may or may not include life contingencies. Structured settlement annuities contain standard and substandard life contingent annuities, non-life contingent streams and some COLA (cost-of-living adjustment) escalators. Assets total $700 million.

Guaranteed Investment Contract (GIC) includes both single deposit and window GIC’s. This segment holds $1.5 billion of assets. $200 million of the portfolio consists of funding agreements that are putable with 60 days notice. $100 million of the portfolio consists of floating rate-funding agreements, payable in Euros, which mature over the next 5 years. The remaining liabilities are benefit-sensitive contracts with institutional pension plans, which mature over the next 5 years.

Separate Account Institutional GIC offers single deposit and window GICs to larger institutional clients. For accounts larger than $150 million, the company will offer to set up a separate portfolio for one client, with its own asset allocation targets.
Administrative fees are reduced for the commingled accounts, which are available to clients with at least $25 million. While the institutional client owns the market value of its share in the separate account, the individual participants receive interest credited to the book value of their individual accounts. LifeCo annually resets the crediting rates, so that the market value gains and losses in the commingled account are shared with participants. The general formula used to set the credited rate is as follows:

Credited rate
  = Market yield of separate account
    - Administration fees
    + (MV separate account – BV individual accounts) / (Duration of separate account)

In addition, LifeCo guarantees that the market value of each separate account will never be less than 80% of the book value of the individual accounts associated with it. LifeCo does not offer synthetic GICs.

Group Benefits

Group Long-Term Disability pays up to 70% of an employee’s salary prior to the disability claim. Premiums are paid through payroll deduction. Premium rates are guaranteed for 2 years. Claims incurred stay with LifeCo even if the employer changes its insurance carrier for new business. The current product provides “own occupation” benefits generally for two years from the date of incurral, after which payments continue only if the claimant is unable to work at all. LifeCo offers rehabilitative services and counseling where it may be effective, usually through the first four years of a claim. Claim runoff is such that reserves at claim duration 10 are expected to be about 10% of
the reserve at date of incurrence. There is no cash surrender benefit to either individual claimants or group policyholders. The claim liabilities and unearned premium in respect of the group LTD segment are backed by $500 million of assets.

*Other A&H* includes short-term group medical, dental, and term life products. These products are sold through the same group benefits general agents who distribute the company’s LTD product. The company competes on strong underwriting and customer service. The products are repriced at least annually to meet profitability targets. While investment margins are material, they are seen as independent of underwriting margins. Earned premium to surplus leverage is low, at about 4/1. The claim reserves and unearned premium in respect of the other A&H segment are backed by $130.8 million of assets.

*Surplus Account* contains the surplus capital. The Surplus Account is managed to maximize total rate of return growth over time subject to a series of constraints related to liquidity, bond ratings and operating income versus surplus income concerns. Company guidelines require an asset mix of 10-70% in equities, 0-50% in real estate, and 5-90% in bonds. The target asset mix is 50% equities, 35% real estate, and 15% public and private bonds.

**RATINGS OF COMPANY**

Mud & Poor’s (M&P) Rating Agency uses the following rating categories:

AAA, AA, A, BBB, BB, B, etc

LifeCo is currently rated “AA-“. One year ago, M&P raised concerns about LifeCo and placed the company under ratings review. LifeCo was not downgraded at that time.

M&P’s report at that time included the following rationale for the review:

**Capital:** LifeCo’s capital position of 3.6% of assets is weak relative to the other insurers rated “AA-“.

**Liquidity:** LifeCo’s liquidity position appears weak. Given that the GICs will mature over the next few years and that a significant portion of the new sales are directed to separate account products, the company would appear to have a higher than usual liquidity risk.

**Credit Risk:** LifeCo is exposed to C1 risk because of its investments in: below investment grade bonds, commercial mortgages, equity, and real estate. LifeCo also has a high percentage of total assets invested in CMO’s, which exhibit cashflow volatility.

**Growth/Profitability:** LifeCo’s business mix is shifting to less capital-intensive lower margin products.
PERFORMANCE HISTORY

LifeCo was established in 1945; however most of LifeCo’s growth has taken place in the last ten years.

Although LifeCo has been profitable on both a Statutory and GAAP basis for the past 6 years, profits have fluctuated. Return on Equity (ROE) has averaged 8% over the past 5 years compared to an ROE of 12% for the industry. LifeCo’s stock has returned an average of 5% on a total return basis over the past 3 years.

ENVIRONMENT

In surveys, the company has generally received positive reviews from its customers for service and for value. One weakness of the company has been its public relations department. Early in 1999, LifeCo took steps to deal with this weakness by hiring one of the top public relations specialists in the country.

The insurance industry in general has received some bad press of late due to perceived market conduct problems. As a result, financial service companies that are not perceived as insurers have taken business away from companies perceived as insurers. LifeCo is definitely viewed as an insurer.

Because of the rapid changes in product design, LifeCo has 16 products running on 6 different administrative systems. With the strong stock market and declining interest rates, money has been moving from the fixed account to the variable accounts for both the variable annuity and the variable life products. The variable life market has been growing recently. The variable annuity market has also been growing, but it has been adversely affected by tax law changes. Additionally, changes in regulation have allowed banks to underwrite variable annuities, and several large banks are offering low load versions of this product. These changes have resulted in a dramatic slowing of variable annuity sales for LifeCo. At the same time, many reinsurers have taken a second look at offering reinsurance for the risk associated with the investment guarantees offered on these products and are either not willing to provide reinsurance on this business at all or are only willing to do so at a much higher cost than was previously assumed in pricing.

DESCRIPTION OF ASSETS

General Fund Assets Backing Individual Life & Annuity and Institutional Pensions
LifeCo invests in private placement bonds, public bonds (including CMO’s), commercial mortgages, equities and real estate. For private placement bonds, LifeCo tries to maintain a 75% investment grade, 25% below investment grade mix. The current mix is worse than these percentages because of downgrades in the portfolio. Thirty percent of the private placement bonds are callable.
For public bonds, LifeCo tries to maintain an 80% investment grade, 20% below investment grade mix. Currently, LifeCo maintains a higher credit quality for the bonds to offset the current mix for the private placement bonds. Seventy-five percent of the public bonds are callable.

General account assets are segmented into portfolios supporting the liability lines. LifeCo’s asset mix backing its pension business is: 83% bonds, 13% commercial mortgages, 2% equities and 2% cash and short term. All bonds and mortgages are denominated in U.S. dollars. LifeCo’s asset mix backing its individual life and annuity business, including the liability arising from the guaranteed minimum death benefit, is: 74% bonds, 10% commercial mortgages, 5% equities, 7% real estate, 2% policy loans and 2% cash and short term. LifeCo’s asset mix backing its Group Life and Health business is: 85% bonds, 8% commercial mortgages, 5% equities and real estate, and 2% cash and other.

Separate Accounts Variable Annuities and Variable UL Policies
The overall distribution is 70% US equity, 15% US bonds, 5% money market, and 10% international bonds/equity for the variable annuity block. Assets total $2.4 billion for variable annuities, and $1.1 billion for variable universal life.

<table>
<thead>
<tr>
<th>Fund Type</th>
<th>Volatility</th>
<th>Equity</th>
<th>Bond</th>
<th>Mortgage</th>
<th>Asian</th>
<th>Global</th>
<th>Money Market</th>
<th>Balanced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equity</td>
<td>18%</td>
<td>1</td>
<td>0.00%</td>
<td>0.00%</td>
<td>25.00%</td>
<td>70.00%</td>
<td>0.00%</td>
<td>95.00%</td>
</tr>
<tr>
<td>Bond</td>
<td>4%</td>
<td>0.00%</td>
<td>1</td>
<td>80.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Mortgage</td>
<td>3%</td>
<td>0.00%</td>
<td>80.00%</td>
<td>1</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Asian</td>
<td>21%</td>
<td>25.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>1</td>
<td>45.00%</td>
<td>0.00%</td>
<td>25.00%</td>
</tr>
<tr>
<td>Global</td>
<td>19%</td>
<td>70.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>45.00%</td>
<td>1</td>
<td>0.00%</td>
<td>70.00%</td>
</tr>
<tr>
<td>Money Market</td>
<td>0%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>1</td>
<td>0.00%</td>
</tr>
<tr>
<td>Balanced</td>
<td>9%</td>
<td>95.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>25.00%</td>
<td>70.00%</td>
<td>0.00%</td>
<td>1</td>
</tr>
<tr>
<td>Unit Value</td>
<td>Variable Annuities ($ millions)</td>
<td>Variable UL ($'millions)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fund Value</td>
<td>Delta</td>
<td>Gamma</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equity</td>
<td>18.2</td>
<td>1,042</td>
<td>(189,993)</td>
<td>5,287</td>
<td>258</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bond</td>
<td>13.1</td>
<td>294</td>
<td>(98,102)</td>
<td>4,263</td>
<td>460</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mortgage</td>
<td>11.1</td>
<td>37</td>
<td>(6,467)</td>
<td>66</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>9.5</td>
<td>49</td>
<td>(10,105)</td>
<td>130</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Global Equity</td>
<td>14.8</td>
<td>343</td>
<td>(11,559)</td>
<td>6,992</td>
<td>56</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Money Market</td>
<td>10</td>
<td>123</td>
<td>(470,985)</td>
<td>896</td>
<td>90</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balanced</td>
<td>15.2</td>
<td>564</td>
<td>(505,539)</td>
<td>30,797</td>
<td>258</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,452</strong></td>
<td></td>
<td></td>
<td><strong>1,122</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The Delta and Gamma applies to the minimum guaranteed death benefit included in the variable annuity product.

<table>
<thead>
<tr>
<th>($ millions)</th>
<th>Reported Book Value</th>
<th>DAC</th>
<th>Net Book Value</th>
<th>PV of Cash-Flows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable Annuities</td>
<td>2459</td>
<td>(74)</td>
<td>2,385</td>
<td>2,360</td>
</tr>
<tr>
<td>Variable UL</td>
<td>1122</td>
<td>(28)</td>
<td>1,094</td>
<td>1,085</td>
</tr>
</tbody>
</table>

The derivatives contracts used to hedge the delta exposure are held in the General Fund.

*Separate Account Institutional GIC*
In total this line of business holds $1.2 billion in market value of assets. Each commingled account offers a different target asset allocation.

