CSP-IU & CSP-IC
Complete Illustrative Solutions
Spring 2009

All solutions apply to both the United States and Canada unless otherwise specified

1.

Learning Objectives:

10 – Understand the professional standards addressing financial reporting and valuation.

Solution:

(a)
- Management is responsible for effectiveness of internal control over financial reporting
- Need to evaluate the effectiveness of control
- Need to have document to support the evaluation
- Written report needs to be presented

(b) **(i)** Inappropriate
- Under ASOP 21, material impact needs to be disclosed
- Change in product mix can be significant and should be assessed and disclosed

(ii) Appropriate
- ASOP 41 – Actuarial Communication along with other ASOP give the actuary discretion in determining significance
- In light of this, the actuary can follow the communication guidance that are appropriate

(iii) Inappropriate
- The company must also disclose reliance on data from others, date limitation, uncertainty and bias in data

(iv) May be inappropriate
- The company should have control in place to determine the effectiveness, accuracy and appropriateness of the automated process

(v) Inappropriate
- There should be peer review before sign off

(vi) Inappropriate
- The company's internal auditor prepares the self-assessment and external auditors must do the sign-off
- The external auditor must also review the documentation

2.

Learning Objectives:

> **4 –** Explain and apply the basic methods, approaches and tools of financial
> management in a life insurance company context.

Solution:

(a)

- Reasons to buy
    - Build economics of scale
    - Reduce expenses
    - Use idle capital
    - Grow company

- Prerequisites
    - Capital available to make purchase
    - Must improve buyers earnings $\rightarrow$ Should reflect risk involved
    - Must have resources to handle purchase $\rightarrow$ need team that knows how to integrate companies
    - Combining operations is difficult
    - People are most difficult aspect

(b)

Product cash flows = Premiums + Invest Income – Death Benefits – Expenses – Commissions

Product cash flows $_{2009}$ = 977 + 391 – 122 – 273 – 195 = 778
Product cash flows $_{2010}$ = 1,123 + 449 – 140 – 314 – 224 = 894
Product cash flows $_{2011}$ = 1,291 + 516 – 161 – 361 – 258 = 1,027

Taxes = Tax rate x Taxable Income = Tax rate x (Product cash flows – Increase in Tax Reserve)

Taxes $_{2009}$ = 35% $\times$ (778 – 345) = 151.55
Taxes $_{2010}$ = 35% $\times$ (894 – 556) = 118.30
Taxes $_{2011}$ = 35% $\times$ (1,027 – 766) = 91.35

After-tax Stat Earnings = Product cash flows – Increase in Stat Reserve – Taxes

After-tax Stat Earnings $_{2009}$ = 778 – 384 – 151.55 = 242.45
After -tax Stat Earnings $_{2010}$ = 894 – 618 – 118.3 = 157.70
After -tax Stat Earnings $_{2011}$ = 1,027 – 852 – 91.35 = 83.65

2. **continued**

Distributable Earnings (DE) = After-tax Stat Earnings –

Increase in Required Capital

$DE_{2009} = 242.45 - 135 = 107.45$

$DE_{2010} = 157.70 - 124 = 33.70$

$DE_{2011} = 83.65 - 72 = 11.65$

$$\textbf{PVDE} = \frac{107.45}{1.09} + \frac{33.70}{1.09^2} + \frac{11.65}{1.09^3} = 135.94$$

(c)

Purchase Price = Solvency Reserve – Assets

Purchase Price for Block 1 = 200 – 170 = 30

Purchase Price for Block 2 = 350 – 325 = 25

Tax = (Solvency Reserve – Tax Reserve – Transaction Cost – Purchase Price) x

Tax rate

Taxes for Block 1 = (200 – 185 – 5 – 30) × 35% = -7

Taxes for Block 2 = (350 – 335 – 10 – 25) × 35% = -7

Embedded Value = Purchase Price + Tax + Transaction Costs +

Required Capital

EV for Block 1 = (30 + (-7) + 5 + 25) = 53

EV for Block 2 = (25 + (-7) +10 +50) = 78

EV is test of recoverability as DAC is recoverable if EV > DAC

EV for Block 1 = 53 > DAC = 45

EV for Block 2 = 78 < DAC = 90

Recommend acquiring block 1 as DAC is recoverable

Do not recommend acquiring block 2 as DAC is not recoverable

3.

Learning Objectives:

4 – Explain and apply the basic methods, approaches and tools of financial management in a life insurance company context.

Solution:

(a)
- The five year ROE of 11.3% is below the company's cost of capital of 15%
- Over the five year period, the company will be destroying economic value

- The growth rate cannot be supported by its earnings
- Even more so with the dividend policy using 3% of equity each year
- Company can only grow at 8.3%

Product line A
- Smallest product line is the most profitable and growth plan is the lowest

Product line B
- The ROE is below the cost of capital so not adding economic value
- The ROE is below the cost of capital but growth rate less than ROE so it is generating free cash flow

Product line C
- Major problem with very low ROE and high growth rate, uses most capital of all product lines
- Destroying significant economic value

Product line D
- Growth rate exceeds ROE and so is consuming free cash flow

(b)
- Establish overall companies guidelines for minimum product profitability
- Product line growth rates cannot exceed the ROE rates unless the ROE exceeds the company cost of capital
- Overall ROE should be 3% higher than the growth rate to support shareholder dividends

The following is the overall approach to modifying the plan to better fit with company goals. Proposal needs to reduce growth on poorly performing product lines, and increasing growth on strong performing ones. Plan should acknowledge that overall growth rate should be 3% less than the ROE to support the dividend policy.

3.   continued

Specific recommendations:

Product line A growth rate should be increased as much as possible.
- Growth rate could exceed ROE and thereby consume free cashflow if free cash flow can be generated by other product lines

Product line B should reduce growth rate since ROE is below the cost of capital
- Look to improve profitability to support growth
- Target growth at a rate below the ROE to generate free cashflow

Product line C
- Slow growth considerably to stop consuming free cashflow and destroying economic value
- Find ways to improve profitability
- Target growth at a rate below the ROE to generate free cashflow that can be used by more profitable product lines

Product line D
- It is appropriate to consume free cashflow when creating economic value
- No changes needed for this product line

4.

Learning Objectives:

6 – Understand the principles underlying the determination of Economic Capital

9 – Understand the sources of risk faced by the enterprise and evaluate the mitigation thereof.

Solution:

(a)

Risk Capital – minimum amount that needs to be invested to insure that the company's net assets earn at least the risk-free rate

- Depends only on the riskiness of the asset – not on form of financing

Regulatory Capital – minimum amount of capital required by authorities and rating agencies

(b)

Accounting Balance Sheet

$$\text{GIC liability} = 3,000 \times \frac{1.05}{1.06} = 2,971.70$$

$$\text{Debt liability} = 1,000 \times \frac{1.05}{1.12} = 937.50$$

Assets		Liabilities	
Risky Assets	5,000	GIC	2,971.70
		Debt	937.50
		Shareholder equity	1,090.80
	5,000		5,000.00

Risk Based Capital Balance Sheet

$$\text{GIC Liability} = 3,000 \times \frac{1.05}{1.05} = 3,000$$

$$\text{Debt} = 1,000 \times \frac{1.05}{1.05} = 1,000$$

Insurance: Customers = 3,000 – 2,971.70 = 28.30

Insurance: Debtholders = 1,000 – 937.50 = 62.50

Insurance: Shareholders = 400 – 28.30 0 62.50 = 309.20

Assets		Liabilities	
Risky Assets	5,000.00	GIC	3,000
Ins GIC	28.30	Debt	1,000
Ins Debt	62.50	Risk Capital	400
Ins S/H	309.20	S/H Equity	1,000
	5,400.00		5,400

4. continued

(c)

With reinsurance of 200

Accounting Balance Sheet

Assets		Liabilities	
Risky Assets	5,000	GIC	2,971.70
		Debt	937.50
Reinsurance	200	Shareholder equity	1,290.80
	5,200		5,200.00

Risk Based Capital Balance Sheet

Assets		Liabilities	
Risky Assets	5,000.00	GIC	3,000
Ins GIC	28.30	Debt	1,000
Ins Debt	62.50	Risk Capital	400
Ins S/H	109.20	S/H Equity	1,000
Reins	200.00		
	5,400.00		5,400

(d)

The statement is not necessarily true

Growth may be occurring because:

- Reinsurers are underpricing their products for the amount of risk they are taking
- They are taking on new products on which they have little experience
- They are relaxing underwriting rules

They may be exposing themselves to concentration risk

Companies need to think about what happens if reinsurer becomes insolvent

5.

Learning Objectives:

5 – Understand the Risk-Based Capital (RBC) regulatory framework and the principles underlying the determination of Regulatory RBC

Solution:

(a)

C0
- Affiliate asset risk is not affected as there are no affiliates of MKH

C1
- **Bonds**
  - Qualities decreasing would increase the amount of C1 required
  - Depending on the diversification of the portfolio, the factor could be higher
- **Mortgages**
  - Increased defaults on mortgages increases the amount of C1 required
  - 90 days overdue has a higher factor than in good standing
  - In foreclosure has a higher factor than 90 days overdue and higher than in good standing
  - If the company's experience is worse than the industry, their mortgage experience adjustment factor will increase
- **Common Stocks**
  - Factor is multiplied by fair value
  - Fair value has decreased, but factor is the same, so less C1 is required
- **Separate Accounts**
  - If there is a guarantee, C1 will increase
- **Asset Concentration Factor**
  - Risk-based capital requirements are double for ten largest holdings; if these have decreased in quality, this factor would increase
- **Reinsurance**
  - Not affected as there is no reinsurance
- **Off Balance Sheet Items**
  - None in this company, so no affect

C2
- **Covers Insurance Risk**
  - Term life net amount at risk is not impacted by market conditions

5. **continued**

C3
- **Interest Rate Risk**
  - Could be increased if assets and liabilities are no longer well-matched
  - C3 Phase 1 testing done in fixed annuities to determine asset adequacy, could increase C3
  - Fixed annuities have market value adjustment, so no change to factor due to market changes
- **Market Risk**
  - Risk increases because minimum death benefit guarantees may be greater than account values
- **C3 Phase 2**
  - Tests equity risk in variable products with guarantees
  - Requirement increases with decrease in equity markets
- Factors will increase by 50% if assets and liabilities are not well matched

C4
- **Business Risk**
  - Life insurance portion does not change as premiums do not change
  - Separate account annuity portion will decrease because value of separate account liabilities has decreased

RBC Ratio is the total adjusted capital of life insurance company divided by the authorized control level of RBC derived from formula
- Total adjusted capital will decrease for the company
- Value of the equities has decreased
- Value of bonds and mortgages may have decreased because of defaults
- Value of the liabilities has increased because of the variable annuity guarantees
- No adjustments to TAC for AVR or dividend liability

Total RBC authorized control level has increased
- C1 – Bonds & mortgages higher, equities lower
- C3 – Higher due to variable annuity guarantees

(b)

- Emphasize products that have low RBC requirements and de-emphasize products with high RBC requirements
  - Increase term insurance and fixed annuities
  - Decrease variable annuities with guarantees
  - Add another type of product with low RBC
  - Redesign products to lower the RBC requirements
  - Change GMDB to be less costly to the company

5. continued

- Increase profitability by lowering expenses, exiting unprofitable business, and/or increase prices
- Reduce asset risk by buying assets with low RBC requirements and selling assets with high RBC requirements
    - Sell equities, move to fixed income
    - Sell bonds of lower quality and move to higher quality
    - Sell any assets and purchase government bonds which are exempt from RBC
    - Sell lower quality mortgages and move to higher quality
- Increase diversification of portfolio to decrease size adjustment
- Reduce liability risks by entering into reinsurance agreements or selling certain product lines
- Reorganize the legal structure of the life insurance company by moving certain subsidiaries to a holding company
- Raise capital by issuing surplus notes or issuing equity securities

6.