**Account 1**
- Treasuries: 5%
- AA/AAA public corporates: 35%
- A public corporates: 15%
- BBB public corporates: 10%
- Govt/Agency MBS passthroughs: 25%
- High grade private corporate debt: 10%

**Account 2**
- Treasuries: 5%
- AA/AAA public corporates: 10%
- A public corporates: 15%
- BBB public corporates: 15%
- High yield public corporates: 15%
- Convertible securities: 10%
- Govt/Agency MBS passthroughs: 15%
- High grade private corporate debt: 10%
- Other private debt: 5%
**Group Long-Term Disability**
The asset portfolio is designed to have relatively low liquidity and high total return, with a duration target of 7 years. The target asset allocation is as follows:

<table>
<thead>
<tr>
<th>Asset Class</th>
<th>Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treasuries</td>
<td>5%</td>
</tr>
<tr>
<td>Inv Grade public corporates</td>
<td>35%</td>
</tr>
<tr>
<td>Govt/Agency MBS passthroughs</td>
<td>20%</td>
</tr>
<tr>
<td>High yield public corporates</td>
<td>10%</td>
</tr>
<tr>
<td>Commercial mortgages</td>
<td>10%</td>
</tr>
<tr>
<td>High grade private corporate debt</td>
<td>10%</td>
</tr>
<tr>
<td>Other private debt</td>
<td>5%</td>
</tr>
<tr>
<td>Real estate partnerships</td>
<td>5%</td>
</tr>
</tbody>
</table>

**Other A&H**
Invested assets are managed for high liquidity and high total return.

<table>
<thead>
<tr>
<th>Asset Class</th>
<th>Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treasuries</td>
<td>10%</td>
</tr>
<tr>
<td>Inv Grade public corporates</td>
<td>50%</td>
</tr>
<tr>
<td>Federal/Agency MBS passthroughs</td>
<td>25%</td>
</tr>
<tr>
<td>High yield public corporates</td>
<td>10%</td>
</tr>
<tr>
<td>Public equities</td>
<td>5%</td>
</tr>
</tbody>
</table>
## Total Company (excluding Separate Accounts)

### Assets

<table>
<thead>
<tr>
<th></th>
<th>Reported Book Value</th>
<th>Book Yield</th>
<th>PV Cash Flows</th>
<th>Effective Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonds (total)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1a Gov’t</td>
<td>202.4</td>
<td>5.97%</td>
<td>202.8</td>
<td>6.1</td>
<td>1.0</td>
</tr>
<tr>
<td>A1b Public Corporate (Inv. Grade)</td>
<td>1573.7</td>
<td>6.76%</td>
<td>1621.0</td>
<td>6.5</td>
<td>23.6</td>
</tr>
<tr>
<td>A1c Public Corporate (below Inv Grade)</td>
<td>399.8</td>
<td>7.21%</td>
<td>419.0</td>
<td>4.5</td>
<td>20.0</td>
</tr>
<tr>
<td>A1d Private Corporate (Inv Grade)</td>
<td>790.3</td>
<td>6.99%</td>
<td>829.1</td>
<td>6.0</td>
<td>15.8</td>
</tr>
<tr>
<td>A1e Private Corporate (below Inv Grade)</td>
<td>437.7</td>
<td>7.54%</td>
<td>470.1</td>
<td>4.6</td>
<td>30.6</td>
</tr>
<tr>
<td>A1f Pass-throughs</td>
<td>274.2</td>
<td>6.88%</td>
<td>288.0</td>
<td>4.4</td>
<td>8.2</td>
</tr>
<tr>
<td>A1g CMO’s</td>
<td>219.2</td>
<td>6.60%</td>
<td>227.5</td>
<td>3.6</td>
<td>6.6</td>
</tr>
<tr>
<td>A1 Bonds Subtotal</td>
<td>3897.2</td>
<td>6.90%</td>
<td>4057.5</td>
<td>5.8</td>
<td>105.8</td>
</tr>
<tr>
<td>A2 Cash &amp; short term</td>
<td>103.0</td>
<td>4.75%</td>
<td>103.0</td>
<td>0.1</td>
<td>0.3</td>
</tr>
<tr>
<td>A3 Commercial Mortgages</td>
<td>554.0</td>
<td>8.39%</td>
<td>595.0</td>
<td>5.4</td>
<td>27.7</td>
</tr>
<tr>
<td>A4 Derivative securities</td>
<td>0.0</td>
<td>0.00%</td>
<td>0.0</td>
<td>-</td>
<td>0.0</td>
</tr>
<tr>
<td>A5 Equities</td>
<td>249.3</td>
<td>1.66%</td>
<td>249.3</td>
<td>5.6</td>
<td>49.9</td>
</tr>
<tr>
<td>A6 Real Estate (unleveraged)</td>
<td>237.0</td>
<td>9.70%</td>
<td>274.1</td>
<td>5.0</td>
<td>35.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Invested Assets Subtotal</td>
<td>5040.5</td>
<td>6.89%</td>
<td>5278.8</td>
<td>5.7</td>
<td>219.3</td>
</tr>
<tr>
<td>A7 Accrued investment income</td>
<td>50.3</td>
<td>0.00%</td>
<td>50.3</td>
<td>-</td>
<td>0.0</td>
</tr>
<tr>
<td>A8 Policyholder Loans</td>
<td>52.5</td>
<td>7.17%</td>
<td>52.5</td>
<td>0.1</td>
<td>0.0</td>
</tr>
<tr>
<td>A9 Provision for asset default</td>
<td>0.0</td>
<td>0.00%</td>
<td>0.0</td>
<td>-</td>
<td>0.0</td>
</tr>
<tr>
<td>A10 Other</td>
<td>75.5</td>
<td>0.00%</td>
<td>75.5</td>
<td>-</td>
<td>0.0</td>
</tr>
<tr>
<td>A11 Total Assets</td>
<td>5218.8</td>
<td>6.73%</td>
<td>5457.1</td>
<td>5.5</td>
<td>219.3</td>
</tr>
</tbody>
</table>

### Liabilities

<table>
<thead>
<tr>
<th></th>
<th>Reported Book Value</th>
<th>Req Interest</th>
<th>PV Cash Flows</th>
<th>Effective Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1 Benefit liabilities</td>
<td>5030.8</td>
<td>6.27%</td>
<td>5220.0</td>
<td>5.3</td>
<td>155.5</td>
</tr>
<tr>
<td>B Total Liabilities</td>
<td>5030.8</td>
<td>6.27%</td>
<td>5220.0</td>
<td>5.3</td>
<td>155.5</td>
</tr>
<tr>
<td>C PreTax Equity</td>
<td>188.0</td>
<td></td>
<td>237.1</td>
<td>10.69</td>
<td></td>
</tr>
</tbody>
</table>

### Tax and Other Adjustments

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>D1 Future tax payments</td>
<td>65.8</td>
<td></td>
<td>83.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D2 Other adjustments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D Subtotal, tax and other adjustments</td>
<td>65.8</td>
<td></td>
<td>83.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Value (C-D)</td>
<td>122.2</td>
<td></td>
<td>154.1</td>
<td></td>
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</table>
### Surplus Account

#### Assets

<table>
<thead>
<tr>
<th></th>
<th>Reported Book Value</th>
<th>Book Yield</th>
<th>PV Cash Flows</th>
<th>Effective Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonds (total)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1a Gov't</td>
<td>0.0</td>
<td>7.53%</td>
<td>4.3</td>
<td>2.20</td>
<td>0.00</td>
</tr>
<tr>
<td>A1b Public Corporate (Inv Grade)</td>
<td>9.2</td>
<td>8.01%</td>
<td>5.9</td>
<td>3.80</td>
<td>0.07</td>
</tr>
<tr>
<td>A1c Public Corporate (below Inv Grade)</td>
<td>4.9</td>
<td>9.17%</td>
<td>8.8</td>
<td>3.90</td>
<td>0.25</td>
</tr>
<tr>
<td>A1d Private Corporate (Inv Grade)</td>
<td>3.5</td>
<td>8.01%</td>
<td>5.9</td>
<td>3.80</td>
<td>0.07</td>
</tr>
<tr>
<td>A1e Private Corporate (below Inv Grade)</td>
<td>10.8</td>
<td>9.82%</td>
<td>18.4</td>
<td>5.30</td>
<td>0.76</td>
</tr>
<tr>
<td>A1f Pass-throughs</td>
<td>0.0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>A1g CMO's</td>
<td>0.0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>A1</td>
<td>Bonds Subtotal</td>
<td>28.4</td>
<td>8.74%</td>
<td>37.4</td>
<td>3.87</td>
</tr>
<tr>
<td>A2 Cash &amp; short term</td>
<td>0.0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>A3 Commercial Mortgages</td>
<td>0.0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>A4 Derivative securities</td>
<td>0.0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>A5 Equities</td>
<td>101.5</td>
<td>2.61%</td>
<td>101.5</td>
<td>4.00</td>
<td>20.30</td>
</tr>
<tr>
<td>A6 Real Estate (unleveraged)</td>
<td>58.0</td>
<td>7.23%</td>
<td>95.1</td>
<td>6.00</td>
<td>8.71</td>
</tr>
<tr>
<td>Invested Assets Subtotal</td>
<td>188.0</td>
<td>4.96%</td>
<td>196.6</td>
<td>9.45</td>
<td>30.2</td>
</tr>
<tr>
<td>A7 Accrued investment income</td>
<td>0.0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>A8 Policyholder Loans</td>
<td>0.0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>A9 Provision for asset default</td>
<td>0.0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>A10 Other</td>
<td>0.0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>A11 Total Assets</td>
<td>188.0</td>
<td>4.96%</td>
<td>234.0</td>
<td>9.45</td>
<td>38.9</td>
</tr>
</tbody>
</table>

#### Liabilities

<table>
<thead>
<tr>
<th></th>
<th>Reported Book Value</th>
<th>Req Interest</th>
<th>PV Cash Flows</th>
<th>Effective Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1 Benefit liabilities</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Total Liabilities</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>C PreTax Equity</td>
<td>188.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Tax and Other Adjustments

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>D1 Future tax payments</td>
<td>0.0</td>
</tr>
<tr>
<td>D2 Other adjustments</td>
<td>0.0</td>
</tr>
<tr>
<td>D Subtotal, tax and other adjustments</td>
<td>0.0</td>
</tr>
</tbody>
</table>

---

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Value (C-D)</td>
<td>188.0</td>
</tr>
</tbody>
</table>
### Individual Life & Annuity - Traditional Life

#### Assets

<table>
<thead>
<tr>
<th>Bonds (total)</th>
<th>Reported Book Value</th>
<th>Book Yield</th>
<th>PV Cash Flows</th>
<th>Effective Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1a Gov't</td>
<td>6.5</td>
<td>6.10%</td>
<td>6.45</td>
<td>13.9</td>
<td>0.03</td>
</tr>
<tr>
<td>A1b Public Corporate (Inv. Grade)</td>
<td>51.6</td>
<td>6.90%</td>
<td>54.44</td>
<td>15.0</td>
<td>0.77</td>
</tr>
<tr>
<td>A1c Public Corporate (below Inv Grade)</td>
<td>12.9</td>
<td>7.30%</td>
<td>13.61</td>
<td>7.0</td>
<td>0.65</td>
</tr>
<tr>
<td>A1d Private Corporate (Inv Grade)</td>
<td>28.4</td>
<td>7.00%</td>
<td>29.94</td>
<td>12.0</td>
<td>0.57</td>
</tr>
<tr>
<td>A1e Private Corporate (below Inv Grade)</td>
<td>15.5</td>
<td>7.50%</td>
<td>16.33</td>
<td>5.0</td>
<td>1.08</td>
</tr>
<tr>
<td>A1f Pass-throughs</td>
<td>7.1</td>
<td>7.00%</td>
<td>7.45</td>
<td>4</td>
<td>0.21</td>
</tr>
<tr>
<td>A1g CMO's</td>
<td>7.1</td>
<td>7.10%</td>
<td>7.52</td>
<td>4.5</td>
<td>0.21</td>
</tr>
</tbody>
</table>

**Bonds Subtotal**

<table>
<thead>
<tr>
<th>Invested Assets Subtotal</th>
<th>129.0</th>
<th>7.01%</th>
<th>135.74</th>
<th>11.7</th>
<th>3.63</th>
</tr>
</thead>
</table>

| A2 Cash & short term                  | 6.0                 | 4.75%      | 6.00          | 0.1                | 0.02        |
| A3 Commercial Mortgages              | 39.0                | 8.00%      | 41.93         | 5.0                | 1.95        |
| A4 Derivative securities             | 0.0                 | 0.00%      | 0.00          | 0.0                | 0.00        |
| A5 Equities                          | 75.0                | 1.00%      | 75.00         | 7.0                | 15.00       |
| A6 Real Estate (unleveraged)         | 21.0                | 10.50%     | 21.00         | 5.0                | 3.15        |

**Invested Assets Subtotal**

| A7 Accrued investment income         | 3.0                 | 0.00%      | 3.00          | 0.0                | 0.00        |
| A8 Policyholder Loans                | 22.5                | 7.00%      | 22.50         | 0.1                | 0.00        |
| A9 Provision for asset default       | 0.0                 | 0.00%      | 0.00          | 0.0                | 0.00        |
| A10 Other                            | 4.5                 | 0.00%      | 4.50          | 0.0                | 0.00        |

**Total Assets**

| A11 Total Assets                     | 300.0               | 5.66%      | 309.7         | 7.8                | 26.8        |

#### Liabilities

<table>
<thead>
<tr>
<th>B1 Benefit liabilities</th>
<th>Reported Book Value</th>
<th>Book Interest</th>
<th>PV Cash Flows</th>
<th>Effective Duration</th>
<th>Req Capital</th>
</tr>
</thead>
</table>

**Total Liabilities**

| C PreTax Equity                      | 0.0                 | -8.3          | 205.14        |

#### Tax and Other Adjustments

| D1 Future tax payments               | 0.0                 | -2.9          |
| D2 Other adjustments                 | 0.0                 | -2.9          |

**Subtotal, tax and other adjustments**

| D Net Value (C-D)                    | 0.0                 | -5.4          |
## Individual Life & Annuity - Non Traditional Life

<table>
<thead>
<tr>
<th>Assets</th>
<th>Reported Book Value</th>
<th>Book Yield</th>
<th>PV Cash Flows</th>
<th>Effective Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonds (total)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1a Gov't</td>
<td>13.8</td>
<td>6.20%</td>
<td>13.75</td>
<td>12.8</td>
<td>0.07</td>
</tr>
<tr>
<td>A1b Public Corporate (Inv Grade)</td>
<td>110.0</td>
<td>7.00%</td>
<td>114.95</td>
<td>15.5</td>
<td>1.65</td>
</tr>
<tr>
<td>A1c Public Corporate (below Inv Grade)</td>
<td>27.5</td>
<td>7.50%</td>
<td>29.01</td>
<td>7.5</td>
<td>1.38</td>
</tr>
<tr>
<td>A1d Private Corporate (Inv Grade)</td>
<td>60.5</td>
<td>7.10%</td>
<td>63.83</td>
<td>12.5</td>
<td>1.21</td>
</tr>
<tr>
<td>A1e Private Corporate (below Inv Grade)</td>
<td>33.0</td>
<td>7.60%</td>
<td>34.82</td>
<td>5.2</td>
<td>2.31</td>
</tr>
<tr>
<td>A1f Pass-throughs</td>
<td>15.1</td>
<td>7.00%</td>
<td>15.88</td>
<td>4</td>
<td>0.45</td>
</tr>
<tr>
<td>A1g CMO's</td>
<td>15.1</td>
<td>7.30%</td>
<td>16.03</td>
<td>4.5</td>
<td>0.45</td>
</tr>
<tr>
<td><strong>Bonds Subtotal</strong></td>
<td><strong>275.0</strong></td>
<td><strong>7.12%</strong></td>
<td><strong>286.27</strong></td>
<td><strong>12.0</strong></td>
<td><strong>7.52</strong></td>
</tr>
<tr>
<td>A2 Cash &amp; short term</td>
<td>8.0</td>
<td>4.75%</td>
<td>8.0</td>
<td>0.1</td>
<td>0.02</td>
</tr>
<tr>
<td>A3 Commercial Mortgages</td>
<td>44.0</td>
<td>8.00%</td>
<td>47.30</td>
<td>5.0</td>
<td>2.20</td>
</tr>
<tr>
<td>A4 Derivative securities</td>
<td>0.0</td>
<td>0.00%</td>
<td>0.0</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>A5 Equities</td>
<td>5.0</td>
<td>1.00%</td>
<td>5.0</td>
<td>7.0</td>
<td>1.00</td>
</tr>
<tr>
<td>A6 Real Estate (unleveraged)</td>
<td>28.0</td>
<td>10.50%</td>
<td>28.00</td>
<td>5.0</td>
<td>4.20</td>
</tr>
<tr>
<td><strong>Invested Assets Subtotal</strong></td>
<td><strong>360.0</strong></td>
<td><strong>7.35%</strong></td>
<td><strong>376.6</strong></td>
<td><strong>10.3</strong></td>
<td><strong>14.9</strong></td>
</tr>
<tr>
<td>A7 Accrued investment income</td>
<td>4.0</td>
<td>0.00%</td>
<td>4.0</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>A8 Policyholder Loans</td>
<td>30.0</td>
<td>7.30%</td>
<td>30.00</td>
<td>0.1</td>
<td>0.00</td>
</tr>
<tr>
<td>A9 Provision for asset default</td>
<td>0.0</td>
<td>0.00%</td>
<td>0.0</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>A10 Other</td>
<td>6.0</td>
<td>0.00%</td>
<td>6.0</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>A11 Total Assets</strong></td>
<td><strong>400.0</strong></td>
<td><strong>7.17%</strong></td>
<td><strong>416.6</strong></td>
<td><strong>9.3</strong></td>
<td><strong>19.1</strong></td>
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</table>

<table>
<thead>
<tr>
<th>Liabilities</th>
<th>Reported Book Value</th>
<th>Req Interest</th>
<th>PV Cash Flows</th>
<th>Effective Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1 Benefit liabilities</td>
<td>400.0</td>
<td>6.30%</td>
<td>406.00</td>
<td>4.0</td>
<td>4.00</td>
</tr>
<tr>
<td><strong>B Total Liabilities</strong></td>
<td><strong>400.0</strong></td>
<td><strong>6.30%</strong></td>
<td><strong>406.0</strong></td>
<td><strong>4.0</strong></td>
<td><strong>4.0</strong></td>
</tr>
</tbody>
</table>

C PreTax Equity

**Tax and Other Adjustments**

| D1 Future tax payments                     | 0.0                 |              | 3.7           |                    |             |
| D2 Other adjustments                       |                     |              |               |                    |             |
| **D Subtotal, tax and other adjustments**  | **0.0**             |              | **3.7**       |                    |             |

**Net Value (C-D)**                         | **0.0**             |              | **6.9**       |                    |             |
### Individual Life & Annuity - Accumulation Annuity

#### Assets

<table>
<thead>
<tr>
<th>Asset Description</th>
<th>Reported Book Value</th>
<th>Book Yield</th>
<th>PV Cash Flows</th>
<th>Effective Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonds (total)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1a Gov't</td>
<td>58.7</td>
<td>6.20%</td>
<td>58.69</td>
<td>5.0</td>
<td>0.29</td>
</tr>
<tr>
<td>A1b Public Corporate (Inv. Grade)</td>
<td>469.5</td>
<td>7.00%</td>
<td>481.24</td>
<td>4.9</td>
<td>7.04</td>
</tr>
<tr>
<td>A1c Public Corporate (below Inv Grade)</td>
<td>117.4</td>
<td>7.50%</td>
<td>120.90</td>
<td>4.5</td>
<td>5.87</td>
</tr>
<tr>
<td>A1d Private Corporate (Inv Grade)</td>
<td>258.2</td>
<td>7.10%</td>
<td>267.26</td>
<td>5.3</td>
<td>5.16</td>
</tr>
<tr>
<td>A1e Private Corporate (below Inv Grade)</td>
<td>140.9</td>
<td>7.60%</td>
<td>148.60</td>
<td>4.3</td>
<td>9.86</td>
</tr>
<tr>
<td>A1f Pass-throughs</td>
<td>64.6</td>
<td>7.00%</td>
<td>67.14</td>
<td>4.6</td>
<td>1.94</td>
</tr>
<tr>
<td>A1g CMO's</td>
<td>64.6</td>
<td>7.10%</td>
<td>67.46</td>
<td>5.2</td>
<td>1.94</td>
</tr>
<tr>
<td><strong>Bonds Subtotal</strong></td>
<td>1173.8</td>
<td>7.11%</td>
<td>1211.28</td>
<td>5.0</td>
<td>32.10</td>
</tr>
<tr>
<td>A2 Cash &amp; short term</td>
<td>30.0</td>
<td>4.75%</td>
<td>30.00</td>
<td>0.1</td>
<td>0.09</td>
</tr>
<tr>
<td>A3 Commercial Mortgages</td>
<td>135.0</td>
<td>8.00%</td>
<td>143.10</td>
<td>4.3</td>
<td>6.75</td>
</tr>
<tr>
<td>A4 Derivative securities</td>
<td>0.0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>A5 Equities</td>
<td>18.8</td>
<td>1.00%</td>
<td>18.75</td>
<td>5.0</td>
<td>3.75</td>
</tr>
<tr>
<td>A6 Real Estate (unleveraged)</td>
<td>105.0</td>
<td>10.50%</td>
<td>105.00</td>
<td>4.0</td>
<td>15.75</td>
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<td><strong>Invested Assets Subtotal</strong></td>
<td>1462.5</td>
<td>7.31%</td>
<td>1508.1</td>
<td>4.8</td>
<td>58.4</td>
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<tr>
<td>A7 Accrued investment income</td>
<td>15.0</td>
<td>0.00%</td>
<td>15.00</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>A8 Policyholder Loans</td>
<td>0.0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>A9 Provision for asset default</td>
<td>0.0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>A10 Other</td>
<td>22.5</td>
<td>0.00%</td>
<td>22.50</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Total Assets</strong></td>
<td>1500.0</td>
<td>7.13%</td>
<td>1545.6</td>
<td>4.7</td>
<td>74.2</td>
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</table>