Learning Objectives:

9 – Understand the sources of risk faced by the enterprise and evaluate the mitigation thereof.

Solution:

(a)

Traditional cash flow risk driven by interest rates is not an issue
Stress liquidity risk driven by the market events is the big concern

Potential of being unable to meet obligations as they become due because of
- Inability to liquidate assets
- Inability to obtain adequate funding (funding-liquidity risk)
- Company is below target for AA ratings capital, may be unable to raise further debt

Cannot easily unwind or offset specific exposures without lowering market prices because of
- Inadequate market depth
- Market disruptions (market liquidity risk)

Asset Liability Matching risk
- Risk of mismatch in asset and liability values – asset values have declined, variable annuity guarantees in the money

Capital Markets
- Risk of not being able to secure adequate funding from outside markets – markets not trading, lack of credit available
- Inadequate capital to meet regulatory, legal or market requirements or economic needs – below AA target
- Regulatory, legal or market requirements include ratings/credit standards, transactional or business

Catastrophes
- Fixed annuities could surrender, causing more outflows than anticipated
- Economic conditions may cause policyholders to discontinue premiums

6.   **continued**

(b)

(i)

Trend Analysis
- Look for patterns that suggest potential emergence of negative situations
- Economics are forecasting continued market disruptions

Stress Testing
- Determine impact on firm of imagined extreme circumstances
- Include impacts of financial, regulatory, reputational, credit ratings
- Stress tests on capital, liquidity
- Situation would be continued economic downturn

Contingency Planning
- Develop detailed action plans
- Action plans need to be helpful in a fast-moving situation
- Action plans should be flexible enough to fit if situation changes from anticipated one

Active Catastrophic Risk Management
- Used when catastrophe strikes
- Firm is prepared to take timely, decisive action
- Clear communication to stakeholders
- Initiate and complete actions and communicate effectively

Problem Post Mortem
- Use problem and solution as learning opportunity
- Look at what went well and what went poorly in terms of ERM process
- Communicate learnings broadly
- Review current capital situation, what could have been done to prevent loss of capital
- Review investment policies

Catastrophic Risk Transfer
- Consider insurance or capital market transaction that would transfer catastrophic risk exposure
- Consider hedging VA guarantees, equity position

6.   continued

(ii)

Put together a liquidity crisis management team
- Selected to identify and manage risk events
- Study historical events and "what-if" scenarios

Train for a liquidity risk event by crisis planning, modeling, stress testing

Stress Testing uncovers responses available to the company in event of crisis
- Reproduce historical examples
- Model pressures such as "run on the bank" or "impaired markets"

Stress Testing can be used to price for liquidity risk at the product development stage

Stress Testing should apply to all business divisions of company
- Determines viability of each under a stress event

Fire Drill Planning
- More realistic testing of assets and liabilities in the event that liquidation becomes necessary
- Establish which assets should be sold first
- Establish what alternative sources of liquidity can be utilized on short notice

7.

Learning Objectives:

8 – Integrate data from various sources into model office and asset/liability models.

Solution:

(a)

Static Validation

- Compare certain actual and modeled values at model start
  - Create ratios of modeled to actual for premiums, reserves, face amounts
- Analogous to a Balance Sheet validation
- Ratio of modeled to actual close to 1.00000 increases confidence in model
- Perfect ratio does not guarantee perfect model
  - Comparison at a single point in time
  - Comparison doesn't capture interaction among variables
- Test granularity of model by testing individual model plans
  - Want 85-115% for each model plan, 5-105% for all plans in total
- Most projection systems product initial values for static validation

Dynamic Validation

- Compare actual historical results trended into the future with modeled amounts projected in the future (Prospective)
  - If modeled values don't compare well with trended values, at least one assumption may be wrong in the model
- Compare actuarial historical results with modeled amounts when the model is started prior to the date of the actuals (Retrospective, back-casting)
  - Because historical results are more certain than historical results trended into the future, retrospective is a more robust comparison than prospective
- Analogous to Income Statement validation
- Not possible if historical results not available, credible, or reliable

Comparison

- Favorable static validation does not necessarily mean favorable dynamic validation
- Dynamic validation compares at multiple points in time, static validation just at model start
- Dynamic validation is more complex and robust than static validation
- If open block, good dynamic validation indicates reliability of the level and distribution of new issues

7. continued

Project may require elements of both static and dynamic validation
- To validate liability model, for pricing/new business purposes
  - Compare ratios and patterns at start and over time with similar products
  - Compare PV of each profit component to PV premium
- To validate asset model
  - Compare initial values par value, book value, and average yield
  - Compare average interest rates to assumed yields
  - Compare asset purchases with asset cash flows that follow

(b)

Term policies are issued at time 0. There are no required assets at time 0.

CF = Cash Flow
CCF = Cumulative Cash Flow within a year

Beg (0)	Mid (1/2)	End (1)
Premiums	Claims	Taxes
Expenses		

$$CCF(0) = Premium(0) - Expenses(0)$$
$$= 25,000 - 60,000$$
$$= -35,000$$

CCF is negative so interest is paid and not received first year
There is no invested asset so no asset cash flow first year

$Interest(\frac{1}{2}) = CCF(0) * ((1 + i)^{0.5} - 1)$, solving for i:

$$((1 + i)^{0.5} - 1) = Interest(\tfrac{1}{2}) / CCF(0)$$
$$= -1,373 / -35,000$$
$$= .0392 = 3.92\% \text{ semi-annual,}$$

Or

$$i = (1 + (-1,373 / -35,000))^2 - 1$$
$$= 0.08$$
$$= 8.0\% \text{ annual interest rate.}$$

Interest on CCF is paid at 8%.

$$CCF(\tfrac{1}{2}) = CCF(0) + Interest(\tfrac{1}{2}) - Claims(\tfrac{1}{2}) + Asset\_CF(\tfrac{1}{2})$$
$$CCF(\tfrac{1}{2}) = -35,000 - 1,373 - 6,000 + 0$$
$$= -42,373$$

7. **continued**

$\text{Interest}(1) = -42{,}373 * ((1.08)^{0.5} - 1)$
$$= -1{,}662.31$$

CCF starts over at zero at beginning of second yr.
$\text{CCF}(1) = \text{Premium}(1) - \text{Expenses}(1)$
$$= 24{,}000 - 6{,}000$$
$$= 18{,}000$$

CCF is positive so interest is received and not paid second yr.