#### Liabilities

<table>
<thead>
<tr>
<th>Liability Description</th>
<th>Reported Book Value</th>
<th>Req Interest</th>
<th>PV Cash Flows</th>
<th>Effective Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1 Benefit liabilities</td>
<td>1500.0</td>
<td>5.90%</td>
<td>1575.00</td>
<td>4.7</td>
<td>15.00</td>
</tr>
<tr>
<td><strong>Total Liabilities</strong></td>
<td>1500.0</td>
<td>5.90%</td>
<td>1575.0</td>
<td>4.7</td>
<td>15.0</td>
</tr>
<tr>
<td>C PreTax Equity</td>
<td>0.0</td>
<td></td>
<td>-29.4</td>
<td>4.96</td>
<td></td>
</tr>
<tr>
<td>D Subtotal, tax and other adjustments</td>
<td>0.0</td>
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<td>-10.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Net Value (C-D)</strong></td>
<td>0.0</td>
<td></td>
<td>-19.1</td>
<td></td>
<td></td>
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</table>
### Institutional Pensions - Payout Annuity

<table>
<thead>
<tr>
<th>Assets</th>
<th>Reported Book Value</th>
<th>Book Yield</th>
<th>PV Cash Flows</th>
<th>Effective Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bonds (total)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1a Gov't</td>
<td>16.9</td>
<td>6.40%</td>
<td>17.26</td>
<td>10.4</td>
<td>0.08</td>
</tr>
<tr>
<td>A1b Public Corporate (Inv Grade)</td>
<td>135.4</td>
<td>7.20%</td>
<td>144.20</td>
<td>7.0</td>
<td>2.03</td>
</tr>
<tr>
<td>A1c Public Corporate (below Inv Grade)</td>
<td>33.9</td>
<td>7.60%</td>
<td>36.56</td>
<td>6.5</td>
<td>1.69</td>
</tr>
<tr>
<td>A1d Private Corporate (Inv Grade)</td>
<td>74.5</td>
<td>7.40%</td>
<td>80.06</td>
<td>6.7</td>
<td>1.49</td>
</tr>
<tr>
<td>A1e Private Corporate (below Inv Grade)</td>
<td>40.6</td>
<td>7.90%</td>
<td>44.28</td>
<td>6.0</td>
<td>2.84</td>
</tr>
<tr>
<td>A1f Pass-throughs</td>
<td>18.6</td>
<td>7.10%</td>
<td>19.55</td>
<td>4</td>
<td>0.56</td>
</tr>
<tr>
<td>A1g CMO's</td>
<td>18.6</td>
<td>7.30%</td>
<td>19.83</td>
<td>5</td>
<td>0.56</td>
</tr>
<tr>
<td>A1 Bonds Subtotal</td>
<td>338.5</td>
<td>7.33%</td>
<td>361.73</td>
<td>7.1</td>
<td>9.26</td>
</tr>
<tr>
<td>A2 Cash &amp; short term</td>
<td>14.0</td>
<td>4.75%</td>
<td>14.00</td>
<td>0.1</td>
<td>0.04</td>
</tr>
<tr>
<td>A3 Commercial Mortgages</td>
<td>286.0</td>
<td>8.75%</td>
<td>308.88</td>
<td>6.0</td>
<td>14.30</td>
</tr>
<tr>
<td>A4 Derivative securities</td>
<td>0.0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>A5 Equities</td>
<td>44.0</td>
<td>1.00%</td>
<td>44.00</td>
<td>7.0</td>
<td>8.80</td>
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<tr>
<td>A6 Real Estate (unleveraged)</td>
<td>0.0</td>
<td>10.50%</td>
<td>0.00</td>
<td>5.0</td>
<td>0.00</td>
</tr>
<tr>
<td>Invested Assets Subtotal</td>
<td>682.5</td>
<td>7.46%</td>
<td>728.6</td>
<td>6.7</td>
<td>32.4</td>
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<tr>
<td>A7 Accrued investment income</td>
<td>7.0</td>
<td>0.00%</td>
<td>7.00</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>A8 Policyholder Loans</td>
<td>0.0</td>
<td>7.00%</td>
<td>0.00</td>
<td>0.1</td>
<td>0.00</td>
</tr>
<tr>
<td>A9 Provision for asset default</td>
<td>0.0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>A10 Other</td>
<td>10.5</td>
<td>0.00%</td>
<td>10.50</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>A11 Total Assets</td>
<td>700.0</td>
<td>7.28%</td>
<td>746.1</td>
<td>6.5</td>
<td>32.4</td>
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<table>
<thead>
<tr>
<th>Liabilities</th>
<th>Reported Book Value</th>
<th>Req Interest</th>
<th>PV Cash Flows</th>
<th>Effective Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B1 Benefit liabilities</td>
<td>700 0</td>
<td>6.75%</td>
<td>759.50</td>
<td>7.3</td>
<td>2.00</td>
</tr>
<tr>
<td>B Total Liabilities</td>
<td>700.0</td>
<td>6.75%</td>
<td>759.5</td>
<td>7.3</td>
<td>2.0</td>
</tr>
<tr>
<td>C PreTax Equity</td>
<td>0.0</td>
<td></td>
<td>-13.4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Tax and Other Adjustments

| D1 Future tax payments | 0.0 | | -4.7 | |
| D2 Other adjustments | | | | |
| D Subtotal, tax and other adjustments | 0.0 | | -4.7 | |

| Net Value (C-D) | 0.0 | | -8.7 | |
### Institutional Pensions - GIC

#### Assets

<table>
<thead>
<tr>
<th></th>
<th>Reported Book Value</th>
<th>Book Yield</th>
<th>PV Cash Flows</th>
<th>Effective Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonds (total)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1a Gov't</td>
<td>71.6</td>
<td>5.60%</td>
<td>71.63</td>
<td>2.5</td>
<td>0.36</td>
</tr>
<tr>
<td>A1b Public Corporate (Inv Grade)</td>
<td>573.0</td>
<td>6.40%</td>
<td>584.46</td>
<td>2.8</td>
<td>8.60</td>
</tr>
<tr>
<td>A1c Public Corporate (below Inv Grade)</td>
<td>143.3</td>
<td>6.75%</td>
<td>146.83</td>
<td>3.0</td>
<td>7.16</td>
</tr>
<tr>
<td>A1d Private Corporate (Inv Grade)</td>
<td>315.2</td>
<td>6.80%</td>
<td>329.33</td>
<td>4.3</td>
<td>6.30</td>
</tr>
<tr>
<td>A1e Private Corporate (below Inv Grade)</td>
<td>171.9</td>
<td>7.30%</td>
<td>181.35</td>
<td>4.0</td>
<td>12.03</td>
</tr>
<tr>
<td>A1f Pass-throughs</td>
<td>78.8</td>
<td>6.80%</td>
<td>83.51</td>
<td>5.0</td>
<td>2.36</td>
</tr>
<tr>
<td>A1g CMO's</td>
<td>78.8</td>
<td>5.80%</td>
<td>79.58</td>
<td>1.3</td>
<td>2.36</td>
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<tr>
<td></td>
<td><strong>Bonds Subtotal</strong></td>
<td><strong>6.58%</strong></td>
<td><strong>1476.59</strong></td>
<td><strong>3.4</strong></td>
<td><strong>39.18</strong></td>
</tr>
<tr>
<td>A2 Cash &amp; short term</td>
<td>30.0</td>
<td>4.75%</td>
<td>30.00</td>
<td>0.1</td>
<td>0.09</td>
</tr>
<tr>
<td>A3 Commercial Mortgages</td>
<td>0.0</td>
<td>8.00%</td>
<td>0.00</td>
<td>5.0</td>
<td>0.00</td>
</tr>
<tr>
<td>A4 Derivative securities</td>
<td>0.0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>A5 Equities</td>
<td>0.0</td>
<td>1.00%</td>
<td>0.00</td>
<td>7.0</td>
<td>0.00</td>
</tr>
<tr>
<td>A6 Real Estate (unleveraged)</td>
<td>0.0</td>
<td>10.50%</td>
<td>0.00</td>
<td>5.0</td>
<td>0.00</td>
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<tr>
<td></td>
<td><strong>Invested Assets Subtotal</strong></td>
<td><strong>5.54%</strong></td>
<td><strong>1506.7</strong></td>
<td><strong>3.4</strong></td>
<td><strong>39.3</strong></td>
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<tr>
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<td>0.00%</td>
<td>15.00</td>
<td>0.0</td>
<td>0.00</td>
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<tr>
<td>A8 Policyholder Loans</td>
<td>0.0</td>
<td>7.00%</td>
<td>0.00</td>
<td>0.1</td>
<td>0.00</td>
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<tr>
<td>A9 Provision for asset default</td>
<td>0.0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.0</td>
<td>0.00</td>
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<tr>
<td>A10 Other</td>
<td>22.5</td>
<td>0.00%</td>
<td>22.50</td>
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<td>0.00</td>
</tr>
<tr>
<td><strong>A11 Total Assets</strong></td>
<td><strong>1500.0</strong></td>
<td><strong>6.38%</strong></td>
<td><strong>1544.2</strong></td>
<td><strong>3.3</strong></td>
<td><strong>39.3</strong></td>
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</tbody>
</table>

#### Liabilities

<table>
<thead>
<tr>
<th></th>
<th>Reported Book Value</th>
<th>Req Interest</th>
<th>PV Cash Flows</th>
<th>Effective Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1 Benefit liabilities</td>
<td>1500.0</td>
<td>6.60%</td>
<td>1537.50</td>
<td>3.1</td>
<td>7.50</td>
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<tr>
<td><strong>B Total Liabilities</strong></td>
<td><strong>1500.0</strong></td>
<td><strong>6.60%</strong></td>
<td><strong>1537.5</strong></td>
<td><strong>3.1</strong></td>
<td><strong>7.5</strong></td>
</tr>
</tbody>
</table>