$\text{Interest}(1\frac{1}{2}) = \text{CCF}(1) * ((1 + i)^{0.5} - 1)$, solving for i:

$((1 + i)^{0.5} - 1) = \text{Interest}(1\frac{1}{2}) \,/\, \text{CCF}(1)$
$$= 619 \,/\, 18{,}000$$
$$= .0344$$
$$= 3.44\% \text{ semi-annual},$$

or

$i = (1 + (619 \,/\, 18{,}000))^2 - 1$
$= 0.07$
$= 7.0\%$ annual interest rate.

Interest on CCF is received at 7%.

$\text{Asset\_CF}(1\frac{1}{2}) = \text{Required\_asset}(1) * (.06 \,/\, 2)$
$$= 15{,}000 * 0.03$$
$$= 450$$

For all of year 2, Asset_CF = 450 * 2 = 900.

$\text{CCF}(1\frac{1}{2}) = \text{CCF}(1) + \text{Interest}(1\frac{1}{2}) - \text{Claims}(1\frac{1}{2}) + \text{Asset\_CF}(1\frac{1}{2})$
$\text{CCF}(1\frac{1}{2}) = 18{,}000 + 619 - 8{,}000 + 450$
$$= 11{,}069$$

$\text{Interest}(2) = 11{,}069 * ((1.07)^{0.5} - 1)$
$$= 380.86$$

(i)

Time Period (Months)	1 – 6	7 – 12	13 – 18	19 – 24
Int Received: Positive CCF	0	0	619.00	380.86
Int Paid: Negative CCF	1,373.00	1,662.31	0	0

7.   continued

(ii)
LiabilityCF = Premiums – Expenses – Claims – Taxes
FreeCF = LiabilityCF + Investment Income + Interest Received – Interest Paid –
    Increase in Required Asset

FreeCF(1) = (25,000 – 60,000 – 6,000 + 10,000) + 0 + 0 – 1,373 – 1,662 + 15,000
    = -49,035

FreeCF(2) = (24,000 – 6,000 – 8,000 – 5,000) + 900 + 619 + 381 – 0 – 5,000
    = 1,900

Year 1:	Beg	Mid	End
Premium	+25,000		
Expenses	-60,000		
Claims		-6,000	
Taxes			+10,000
Liability CF	-35,000	-6,000	+10,000
Asset CF	0	0	0
Interest Received	0	0	0
Interest Paid	0	-1,373	-1,662
Sum CF	-35,000	-7,373	+8,338
CCF	-35,000	-42,373	-34,035
Increase in Required Asset			-15,000
Free CF			-49,035

Year 2:	Beg	Mid	End
Premium	+24,000		
Expenses	-6,000		
Claims		-8,000	
Taxes			-5,000
Liability CF	+18,000	-8,000	-5,000
Asset CF	0	+450	+450
Interest Received	0	+619	+381
Interest Paid	0	0	0
Sum CF	+18,000	-6,931	-4,169
CCF	+18,000	+11,069	+6,900
Increase in Required Asset			-5,000
Free CF			+1,900

8.

Learning Objectives:

7 – Understand embedded value and value creation conceptual frameworks.

Solution:

Calculate risk free rate on investment income for both periods:

$$r_f = \frac{Investment\ Income}{Economic\ Liability}$$

$$r_{f\,2009} = \frac{3.15}{45.06} = 7\%$$

$$r_{f\,2010} = \frac{4.67}{(45.06 + 21.65)} = 7\%$$

Need to recalculate economic profit at the risk free rate plus 1% = 8%

Start by calculating Net Cash Flow after Frictional Costs:

$$Net\ Cash\ Flow\ after\ Frictional\ Costs = Premium - Claims - Expenses - Risk\ Charges$$

$$Net\ Cash\ Flow\ after\ Frictional\ Costs_{2008} = 60 - 0 - 10 - 0 = 50$$

$$Net\ Cash\ Flow\ after\ Frictional\ Costs_{2009} = 40 - 20 - 1 - 0.50 = 18.50$$

$$Net\ Cash\ Flow\ after\ Frictional\ Costs_{2010} = 0 - 70 - 1 - 0.38 = -71.38$$

Use this to calculate Economic Liability:

$$Economic\ Liability = -NPV(Net\ Cash\ Flow\ after\ Frictional\ Costs)\ @\ 8\%$$

$$Economic\ Liability_{2009} = -\left(\frac{18.5}{1.08} + \frac{-71.38}{1.08^2}\right) = 44.07$$

$$Economic\ Liability_{2010} = -\left(\frac{-71.38}{1.08}\right) = 66.09$$

Now calculate Investment Income

$$Investment\ Income = r_f \times Economic\ Liability$$

$$Investment\ Income_{2008} = 8\% \times 0 = 0$$

$$Investment\ Income_{2009} = 8\% \times 44.07 = 3.53$$

$$Investment\ Income_{2010} = 8\% \times 66.09 = 5.29$$

Finally, calculate Economic Profit for 2008:

$$Economic\ Profit = Net\ Cash\ Flow - Investment\ Income + Change\ in\ Economic\ Liability$$

$$Economic\ Profit_{2008} = 50 + 0 - 44.07 = 5.93$$

The effect on Economic Profit is an increase: 5.93 – 4.94 = 0.99.

9.

Learning Objectives:

    9 – Understand the sources of risk faced by the enterprise and evaluate the mitigation thereof.

Solution:

(a)

Lapse risk may be mitigated by surrender charge during surrender charge period

Existence of guarantees (esp if in money) might be expected to reduce lapses
But if policyholder has monthly income needs, rich GMDB benefit may lead to lower lapses

High lapse rates could have two different impacts
- Can negatively affect profit of the base variable annuity
- Can actually decrease the cost of any guarantees

Market has decreased – so more policies in the money

Annuitization rate
- If GMIB is in money, policyholder may choose to annuitize

Concern is if the policyholder is in poor health, they will be less likely to lapse a policy that is in the money
- Could lead to anti-selection

Policyholder may wait to annuitize if they think market performance will improve
Policyholder may flock to safety of guaranteed annuity
Policyholder may make decisions that are not in their best interest based on media or broker recommendations

Availability of viatical settlements for the death benefits will decrease lapses
- Assumes the contract allows the owner to assign the policy to the purchaser

(b)

Common characteristics
There may be limits on the guarantee amount
- Based on total net amount at risk or capped at (for example) twice the starting point

9. continued

- Guarantees only adjust (ratchet, reset, or rollup) to a certain attained age
- Guarantees may not be applicable after a certain age
- Guarantees may only be offered a certain issue age
- Guarantees may be capped by some absolute limit
- Guarantees may be adjusted proportionally rather than on a dollar-for-dollar basis for withdrawals

Limits on investment options
- High volatility and/or low returns increase the value of the guarantees and the cost of the guarantee
- Require specific fund allocation
- Or, exclude certain funds in certain situations

Maximum annuitization age (when policyholder must annuitize or surrender the contract)
Limits on sales or future contributions

GMDB
- Who is covered – limit risk by covering only one person, not joint
- Continuation of policy after death – reduce risk by limiting ability to continue policy with guarantee after spouse's death
- Effective date of death benefit calculation – may be day of death or day documentation submitted – doesn't necessarily limit risk

GMIB
- Length of waiting period must be long enough so company can recoup acquisition expenses
- Length of waiting period must allow for positive equity returns to offset negative years
  - Commonly 7 or 10 years
- Assumptions for determining interest rate in guarantee – lower is less risky for insurer
  - May be constrained by statutory minimums
- Lower projected mortality assumption lowers cost of guarantee
- Longer certain periods reduce impact of mortality improvements

10. United States

Learning Objectives:

        1 – Understand and apply valuation principles of individual life insurance and annuity products issued by U.S. life insurance companies.

Solution:

(a)

U.S. Statutory Reserve

$$q^p_{[x]+t} = q^u_{[x]+t} \times A^{id}_{[x]+t}$$

$$A^{id}_{[x]+t} = \left(1 - q^q_{[x]}\right)^s \; ; \; s = 0 \text{ to } t$$

$$q^p_{[75]+0} = 0.02 \times (0.99)^0 = 0.02$$

$$q^p_{[75]+1} = 0.025 \times (0.99)^1 = 0.02475$$

$$q^p_{[75]+2} = 0.030 \times (0.99)^2 = 0.02940$$

$$q^p_{[75]+3} = 0.035 \times (0.99)^3 = 0.03396$$

$$_3|a_{75} = {}_2|a_{76} \times (1 - q_{75}) \times v$$

$$= \$68,329 \times \frac{(1 - 0.02)}{1.05}$$

$$= \$63,774$$

$$_1|a_{77} = {}_2|a_{76} \times (1 - q_{76}) \times v$$

$$= \$68,329 \times \frac{1.05}{(1 - 0.02475)}$$

$$= \$73,566$$

$$a_{78} = {}_2|a_{77} \times (1 - q_{77}) \times v$$

$$= \$73,566 \times \frac{1.05}{(1 - 0.02940)}$$

$$= \$79,584$$

10. **continued – United States**

$$_tV_x = a_{nCP-t} + {}_{nCP-T}|a_{x+t}$$

$$_0V_{75} = a_3 + {}_3|a_{75}$$
$$= \$27,232 + \$63,774$$
$$= \$91,006$$

Retrospective calculation:

$$_{t+1}V_x = {}_tV_x \times (1+i) - BI_{[x]+t} + \left(q_{[x]+t}\right) \times \left({}_{nCP-t-1}|a_{x+t-1}\right) \quad \text{if } t < nCP$$

$$= {}_tV_x \times \frac{(1+i)}{\left(1 - q_{[x]+t}\right)} - BI_{[x]+t} \qquad\qquad \text{if } t \ge nCP$$

$$_1V_{75} = \$91,006(1.05) - \$10,000 + 0.02 \times \$68,329 = \$86,923$$
$$_2V_{75} = \$86,923(1.05) - \$10,000 + 0.02475 \times \$73,566 = \$83,090$$
$$_3V_{75} = \$83,090(1.05) - \$10,000 + 0.02940 \times \$79,584 = \$79,584$$

OR

Prospective calculation:

$$_tV_{75} = a_{(3-t)} + {}_3|a_{[75]} \times \frac{(1+i)^t}{{}_tP_{[75]}}$$

$$_1V_{75} = \left[\left(\frac{10,000}{1.05}\right) + \left(\frac{10,000}{1.05^2}\right)\right] + 63,774 \times \frac{1.05}{1-0.02} = \$86,923$$

$$_2V_{75} = \left[\left(\frac{10,000}{1.05}\right)\right] + 63,774 \times \left[\frac{1.05^2}{(1-0.02) \times (1-0.02475)}\right] = \$83,090$$

$$_3V_{75} = 63,774 \times \frac{1.05^3}{(1-0.02) \times (1-0.02475) \times (1-0.0294)} = 79,584$$

10. continued – United States

(b)

Deferred profit liability for first policy year

For annuities in payment status with more than an insignificant amount of mortality risk, any excess of gross premium collected over sum of acquisition expenses plus initial benefit and maintenance expense reserve established is capitalized as a deferred profit liability (DPL).