#### C PreTax Equity

|                     | 0.0 | 6.7 |

#### Tax and Other Adjustments

|                     | 0.0 | 2.3 |

#### D Subtotal, tax and other adjustments

|                     | 0.0 | 2.3 |

#### Net Value (C-D)

|                     | 0.0 | 4.4 |
### Group Business

<table>
<thead>
<tr>
<th>Assets</th>
<th>Reported Book Value</th>
<th>Book Yield</th>
<th>PV Cash Flows</th>
<th>Effective Duration</th>
<th>Req Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonds (total)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1a Gov't</td>
<td>35 0</td>
<td>6.00%</td>
<td>35 00</td>
<td>8.9</td>
<td>0.18</td>
</tr>
<tr>
<td>A1b Public Corporate (Inv Grade)</td>
<td>225 0</td>
<td>6.70%</td>
<td>237 38</td>
<td>12.0</td>
<td>3.38</td>
</tr>
<tr>
<td>A1c Public Corporate (below Inv Grade)</td>
<td>60 0</td>
<td>7.20%</td>
<td>63 30</td>
<td>5.0</td>
<td>3.00</td>
</tr>
<tr>
<td>A1d Private Corporate (Inv Grade)</td>
<td>50 0</td>
<td>6.80%</td>
<td>52 75</td>
<td>8.0</td>
<td>1.00</td>
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<tr>
<td>A1e Private Corporate (below Inv Grade)</td>
<td>25 0</td>
<td>7.30%</td>
<td>26 38</td>
<td>6.0</td>
<td>1.75</td>
</tr>
<tr>
<td>A1f Pass-throughs</td>
<td>90 0</td>
<td>6.80%</td>
<td>94 50</td>
<td>3.9</td>
<td>2.70</td>
</tr>
<tr>
<td>A1g CMO's</td>
<td>35 0</td>
<td>6.70%</td>
<td>37 10</td>
<td>4.5</td>
<td>1.05</td>
</tr>
<tr>
<td>A1 Bonds Subtotal</td>
<td>520 0</td>
<td>6.77%</td>
<td>546 40</td>
<td>8.8</td>
<td>13.05</td>
</tr>
<tr>
<td>A2 Cash &amp; short term</td>
<td>15 0</td>
<td>4.75%</td>
<td>15 00</td>
<td>0.1</td>
<td>0.05</td>
</tr>
<tr>
<td>A3 Commercial Mortgages</td>
<td>50 0</td>
<td>8.00%</td>
<td>53 75</td>
<td>5.0</td>
<td>2.50</td>
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<tr>
<td>A4 Derivative securities</td>
<td>0.0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>A5 Equities</td>
<td>5.0</td>
<td>1.00%</td>
<td>5.00</td>
<td>7.0</td>
<td>1.00</td>
</tr>
<tr>
<td>A6 Real Estate (unleveraged)</td>
<td>25 0</td>
<td>10.50%</td>
<td>25 00</td>
<td>5.0</td>
<td>3.75</td>
</tr>
<tr>
<td>Invested Assets Subtotal</td>
<td>615 0</td>
<td>6.92%</td>
<td>645.2</td>
<td>8.2</td>
<td>20.3</td>
</tr>
<tr>
<td>A7 Accrued investment income</td>
<td>6 3</td>
<td>0.00%</td>
<td>6.31</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>A8 Policyholder Loans</td>
<td>0.0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.1</td>
<td>0.00</td>
</tr>
<tr>
<td>A9 Provision for asset default</td>
<td>0.0</td>
<td>0.00%</td>
<td>0.00</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>A10 Other</td>
<td>9.5</td>
<td>0.00%</td>
<td>9.46</td>
<td>0.0</td>
<td>0.00</td>
</tr>
<tr>
<td>A11 Total Assets</td>
<td>630.8</td>
<td>6.75%</td>
<td>660.9</td>
<td>8.0</td>
<td>24.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Liabilities</th>
<th>Reported Book Value</th>
<th>Req Interest</th>
<th>PV Cash Flows</th>
<th>Effective Duration</th>
<th>Req Capital</th>
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</thead>
<tbody>
<tr>
<td>B1 Benefit liabilities</td>
<td>630 8</td>
<td>5.90%</td>
<td>624.00</td>
<td>6.5</td>
<td>125.00</td>
</tr>
<tr>
<td>B Total Liabilities</td>
<td>630.8</td>
<td>5.90%</td>
<td>624.0</td>
<td>6.5</td>
<td>125.0</td>
</tr>
<tr>
<td>C PreTax Equity</td>
<td>30.8</td>
<td></td>
<td>36.9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Tax and Other Adjustments

| D Subtotal, tax and other adjustments | 10.8              | 12.9          |

| Net Value (C-D)                     | 20.0              | 24.0          |
APPENDIX B

ASSET LIABILITY MANAGEMENT
POLICY STATEMENT

I. Overall Objective for the ALM Function
ALM is the ongoing process of formulating, implementing and monitoring strategies with respect to assets and liabilities to attain our financial objectives for a given set of risk tolerances and constraints.

As with all financial services companies, risk is an inherent part of doing business. Over the normal course of business LifeCo is exposed to credit risk, interest rate risk, foreign exchange rate risk, off-balance sheet risk, pricing risk, liquidity risk, as well as other various market risks. ALM is a vital ongoing process that requires the management of all these risks.

The principal risk management objectives are to eliminate excessive and unacceptable risk and optimize the risk/return profile of the total company. A key focus of the ALM function at LifeCo is interest rate risk.

As a result of timing differences in the repricing of assets and liabilities, fluctuations in market interest rates can affect both accounting earnings and the market value of assets, liabilities and off-balance sheet items and hence the economic value and net worth of LifeCo. The objectives in managing interest rate risk are to:

- Maximize the value of LifeCo's stock subject to stated risk tolerances and constraints (see ALM Guidelines).
- Support the achievement of business strategies while protecting earnings and liquidity.
- Minimize the potential for significant loss as a result of changes in interest rates.
- Manage interest rate risk of current and future earnings to a level that is consistent with the mix of businesses and that limits such exposure to a percentage of the book value of assets.

A key focus of the ALM function at LifeCo is market risk. Market risk arises whenever financial results can be adversely affected by changes in the equity markets. The most extreme exposure to market risk occurs when investment guarantees are offered. The risk exposure associated with these guarantees is managed by using a dynamic delta hedging strategy.

Liquidity risk is the risk that LifeCo will be unable to maintain cash flows that are adequate to fund its operations and meet all present and future financial obligations on a timely and cost effective basis.

A separate Liquidity Policy details the management of LifeCo's liquidity risk.
Foreign exchange rate risk arises whenever future payments are expected in a foreign currency. A loss occurs if there is an appreciation (in the case of foreign dollars owed) or depreciation (in the case of foreign dollars due) of the local currency relative to the foreign currency. The objective is to eliminate any foreign exchange rate risk. This is accomplished through the use of currency swaps.

Credit risk includes the risk of default on scheduled payments of either interest or principal. Credit quality guidelines are determined by the Investment Department of LifeCo, approved by the Board of Directors and are specified in the Investment Policy. The credit quality of the assets is monitored by the Investment Department of LifeCo and reported to the Board of Directors.

Off-balance sheet risk refers to the risk associated with derivative instruments. The Operational Guidelines for Use of Derivatives provides control procedures and details the management of LifeCo’s exposure to derivatives risk.

II. ALM Process
The ALM process consists of four fundamental steps:

Identify the level of risk exposure
It is a requirement that at all times the exposure to all risks be quantified. This is accomplished by regular measurement and monitoring of the exposure to various risks.

Decide whether the risk exposure is appropriate
The purpose of ALM is not necessarily to eliminate or even minimize risk. The level of risk will vary with the return requirement and financial objectives. Return objectives and risk tolerances are determined by LifeCo and reviewed from time to time.

Modify the existing risk
This is accomplished by rebalancing the portfolio or through the use of interest rate swaps, currency swaps or other hedging techniques to offset risk.

Optimize the risk/return profile of the business
For a given level of risk, financial objectives are maximized. Optimization ensures that portfolios lie on the risk/return efficient frontier for LifeCo’s stated return objectives, risk tolerances and constraints.

III. ALM Committee Purpose
Risk tolerances are determined by the ALM Committee and approved by the Board of Directors. Asset/liability management strategies as well as the policies and guidelines for the management of the aforementioned risks are established by the ALM committee. The ALM committee discusses limits on potential earnings fluctuations that could arise from interest rate risk as well as on- and off- balance sheet accrual positions. The ALM committee monitors exposures in view of market developments and LifeCo’s financial condition, provides guidance for interest rate risk management decisions and monitors
liquidity and capital adequacy. ALM policy is established by the ALM Committee, reviewed by the Board of Directors at least annually and is implemented by the Investment Department in conjunction with the Corporate Actuarial Department and the Finance division.

IV. ALM Committee Composition/Frequency of Meetings
The ALM committee meets monthly and consists of the CEO, CFO, Chief Actuary, CIO, VP Risk Management and includes representation from functional areas as appropriate. Committee proceedings are chaired and recorded by the VP Risk Management.

V. ALM Guidelines
LifeCo’s exposure to interest rate risk is quantified by calculating price sensitivity statistics such as effective duration, dollar duration, convexity, partial durations, delta, and by performing scenario testing and cash flow analysis. A pure dedication strategy of matching asset and liability cash flows is widely recognized as costly, unnecessary and would not be appropriate for LifeCo. Negative net cash flows are identified and assessed from a liquidity perspective only. Exposure to interest rate risk is monitored for each product line and for all major products. Although ALM is performed at both the product and product line level, specific guidelines are set for Accumulation Annuities in total, Traditional Life Products in total, Non-Traditional Life Products in total and total company surplus.