Because these contracts have mortality risk, they are considered insurance products for which methodologies in SFAS60 apply
- Assumptions used in development of reserves and deferred profit liability are determined at issue & locked in

Benefit reserve at t is the net present value of stream of $10,000 payments for $20 - t$ years at 5%
Benefit reserve at $t = 0$ is 124,622
Benefit reserve at $t = 1$ is 120,853

No maintenance expenses, so no maintenance expense reserve

Initial deferred profit liability
$$= \text{premium} - \text{acq expenses} - \text{benefit reserve at } t = 0 - \text{maint exp at } t = 0$$

DPL at time $0 = 150,000 - 5,000 - 124,622 - 0$
$$= 20,378$$

DPL is amortized in proportion to expected annuity payments to be made

$$\text{Amortization factor} = \text{profit per annuity payment} = \frac{\text{deferred profit liab at } t = 0}{\text{benefit reserve at } t = 0}$$

$$\text{Amort factor} = \frac{20,378}{124,622}$$
$$= 0.1635$$

DPL at time t = amortization factor times benefit reserve at time t

DPL at time $1 = 0.1635 \times 120,853$
$$= 19,762$$

10. Canada

Learning Objectives:

    1 – Understand the preparation of financial statements and reports of Canadian life insurance companies and be able to analyze the data in them.

    2 – Understand and apply valuation principles of individual life insurance and annuity products issued by Canadian life insurance companies.

Solution:

(a)

    (i)

- Method should be non-manipulative
  - Laid out in advance
  - Applied on a formula basis
- Consistently applied from year to year
  - Disclosure if changed
- Liability would be in CTE(65) to CTE(80) range
- Would be actuarially sound
  - Change in provision for adverse deviation consistent with change in the level of risk
- Resulting future returns should be reasonable in the context of a forward looking assessment

    (ii)

- Change for Management's reason not inappropriate but inaccurate in CIA's view
- Change in CTE level inappropriate if designed to achieve stability in liabilities
- Might be appropriate in recognizing a change in the level of risk
- Lowering CTE level likely would not result in a lower liability

(b)

- Objective of RM is to convey decision-useful info about the uncertainty associated with future cash flows
- RM is not meant to be a shock absorber, nor enhance insurer solvency
- Explicit and unbiased estimate of RM is one of 3 building blocks in IASB measurement model
- Preferred measurement model is based on "current exit value" assuming hypothetical transfer to another party
- RM reflects the allowance for uncertainty a market participant would require to take on the contractual obligations

    IASB does not express a preference for a method

10. continued - Canada

Basic steps:
- Assess how market participants would measure quantity of risk
- Use cash flow scenarios to estimate the number of units of risk
- Estimate the margin per unit of risk (inputs might be rein, new contracts, portfolio transfers)
- Multiply the estimated margin per unit by the estimated number of units
- Test for errors and omissions

Implementation A – RM calibrated to premiums
Implementation B – RM not calibrated to premiums, but they may serve as a check
- Profit might arise at inception under Implementation B

IASB supports Implementation B although some support for Implementation A

RM is portfolio rather than entity-specific
RM cannot be observed typically, so needs to be estimated
RM should not reflect risks that do not arise from the liability, such as investment or asset-liability mismatch
RM should be explicit, not implicit
- Approach should take into account tail risks in contracts with skewed payoffs (such as with embedded options)
- Use of explicit confidence levels preferred
- Cost of capital models, percentile models, and capital-asset pricing models might be utilized
- May use tail value-at-risk (conditional tail expectation)

11.

Learning Objectives:

4 – Explain and apply the basic methods, approaches and tools of financial management in a life insurance company context.

Solution:

(a)

Proper Capital Structure

Equity
- Usually the largest component of capital
- No obligation to pay dividends
- Highest risk → investors demand the highest rate of return on equity capital
- Equity is most appropriate for supporting high-risk capital needs, e.g. the portion of capital that is truly at risk.

Debt
- Typically used by stock companies
- Low-risk capital for companies with good financial ratings; hence lower rate of return on debt capital
- Must paid interests when come due, increased liquidity risk
- Interest paid on debt may be tax deductible in some countries
- Debt is appropriate for supporting low-risk capital needs, e.g. redundant reserves or excess capital requirements
- Debt should be structured in conjunction with asset & liability management as debt is a form of liability
- A small percentage of debt can be used to leverage the company's return because of the relative low cost of debt

Reinsurance
- Obtain financing more quickly, and often at lower cost, than debt or equity
- Increase counterparty risk
- Transfer of risk as well as capital
- Reduction the need of outside capital
- Access to capital as needed, rather than prematurely raising idle capital in the form of equity or debt
- Can use to reinsurance to put excess capital to work

11. continued

(b)

Calculate overall company's ROE:

ROE = (Total new investment income + Interest on T2 capital –
After-tax cost on Debt)/Equity

At 20% Debt level:

Debt amount $= 0.2 \times (125 + 75) = 40$

Interest on T2 capital $= 0.05 \times 75 = 3.75$
After-tax cost on Debt $= 0.08 \times 40 = 3.20$
Equity $= 125 + 75 - 40 = 160$
ROE $= (21 + 3.75 - 3.20) / 160 = 13.47\%$

At 50% Debt level:

Debt amount $= 0.5 \times (125 + 75) = 100.0$
After-tax cost on Debt $= 0.08 \times 100 = 8.0$
Equity $= 125 + 75 - 100 = 100$
ROE $= (21 + 3.75 - 8.0) / 100 = 16.75\%$

The preferred structure is 50% of Debt and 50% of Equity.

(c)

ROE for each business unit

ROE = Net income after T2 capital charge / Tier 1 Capital

Life:
- Net income after T2 capital charge $= 14 - 0.02 \times 50 = 13$
- ROE $= 13 / 93 = 13.98\%$

Annuities:
- Net income after T2 capital charge $= 5 - 0.02 \times 20 = 46$
- ROE $= 4.6 / 25 = 18.40\%$

Investment Management:
- Net income after T2 capital charge $= 2 - 0.02 \times 5 = 1.9$
- ROE $= 1.9 / 7 = 27.14\%$

Evaluate current capital allocation:
- Life business unit does not meet the company's capital requirement of 15%
- Annuities exceed the company's capital requirement of 15%
- Investment Management unit exceeds the company's capital requirement of 15%
- New or excess capital would be better invested in the annuities or Investment Management lines to generate higher overall return

12. United States

Learning Objectives:

2 – Understand and apply valuation principles of individual life insurance and annuity products issued by U.S. life insurance companies.

Solution:

(a)

Limited pay contracts
- SFAS 97
- Definition: Contracts that subject the insurer to risk of benefits payments extending beyond the period where premiums are payable, and that have terms that are fixed and guaranteed
- The DPL (URL) should be established in addition to the benefit reserve to ensure a profit emergence in a constant relationship to the amount of insurance in force
- Premiums continue to be reported as revenues
- Gross premium in excess of net premium should be deferred and recognized over the benefit period
- Income from limited-payment contracts must be recognized over benefit period rather than premium period
- Reserves are established based on assumptions of future experience including provisions for adverse deviation; Reserve Calcs similar to that of SFAS60
- Assumptions are locked-in
- Deferred policy acquisition costs are amortized over premium paying period by using assumptions consistent with reserve assumptions; DAC Amortization similar to that of SFAS60
- For limited-payment contracts, profits will not emerge as a level percentage of premiums but as a level percentage of insurance in force as well as a release of the provision for adverse deviation.
- Best estimate assumption with PAD
- Loss recognition testing if PV(pre-tax GAAP profits, based on best estimate assumptions) < 0
- Benefit period includes periods during which the insurer is subject to risk from policyholder morbidity and mortality and during which the insurer is responsible for administration of the contract
- Benefit period does not include the subsequent period over which the policyholder or beneficiary may elect to have settlement proceeds disbursed
- Collection of premiums does not represent the completion of the earnings process
- Provisions dealing with loss recognition, accounting for reinsurance, and financial statement disclosure apply to limited-payment contracts

12. continued – United States

- Limited-payment policies would include
  - Traditional non-par single payment whole life, and
  - Traditional 10 and 20-payment whole life, and
  - Life paid-up at age 65
- The 3-year benefit period with 2-year premium period term life product is a limited-payment contract
- Single Premium UL products are not limited-pay contracts (use rules applicable to UL contracts)
- Without FAS 97 for limited-payment contracts, applying FAS 60 would result in a substantial portion of the total profits to be recognized in relation to premium payments
- In the extreme, a large portion of the profits of a single payment contract would be reported at issue
- Conflicts with underlying premise that profits are to be recognized over life of policy in relation to performance

Non-Limited payment contracts
- SFAS60
- Premium is recognized as revenue
- Reserve equals the present value of future benefits less the percent value of net premiums
- Recoverability is done at initial sale or pricing and can only defer expenses if they can be recovered from future profits; if (Benefits + Expenses) ≤ 1
- Best estimate assumption with PAD
- Assumptions are locked in at time of sale
- DAC amortization similar to that of SFAS 97
- Loss recognition is done periodically throughout the life of the policy to ensure that deferred expenses can be recovered from future profits

(b)

(i)

Net Level Premium Method

Net Level Premium Reserve (t) = Present Value of Future Benefits (t) – (Net Level Premium in the first Policy Year)(Present value of Annuity Due (t))

$$_t^m V_{[x]:n} = AB_{[x]+t:n-t} - \left(_m PB_{[x]:n} \right) \times \left(\ddot{a}_{[x]+t:m-t} \right)$$

$$_m PB_{[x]:n} = \frac{AB_{[x]:n}}{\ddot{a}_{[x]:m}}$$

12. continued – United States

Given $AB_{57:3} = 2,047.93 = vq_{57} + v^2 p_{57} q_{58} + v^3 p_{57} p_{58} p_{59}$

$$AB_{58:2} = vq_{58} + v^2 p_{58} q_{59}$$
$$= \frac{0.00742}{1.04} + \frac{(1 - 0.00742)(0.0081)}{1.04^2}$$
$$= 0.014567953 \times 100,000$$
$$= 1,456.80$$

$$AB_{59:1} = vq_{59}$$
$$= \frac{0.0081}{1.04}$$
$$= 0.00778462 \times 100,000$$
$$= 778.85$$

$$\ddot{a}_{57:2} = 1 + vp_{57}$$
$$= 1 + \frac{1 - 0.00683}{1.04}$$
$$= 1.954971154$$

$$\ddot{a}_{58:1} = 1$$

$$_2 p_{57:3} = \frac{AB_{57:3}}{\ddot{a}_{57:2}}$$
$$= \frac{2,047.93}{1.954971154}$$
$$= 1,047.55$$

$$_0^2 VB_{57:3} = AB_{57:3} - \left(_2 PB_{57:3} \right) \times \left(\ddot{a}_{57:2} \right)$$
$$= 2,047.93 - (1,047.55) \times (1.954971154)$$
$$= 0$$

$$_1^2 VB_{58:2} = AB_{58:2} - \left(_2 PB_{57:3} \right) \times \left(\ddot{a}_{58:1} \right)$$
$$= 1,456.80 - (1,047.55) \times (1)$$
$$= 409.31$$

12. continued – United States

$$_2^2 VB_{59:1} = AB_{59:1} - \left(_2 PB_{57:3} \right) \times (0)$$
$$= 778.85 - (1,047.55) \times (0)$$
$$= 778.85$$

(ii)

Full Preliminary Term Method

Full Preliminary Term Reserve (t) = Modified Reserve (t) – Unamortized expense allowance (t)

$$_t^m V_{[x]:n}^{Mod} = {_t^m} VB_{[x]:n} - {_t^m} VE_{[x]:n}$$

$$_t^m V_{[x]:n} = AB_{[x]+t:n-t} - \left(_m PB_{[x]:n} \right) \times \left(\ddot{a}_{[x]+t:n-t} \right)$$

$$_m PB_{[x]:n} = \frac{AB_{[x]:n}}{\ddot{a}_{[x]:m}}$$

$$_t^m VE_{[x]:n} = \left(_m PE_{[x]} \right) \times \left(\ddot{a}_{[x]+t:m-t} \right)$$

$$_m PE_{[x]:n} = \frac{_m EA_{[x]:n}}{\ddot{a}_{[x]:m}}$$

$$_m EA_{[x]:n}^{FPT} = \left(\frac{AB_{[x]+1:n-1}}{\ddot{a}_{[x]+1:m-1}} \right) - c_{[x]}$$