(a) Accumulation Annuities

Dollar Duration of Assets less Dollar Duration of Liabilities
< 30% x book value of assets

Partial Duration Sensitivity
< 0.02% x book value of assets for any and all partial durations

Worst Case Scenario at 95% Confidence Level
< 0.50% x book value of assets

(b) Variable Annuities

Delta of liability less delta of assets
<10% of delta of liability

Gamma
Unhedged

Vega
Unhedged

Rho
<5% of rho of liability

(Rho of liability less rho of assets)
(c) Traditional Life Products

Dollar Duration of Assets less Dollar Duration of Liabilities < 100% x book value of assets

Partial Duration Sensitivity < 0.10% x book value of assets for any and all partial durations

Worst Case Scenario at 95% Confidence Level < 5.00% x book value of assets

(d) Non-Traditional Life Products

Dollar Duration of Assets less Dollar Duration of Liabilities < 100% x book value of assets

Partial Duration Sensitivity < 0.10% x book value of assets for any and all partial durations

Worst Case Scenario at 95% Confidence Level < 5.00% x book value of assets

(e) Institutional Pension - Payout

Dollar Duration of Assets less Dollar Duration of Liabilities < 100% x book value of assets

Partial Duration Sensitivity < 0.10% x book value of assets for any and all partial durations

Worst Case Scenario at 95% Confidence Level < 5.00% x book value of assets

(f) Institutional Pension - GIC

Dollar Duration of Assets less Dollar Duration of Liabilities < 30% x book value of assets

Partial Duration Sensitivity < 0.02% x book value of assets for any and all partial durations

Worst Case Scenario at 95% Confidence Level < 2.00% x book value of assets

(g) Group Business

Dollar Duration of Assets less < 100% x book value of assets
Dollar Duration of Liabilities

Partial Duration Sensitivity < 0.1% x book value of assets for any and all partial durations

Worst Case Scenario at 95% Confidence Level < 5.00% x book value of assets

(h) Total Company

Dollar Duration of Assets less Dollar Duration of Liabilities < 100% x book value of assets

Partial Duration Sensitivity < 0.05% x book value of assets for any and all partial durations

Worst Case Scenario at 95% Confidence Level < 2.00% x book value of assets

(i) Surplus

Dollar Duration of Actual Assets less Dollar Duration of Benchmark < 100% x book value of assets

Where the effective duration of the benchmark is assumed to be 10 years and the present value of the benchmark is assumed equal to the present value of the assets.

In order to ensure that the above guidelines are met for each product line, it may be necessary to rebalance the portfolio by trading assets or through the use of financial engineering. Rebalancing is performed periodically for Accumulation Annuities and for Life Products. In addition to meeting the above guidelines, for rebalancing purposes, each asset segment should have assets that do not exceed the liabilities by more than +/- $2,000,000.

The Investment Department has discretion to position the portfolio within the above guidelines.
ASSET LIABILITY MANAGEMENT
PROCEDURE MANUAL

I. Reporting

Corporate Actuarial reports on LifeCo’s ALM position to the Investment Department and the ALM Committee on a quarterly basis. For Accumulation Annuities the ALM position is monitored on a weekly basis and reflects all asset commitments from the time at which they are priced. Corporate Actuarial reports on LifeCo’s ALM position to the Board of Directors at each of its meetings.

The quarterly reports include a discussion of exposure to interest rate risk, changes in market interest rates during the period, the results of scenario testing and various technical notes. Attached to the report are the following:
• price sensitivity statistics including effective duration, dollar duration, convexity, and partial duration sensitivity analysis
• cash flow analysis
• a comparison of the mismatch provision for the past 12 months
• book values and market values of assets and liabilities
• a comparison of the term structure of interest rates for the current and prior periods

Appendix D contains a sample ALM report

II. Allocation of Asset Commitments

Status of Commitments
Portfolio management prepares a weekly report on the status of asset commitments which contains information on the following stages of commitment:
1. Under Review/Negotiation
2. Under Application/Recommended for Investment
3. Internal Approval - Not Yet Committed
4. Committed - Not Yet Priced
5. Priced
6. Funded

Allocation of Commitment to Product Lines
Once an asset reaches the committed stage, Portfolio Management reviews each of the product line portfolios in terms of the liability characteristics and ALM guidelines and allocates the commitment to the most suitable product line. Once an asset reaches the committed stage the Investment Department will determine whether a hedge transaction will be needed between the time the commitment is priced and the time it is funded.

Determination of Method of Funding
The committed asset is added to the portfolio for purposes of measuring exposure to interest rate risk. Portfolio management examines the impact of various funding alternatives and recommends the purchase of asset(s) that optimizes the portfolio with respect to LifeCo’s financial objectives within the approved ALM guidelines.
Priced Commitments
Committed assets are not reflected for ALM purposes until they become priced. Until this point there is no exposure to interest rate risk. If a hedge transaction was previously deemed necessary, it will be affected once the asset becomes priced.

III. Hedging

Measurement
A hedge is the assumption of an additional risk exposure that offsets an existing risk. The intended effect of a hedge is to reduce the overall portfolio risk (e.g. currency or interest rate risk). Thus the impact on the overall risk exposure of the portfolio is examined for all hedges. Although hedges are examined at the portfolio level, care must be taken to ensure that any derivatives transactions are appropriately arranged to qualify for hedge accounting treatment where intended.

IV. Priced Commitments
A newly priced commitment will add exposure to interest rate risk to a portfolio. Before a hedge is affected for this transaction the overall impact on the portfolio must be examined.

V. Portfolio Rebalancing
From time to time, portfolio rebalancing will be required to keep the assets in balance with the liabilities and in accordance with ALM guidelines specified in the ALM Policy Statement. Formally, all portfolios are reviewed quarterly with the exception of the Accumulation Annuities portfolio that is reviewed monthly. Optimization is also performed in order to maximize LifeCo’s expected returns subject to its risk tolerances and constraints. Portfolio rebalancing and optimization may involve asset trades and/or the use of financial engineering. Any asset transfer between asset segments must be done at market value and requires the physical sale and purchase of assets. Transfers at book value are strictly prohibited.

VI. Interest Rate Sensitivity
A number of tools are used to measure the interest rate sensitivity of the assets and liabilities.

Effective duration provides a measure of the interest rate sensitivity in percentage terms of the market value of the assets and liabilities for a parallel change in interest rates. For example, if the effective duration of an asset is 4, then for a 100 basis point increase in interest rates the market value of the asset will decline by approximately 4%. Effective duration will explicitly recognize interest sensitive cash flows whenever a suitable model is available, otherwise expected cash flows will be used.

Dollar duration provides a measure of the interest rate sensitivity in dollar terms of the market value of the assets and liabilities for a parallel change in interest rates. For example, if the dollar duration of assets is $100 million greater than the dollar duration of liabilities, then for a 100 basis point increase in interest rates for all terms to maturity
across the yield curve, the market value of assets will decrease by approximately $1 million more than the market value of liabilities. The measurement of dollar duration is consistent with effective duration.

**Convexity** measures the rate of change of effective duration. Effective duration only provides an approximation of the price sensitivity to changes in interest rates. The precision of the approximation deteriorates as the change in interest rates increases. Including convexity improves the approximation. In general, assets with greater convexity are more desirable than assets with less convexity. This is because as interest rates decrease the increase in the market value of the assets increases at a faster rate. Conversely, as interest rates increase the rate of decrease in the market value of the assets decreases. It is therefore desirable to have assets which have higher convexity than the liabilities.

**Partial durations** provide measures of the interest rate sensitivity in percentage terms of the market value of the assets and liabilities for a change in each portion of the yield curve. The sum of partial durations is equal to the effective duration described above.

**Partial duration sensitivity** measures the impact on market value of changes in interest rates at various terms to maturity along the yield curve. It is a dollar duration type of calculation using partial durations. This is a valuable tool as interest rates seldom move in a parallel fashion.

**Cash flow analysis** assumes no renewal or reinvestment of cash flows and must be interpreted with care. It is not necessary or advisable to be perfectly cash flow matched; however, large net cash outflows must be considered in the context of liquidity available in the portfolio.

**Scenario testing** is performed on a deterministic basis and involves measuring the sensitivity of economic value to both parallel and non-parallel yield curve shifts.

**Asset Quality**
Credit quality guidelines are contained in the Investment Policy and specify maximum holdings of individual credits for new purchases (these maximums decline as credit quality declines). The guidelines also specify an average quality constraint on the total portfolio. It is the philosophy of LifeCo that the credit risk exposure of the Company's assets should be highly diversified, actively managed, and under continuous review by the Investment Department. The ALM committee will be informed by the Investment Department of the credit risk exposure of the Company's assets to monitor compliance with the credit quality guidelines.

**VII. Liquidity**
Cash flow analysis is performed which provides an indication of the potential liquidity requirements of the portfolio. In addition, asset mix is monitored with respect to renewal and surrender experience to ensure that sufficient liquid assets exist to meet anticipated cash outflow requirements.
VIII. Capital Adequacy
Target capital is 150% of regulatory capital required.

IX. Profitability
Profitability is measured in terms of return on total company surplus. Economic value is the central focus of ALM, with the impact on GAAP income a constraint.

X. Specific Responsibilities

ALM Committee
The ALM Committee is responsible for overall policy formulation as detailed in the Policy Statement. The ALM Committee is also responsible for monitoring the ALM position of LifeCo and reporting whether all guidelines are being adhered to.

ALM Sub-Committees
Portfolio Rebalance Subcommittee
All asset trades affect the statutory reserve and mismatch provision under GAAP, the measurement of profitability, the economic value of surplus, partial duration sensitivity, capital requirements and the return on capital. In addition to determining whether a trade increases the yield to maturity - or even the total rate of return - of a portfolio, the aforementioned considerations need to be taken into account whenever any asset trade is contemplated. The function of this subcommittee is to examine portfolio changes, quantify the impact of derivatives and asset trades, monitor and measure the exposure to interest rate and other risks and perform optimization of all portfolios. This subcommittee meets a minimum of once per quarter and consists of a representative from the Investment Department, Corporate Actuarial and Finance.

Rate Setting Subcommittee
The function of this subcommittee is to determine crediting rates for both Life and Accumulation Annuities. This subcommittee meets weekly and consists of a representative from the Investment Department, Corporate Actuarial, Finance, Marketing Actuarial and Accumulation Annuities Marketing.

Product Managers
The Life and Investment Product vice-presidents are responsible for the execution of business strategies decided at ALM Committee.

Corporate Actuarial
Corporate Actuarial is responsible for monitoring ALM policy to see whether ALM guidelines are adhered to. Corporate Actuarial projects asset and liability cash flows, calculates all price sensitivity statistics, performs partial duration sensitivity analysis and scenario testing, and determines reserves and mismatch provisions. Corporate Actuarial assists the Investment Department in the selection of asset trades and the use of financial engineering.
Investment Department

The Investment Department is responsible, with input from Corporate Actuarial, for the determination and execution of all trades, financial engineering and hedging strategies in accordance with the guidelines specified in the ALM Policy Statement. The Investment Department communicates all transactions including forward commitments to Finance and Corporate Actuarial and distributes a quarterly report on the status of mortgage and private placement commitments and related hedging arrangements.

Finance

Finance is responsible for recording all transactions and keeping the asset accounting system up to date. Finance provides electronic files of bonds and private placements on a quarterly basis.
OPERATIONAL GUIDELINES FOR USE OF DERIVATIVES

I. Overview
LifeCo, by the nature of its business activities and products, is routinely exposed to risks such as those described in sections V through VIII.

LifeCo portfolio managers purchase derivatives to manage the risks that are identified by the liability product managers, Finance, and/or Corporate Actuarial. Derivatives may not be purchased for speculative purposes.

The guiding principle in the use of derivatives is that LifeCo is a limited end-user acting primarily to reduce risk. Strategies that involve the writing of options by LifeCo are specifically excluded, with the exception of options embedded in LifeCo’s products or issued company debt.

II. Definition of Derivatives
For purposes of these guidelines, derivatives are defined as contracts that the company enters into with a counterparty, where the contract value derives from the value of an underlying asset or underlying reference rate or index. Such indices include, but are not limited to, LIBOR, U.S. Treasury instruments, and the S&P 500 index. This definition of derivatives includes instruments as described in section IX. This definition does not include asset classes such as mortgage-backed securities, collateralized mortgage obligations, asset-backed securities, and other structured assets that are treated as bonds for statutory accounting and regulatory purposes.

III. Responsibilities
The ALM Committee is responsible for reviewing the type and amount of each derivative purchase. The Investment Department is responsible for the purchase of derivatives. The Finance Department is responsible for derivatives accounting and reporting. The ALM Committee is responsible for all board reports relating to derivatives activity.

IV. Objectives
The primary objective of derivatives use at LifeCo is to reduce potential volatility in the future operating income of the lines of business. Depending on the source of the volatility and the type of derivative purchased, the derivative may reduce both upside and downside earnings volatility, or may reduce only downside earnings volatility.

V. Business Exposures Managed
LifeCo’s life insurance and accumulation annuity products have minimum interest guarantees. In an extended period of low interest rates, profit margins would be reduced, and possibly even be negative.
The life insurance and accumulation products allow surrenders at book value, possibly with a book value surrender charge. In periods of rapidly rising interest rates, the assets backing these products would not support a credited rate that is competitive with new money rates. If the company chose to maintain competitive credited rates, then profit margins would be reduced or even be negative. If the company chose to maintain profit margins with an uncompetitive credited rate, then policy surrenders could increase, leading to a loss of future profit margins and market value losses on asset sales to pay the surrender benefits.

LifeCo’s equity-linked GIC credits a rate that is linked to the performance of the S&P 500 equity index. This product also guarantees the return of principal. LifeCo’s investments need to meet both of these guarantees.

LifeCo’s variable annuities contain a GMDB benefit. This benefit exposes the company to equity market risk. In an extended period of low or negative equity market returns, death claims may be greater than the corresponding account values of the variable annuities. This risk is managed through a dynamic delta hedging strategy. The company matches the delta on its variable annuity block to the delta of a book of S&P 500 futures. The futures position is updated weekly for changes in the inforce as well as changes in the market and the fund returns relative to the market. The gamma and vega are unhedged.

VI. Mismatch risk
The company’s assets and liabilities are not cash flow matched. In time periods where the company’s asset cash flows exceed the liability cash flows, there is reinvestment risk. For example, the assets allocated to the payout annuity business are shorter than the liability cash flows. Since the payout annuity benefits cannot be changed, reinvestment risk would be realized if interest rates were low at the time of the asset reinvestment.

In time periods where the company’s liability cash flows exceed the asset cash flows, there is funding risk. For example, if assets have to be sold to pay excess benefits at a time when interest rates are high, market value losses will be realized on the asset sales. There is also potential mismatch risk in LifeCo’s equity-linked GIC. If the assets allocated to this business do not match the performance guarantee relative to the S&P 500 index, then the profits may vary substantially from the product’s pricing assumption.

VII. Mortgage commitment risk
LifeCo’s Investment Department commits to funding commercial mortgage loans weeks in advance of disbursing funds for the loan. These commitments require a loan rate to be locked in at that time for the mortgage. If interest rates rise between this commitment date and the disbursement date, then the earned rate on these assets acquired on the disbursement date will be lower than the earned rates that the liability pricing areas would expect the Investment Department to be able to achieve in then current interest rate environment.
VIII. Foreign exchange risk
The Investment Department may invest in assets denominated in foreign currencies. In addition, the funding agreement program produces future liability cash flows denominated in more than one currency. As currency exchange rates fluctuate, the value of LifeCo’s investment income and operating income will also fluctuate unless the currency risk is hedged.

IX. Approved Derivative Classes
The Board of Directors has currently approved the purchase, subject to the guidelines detailed below, of the types of derivatives listed below. Derivatives not in these categories may be purchased only with the prior approval of both the Chief Investment Officer and Chief Executive Officer of LifeCo.

**Interest rate swaps**: interest rate swaps are bilateral agreements between LifeCo and a counterparty to exchange a series of cash flows at specified intervals. The cash flows may be fixed or floating. Floating-rate cash flows would be calculated based on a set formula and reference index. Swap terms and conditions such as a reference index, frequency of payments, expiry date of the contract, and notional amount of the contract are set at the time of the swap purchase.

**Government bond futures**: a futures contract obligates its owner to buy a specified amount of a specified government bond at a specified price on a specified date. These contracts are used by LifeCo in either “long” positions (an agreement to buy a government bond) or “short” positions (an agreement to sell a government bond). Futures contracts are entered into directly with an exchange clearinghouse.

**Purchased options on government bond futures**: these options give LifeCo the right, but not the obligation, to buy (or sell, depending on the type of option) government bond futures at a set price on a set future date. These options allow LifeCo to benefit from favorable price movements in government bond futures. LifeCo’s loss on unfavorable price movements is limited to the premium paid to purchase the option.

**Forward rate agreements**: these agreements are similar to the futures described above, but they are negotiated with other financial institutions rather than an exchange clearinghouse. They are agreements that a certain interest rate will apply to a certain principal amount for a certain time period in the future.

**Foreign currency swaps**: these are bilateral agreements between LifeCo and a counterparty whereby interest and principal in one currency are exchanged for interest and principal in another currency.

**Foreign currency forward rate agreements**: forwards are transacted over-the-counter, typically with a domestic Schedule I bank. LifeCo agrees to buy or sell a specific amount of foreign currency at a specified rate of exchange on a specified date.

**Foreign currency futures**: LifeCo agrees to buy or sell a specific amount of foreign currency at a specified rate of exchange on a specified date. The actual currency
transaction being hedged seldom coincides with the maturity of the futures contract. The futures are usually sold prior to maturity and the gain or loss on the contract is used to offset the increase or decrease in the value of the currency transaction being hedged.

**Purchased interest rate caps and floors:** interest rate caps protect LifeCo in rising interest rate environments by paying the excess, if any, of a prevailing reference rate at a future date over the strike rate in the contract. The contract has a set notional amount, maturity date, payment dates, and reference rate. Since only positive differences are paid to LifeCo, LifeCo’s only outlay is the premium paid for the cap. Interest rate floors are similar to caps, but protect LifeCo in falling rate environments by paying the excess, if any, of the contract’s strike rate over the prevailing reference rate at a future date.

**Equity index futures:** LifeCo agrees to buy or sell the value of the S&P 500 index on a specified maturity date. The futures are usually sold prior to maturity and the gain or loss on the contract is used to offset the increase or decrease in the value of the variable annuity block. Each futures contract is for $250 times the S&P 500 index.

**Equity index options:** European-type call options on the S&P 500 index give LifeCo a payment at maturity equal to the excess, if any, of the value of the index over the option’s strike price. Each call option contract is for $100 times the value of the index. LifeCo’s only outlay is the premium paid for the call option.

**Credit Default Swaps:** These contracts establish an economic value for transferring credit risk between parties in isolation from other risks (such as interest rate, market price, and foreign currency). They allow investors to hedge credit risk by buying credit protection or assume credit risks on individual names or a basket of securities to enhance yield and diversification. The elements of such contracts include: counterparty, notional, reference entity (whose credit risk is transferred), obligation (class of debt instruments whose credit risk is transferred), credit event (event triggering payment), premium fee (payable for the protection), maturity (or tenor) of the swap, and settlement (details of how the protection buyer is paid on the occurrence of a credit event).

**Swaptions:** These are options on interest rate swaps, which give LifeCo the right to enter into a certain interest rate swap at a certain time in the future. A receiver (or call) swaption is such a contract in which LifeCo has purchased the right to enter into a receive-fixed rate swap for a specified period at a predetermined option exercise date in the future, while a payer (or put) swaption is a contract in which LifeCo has purchased the right to enter into a pay-fixed rate swap. These instruments may be used as alternatives to purchasing interest rate floors and caps as hedges in falling or rising rate scenarios.

**Spread Locks:** Spread locks may be used as a hedge against the risk of corporate and swap spreads widening that may result from the flattening of the yield curve. A typical application would be in the case of an investor’s concern with the spread exposure resulting from a high allocation to credit-sensitive securities. The contract has a set notional, maturity date, spread lock, and the tenor (or maturity) of the interest rate index whose spread is being measured. The payoff from this instrument is equal to the notional

30
times the duration of the interest index times the spread difference between the actual spread level and the spread lock.

X. Acquisition of Derivatives
Interest rate swaps may be entered into in combination with a floating rate asset to achieve a fixed rate of return. The procedures and policies are then the same as the procedures and policies for acquiring fixed rate assets. If an interest rate swap is used for other ALM purposes, the ALM Committee must submit a written request to the Investment Department.

Purchases of interest rate caps and floors and equity options must be in the form of a written request from the ALM Committee to the Investment Department. The Investment Department must obtain a minimum of two quotes from approved counterparties.

XI. Transaction Approval
Each derivative purchase will result in a written sheet with the terms and conditions (the "confirmation sheet") of that derivative. This sheet must be signed by the Investment Department employee responsible for that purchase.

XII. Exposure Limits
The net market value exposure of all interest rate and currency swaps with any one counterparty will not exceed $250 million. The market value of all equity call options with any one counterparty will not exceed $100 million. The market value of all interest rate caps and floors with any one counterparty will not exceed $100 million.

XIII. Transaction Documentation and Control Procedures
Each derivative purchase results in a confirmation sheet (see section XI). A copy of this sheet is sent by the Investment Department to the Finance Department. The Finance Department maintains a file for all derivatives. The Finance Department documents all payments made and received under swap contracts and verifies the calculation of these payments. The Finance Department also verifies the amounts of payments, if any, due from the counterparty on all caps and floors each time a payment, if any, is due. The Vice President of Finance reviews and initials all of these payment calculations.

XIV. Accounting and Disclosure
LifeCo will follow all required accounting practices for derivatives and disclose the balance sheet effect of derivatives in all shareholder reports and other required reports for securities regulators.

XV. Communication of Purchases
The Board of Directors will be notified of each derivative purchase at the next scheduled board meeting following such purchase.

XVI. Approved Counterparties
Counterparties must have a credit rating of at least BBB from Mud & Poor's Agency. LifeCo must have a master ISDA agreement signed with the counterparty prior to the
derivative purchase. Each agreement is subject to the approval of LifeCo’s Secretary and General Counsel.

XVII. Market Valuation
Each December 31st, the Investment Department will obtain market valuations for each derivative from the counterparty for that derivative. A report showing the market values and market values from the prior December 31st will be provided to the ALM Committee.

XVIII. Administration
All derivatives will be maintained where possible on LifeCo’s Investment Administration System. If a derivative cannot be administered on this system, it will be identified in an exception report, which will be submitted by the Finance Department to the ALM Committee each December 31st. This report will show, for each derivative not administered on the Investment Administration System, the type of derivative, the counterparty, the purchase date, the notional amount, and the current market value as provided by the Investment Department.

XIX. Sample Term Sheets

Term Sheet for a Credit Default Swap:

Counterparties: Party A (Buyer of Credit Protection)  
Party B (Seller of Credit Protection)

Notional Amount: $10,000,000

Reference Entity: Entity / obligor whose credit risk is to be transferred  
(e.g., IBM, GM, US corporate index)

Obligation: Class of debt instruments whose credit risk is transferred  
(e.g., senior unsecured long-term debt obligations)

Credit Event: Bankruptcy, failure to pay coupon or principal on time, or a Restructuring

Premium Due: 140 basis points

Maturity (or Tenor): 5 Years

Settlement: Physical delivery or cash settlement

Term Sheet for a Spread Lock

Counterparties: Party A (Buyer of Spread Protection)  
Party B (Seller of Spread Protection)

Notional Amount: $10,000,000
Maturity: "N" Years

Interest Index: Index whose spread is being measured (e.g., 5-year Constant Maturity Swap, 10-year Baa corporate index)

Spread Lock: 150 basis points

**Term Sheet for a Swaption:**

| Counterparties | Party A (Floating Rate Payer)  
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Party B (Fixed Rate Payer)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of Swaption</th>
<th>Receiver or Payer Swaption</th>
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<table>
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<table>
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<table>
<thead>
<tr>
<th>Fixed Rate</th>
<th>Predetermined fixed rate (or strike rate)</th>
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**Fixed Rate Payment Frequency:**

| Semi-annual, 30/360 basis |

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<tr>
<th>Floating Rate</th>
<th>3-month Libor flat</th>
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**Floating Rate Payment Frequency:**

| Quarterly, 30/360 basis |

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<th>Some date in the future</th>
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<table>
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<th>Option Cost</th>
<th>Upfront cost in basis points or Annual cost in basis points</th>
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<table>
<thead>
<tr>
<th>Settlement</th>
<th>Physical delivery or Cash Settlement</th>
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APPENDIX D

Asset Liability Management Report for
December 31, 2000

This report details the ALM position for all of LifeCo’s products and focuses on the company’s exposure to interest rate risk. The ALM guidelines specified in the company’s ALM Policy Statement and Procedure Manual reflect the company’s tolerance to interest rate risk.

Interest Rates

**Risk Free (Government) Spot Rate Curve**

**Implied Forward Curve**

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### Stress Scenario #3 Forward Rates

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Baa Corporate Spreads

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<th>Nominal Spreads Over Treasuries of Comparable Maturity</th>
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Summary of ALM Position
At December 31, significant mismatches existed in the Life and Group Benefit portfolios, all other portfolios were within the guidelines specified in the ALM Policy Statement and Procedure Manual. Various ways are being investigated to reduce asset liability mismatches. It is anticipated that extensive rebalancing of the affected asset portfolios will be required. A summary of the ALM position for LifeCo follows.
<table>
<thead>
<tr>
<th></th>
<th>Book Value ('000)</th>
<th>Present Value ('000)</th>
<th>Effective Duration</th>
<th>Dollar Duration ('000)</th>
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<tr>
<td>Difference</td>
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<td>243,020</td>
<td></td>
<td></td>
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<tr>
<td>Guideline</td>
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<td></td>
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<td><strong>TOTAL COMPANY</strong></td>
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ACCUMULATION ANNUITIES

Effective Duration (Price Sensitivity to Parallel Shifts in the Yield Curve)
The effective duration of assets is longer than the duration of liabilities by less than 0.01. The difference between the dollar duration of assets and liabilities is (146 million). This is within the approved guideline of +/- 450 million.

Partial Duration Sensitivity Analysis (Price Sensitivity to Specific Rate Changes)
For all points along the curve partial duration sensitivities are within the approved guideline of 300 thousand.

Scenario Testing
Worst Case Scenario
The worst-case scenario that was tested was an increase followed by a decrease in interest rates. If this scenario were realized, it would result in a loss of $7.6 million in economic surplus.

Cash Flow Analysis
The accompanying graph does not represent actual cash outflows but rather interest rate reset dates for the assets and liabilities. No renewals or new sales are projected and asset maturities are not reinvested. Thus the usefulness of this analysis is limited to studying interest rate risk exposure. This would represent an extreme adverse scenario for measuring liquidity risk exposure.
**Portfolio Rebalance**

Rebalancing is performed on a monthly basis for Accumulation Annuities. At the end of December, except for cash reallocation there was no rebalancing required for Accumulation Annuities.

**Asset Mix**

The target mix calls for more bonds and private placements and less mortgages. The C1 capital requirement for the Accumulation Annuities portfolio excluding additional requirements for troubled assets is approximately $117 million at the end of December. In comparison, the C1 requirement based on the target asset mix would be $112 million.
TRADITIONAL LIFE PRODUCTS
Effective Duration (Price Sensitivity to Parallel Shifts in the Yield Curve)
The effective duration of assets is shorter than the duration of liabilities by 5.2 years. This reflects the difficulty in finding assets that match the extremely long duration of the liabilities. The difference between the dollar duration of assets and liabilities is (1.71 billion) which exceeds our approved guideline of +/- 300 million.

Partial Duration Sensitivity Analysis (Price Sensitivity to Specific Rate Changes)
We are exposed to rates falling at the 20, 25 and 30-year terms and to rates increasing at earlier terms. Exposure is large yet exceeds guidelines of 300 thousand for the 25 year term only.

Scenario Testing
The maximum decline in economic surplus at the 95% confidence level was $89.7 million at the end of December. The scenario that gives rise to this exposure is a decrease in long-term interest rates.

Cash Flow Analysis
The large positive spikes represent the maturity of the long zero coupon bonds that were purchased to extend the duration of the assets.
Portfolio Rebalance
At the end of December rebalancing was necessary as a result of the lengthening of the liabilities due to assumption changes.

Asset Mix
The target mix does not reflect policy loans, calls for more government bonds, and less private placements. The C1 capital requirement for the Traditional Life Products portfolio excluding additional requirements for troubled assets is approximately $0.5 million. In comparison, the C1 requirement based on the target asset mix would be $0.5 million. The asset mix does not reflect the assumed equity position.
NON-TRADITIONAL LIFE PRODUCTS

Projection of Cash Flows
Based on December 31 assets and liabilities, net cash flows are projected to be an average of $1.3 million per month going forward.

Margin Squeeze
Interest sensitive cash flows have been modeled to vary for given changes in interest rates (i.e., the margin squeeze will be reflected in the price sensitivity statistics). The impact of the margin squeeze for a 1% decrease in interest rates is a $10.3 million loss in economic value.

Effective Duration (Price Sensitivity to Parallel Shifts in the Yield Curve)
The effective duration of assets is longer than the duration of liabilities by 5.3 years. The difference between the dollar duration of assets and liabilities is 2.235 billion. This significantly exceeds the guideline of ± 400 million.

Partial Duration Sensitivity Analysis (Price Sensitivity to Specific Rate Changes)
Significant exposure exists to an increase in interest rates between the 7 and 20-year rates, a result of the duration mismatch between the assets and liabilities. The company is exposed to a decrease in interest rates for early durations. The guideline of 400 thousand is exceeded in both directions for 4 points on the rate curve.

<table>
<thead>
<tr>
<th>Partial Duration Sensitivity</th>
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<tbody>
<tr>
<td>Changes in Net Position ('000) per .01% increase in Rate</td>
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</table>

Scenario Testing
The maximum decline in economic surplus at the 95% confidence level decreased from $129.3 million to $122.1 million at the end of December. The scenario that gives rise to this exposure is a gradual decrease in long-term interest rates.
Cash Flow Analysis
Note that cash flows for both the fixed life and variable UL products are shown together.

Portfolio Rebalancing
At the end of December the need for rebalancing was identified to deal with the growing duration mismatch between assets and liabilities. Implementation was postponed due to a lack of resources to analyze and explain the mismatch.
INSTITUTIONAL PENSION - PAYOUT
Effective Duration (Price Sensitivity to Parallel Shifts in the Yield Curve)
The effective duration of assets is shorter than the duration of liabilities by 0.8 years. The
difference between the dollar duration of assets and liabilities is (675 million) and is
within the approved guideline of ± 700 million.

Partial Duration Sensitivity Analysis (Price Sensitivity to Specific Rate Changes)
Due to the efficiency of the immunization strategy, no significant interest rate exposure
exists on that line of business.

Scenario Testing
The maximum decline in economic surplus at the 95% confidence level stands at $5.96
million, and is the result of a gradually increasing interest rate for the first 20 years
followed by a sharp increase.

Cash Flow Analysis
INSTITUTIONAL PENSION - GIC
Effective Duration (Price Sensitivity to Parallel Shifts in the Yield Curve)
The effective duration of assets is longer than the duration of liabilities by 0.20 years. The difference between the dollar duration of assets and liabilities is 300 million. This is within the approved guideline of ± 450 million.

Partial Duration Sensitivity Analysis (Price Sensitivity to Specific Rate Changes)
Due to the efficiency of the immunization strategy and the short duration of the liabilities, no significant interest rate exposure exists on that line of business.

Scenario Testing
The maximum decline in economic surplus at the 95% confidence level stands at $5.2 million, and is the result of an immediate, large increase in interest rates.

Cash Flow Analysis

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Currency Exposure
The Euro-denominated liabilities are valued at $100 million using exchange rates in effect as of December 31. This is approximately 20% higher than the value at last year-end. This liability exposure has not been hedged given the relatively small size of the exposure and the previously stable Euro/U.S. dollar exchange rate relationship over its short history.
GROUP BENEFITS
Effective Duration (Price Sensitivity to Parallel Shifts in the Yield Curve)
The effective duration of assets exceeds the duration of liabilities by 1.51 year. The difference between the dollar duration of assets and liabilities is 1.206 billion. This significantly exceeds the guideline of ± 630 million.

Partial Duration Sensitivity Analysis (Price Sensitivity to Specific Rate Changes)
The exposure tends to be at the longer durations, where an increase in interest rates will create a loss. All measures are within the 630 thousand guideline.

Scenario Testing
The maximum decline in economic surplus at the 95% confidence level stands at $11 million, and is the result of a slow decrease in interest rates.

Cash Flow Analysis