$$c_{[x]} = vq_{[x]} DB_{[x]}$$

Given $AB_{57:3} = 2047.93$

$$= vq_{57} + v^2 p_{57} q_{58} + v^3 p_{57} p_{58} q_{59}$$

$$AB_{58:2} = vq_{58} + v^2 p_{58} q_{59}$$

$$= \frac{0.00742}{1.04} + \frac{(1-0.00742)(0.0081)}{1.04^2}$$

$$= 0.014567953 \times 100,000$$

$$= 1,456.80$$

$$AB_{59:1} = vq_{59}$$

$$= \frac{0.0081}{1.04}$$

$$= 0.007788462 \times 100,000$$

$$= 778.85$$

12. continued – United States

$$\ddot{a}_{57:\overline{2}|} = 1 + v p_{57}$$

$$= 1 + \frac{1 - 0.00683}{1.04}$$

$$= 1.954971154$$

$$\ddot{a}_{58:\overline{1}|} = 1$$

$$c_{57} = v q_{57} \times 100,000$$

$$= \frac{0.00683 \times 100,000}{1.04}$$

$$= 656.73$$

$$_{2} p_{57:\overline{3}|} = \frac{AB_{57:3}}{\ddot{a}_{57:\overline{2}|}}$$

$$= \frac{2,047.93}{1.954971154}$$

$$= 1,074.55$$

$$_{2} EA_{57:3}^{FPT} = \frac{AB_{58:2}}{\ddot{a}_{58:\overline{1}|}} - c_{57}$$

$$= \frac{1,456.80}{1} - 656.73$$

$$= 800.07$$

$$_{2} PE_{57} = \frac{_{2} EA_{57:3}}{\ddot{a}_{57:\overline{2}|}}$$

$$= \frac{800.71}{1.954971154}$$

$$= 409.25$$

$$_{0}^{2} VB_{57:3} = AB_{57:3} - \left(_{2} PB_{57:3}\right) \times \left(\ddot{a}_{57:\overline{2}|}\right)$$

$$= 2,047.93 - \left(1,047.55\right) \times \left(1.954971154\right)$$

$$= 0$$

12. **continued – United States**

$$\begin{aligned}
{}^2_1VB_{58:2} &= AB_{58:2} - \left({}_2PB_{57.3}\right) \times \left(\ddot{a}_{58:1}\right)\\
&= 1,456.80 - \left(1,047.55\right) \times \left(1\right)\\
&= 409.31
\end{aligned}$$

$$\begin{aligned}
{}^2_2VB_{59:1} &= AB_{59:1} - \left({}_2PB_{57.3}\right) \times \left(0\right)\\
&= 778.85 - \left(1,047.55\right) \times \left(0\right)\\
&= 778.85
\end{aligned}$$

$$\begin{aligned}
{}^2_0VE_{57:3} &= \left({}_2PE_{57}\right) \times \left(\ddot{a}_{57:2}\right)\\
&= 409.25 \times 1.954971154\\
&= 800.07
\end{aligned}$$

$$\begin{aligned}
{}^2_1VE_{57:3} &= \left({}_2PE_{57}\right) \times \left(\ddot{a}_{58:1}\right)\\
&= 409.25 \times 1\\
&= 409.25
\end{aligned}$$

$$\begin{aligned}
{}^2_2VE_{57:3} &= \left({}_2PE_{57}\right) \times \left(0\right)\\
&= 409.25 \times 0\\
&= 0
\end{aligned}$$

$$\begin{aligned}
{}^2_0V^{Mod}_{57:3} &= {}^2_0VB_{57:3} - {}^2_0VE_{57:3}\\
&= \text{Max}\left(0, 0 - 800.07\right)\\
&= 0
\end{aligned}$$

$$\begin{aligned}
{}^2_1V^{Mod}_{57:3} &= {}^2_1VB_{57:3} - {}^2_1VE_{57:3}\\
&= \text{Max}\left(0, 409.31 - 409.25\right)\\
&= 0
\end{aligned}$$

$$\begin{aligned}
{}^2_2V^{Mod}_{57:3} &= {}^2_2VB_{57:3} - {}^2_2VE_{57:3}\\
&= \text{Max}\left(0, 778.85 - 0\right)\\
&= 778.85
\end{aligned}$$

12. Canada

Learning Objectives:

> **2 –** Understand and apply valuation principles of individual life insurance and annuity products issued by Canadian life insurance companies.
>
> **3 –** Evaluate various forms of reinsurance, what the financial impact is of each form, and describe the circumstances that would make each type appropriate.

Solution:

(a)

Calculate gross and net reserves

Held to Maturity coupon held at amortized cost

Bond value at beginning of year = maturity value/1.07

- Market to market on divestiture
- Immaterial amount shouldn't affect classification

Valuation mortality = expected mortality + (mortality rate addition / curtate life expectancy)

- Mortality rate addition is 0.015 or 15 per 1,000
- Valuation mortality rate is $0.005 + \dfrac{0.015}{25} = 0.0056$

Valuation expense = expected expense × (1 + loading)

- Loading = 10%
- Valuation expense = 75 × 1.1 = 82.5

Gross Reserve

Cash flow at time 0 = 450 – 82.5 = 367.50

Invest at short term rate

Amount needed at end of year = 100,000 × 0.0056 – 367.50 × 1.04 = 177.80

Book value of asset required at time 0 = 177.80 / 1.07 = 166.17

Gross Reserve = 166.17

Net Reserve

New cash flow at time 0 = 217.50 + 90% × 100 × 0.50 – 90% × 100 × 3.00
                        = 142.50

Invest at short term rate

Amount needed at end of year = 100,000 × 0.0056 × 10% - 142.50 × 1.04
                             = -92.20

PV of asset required = -92.20 / 1.07 = -86.17

Net Reserve = -86.17

12. continued - Canada

May need to check if death supported
- If so, subtract margin from expected

(b)

Called mirroring
- Has merit in rules based reserving
- Some states require mirroring
- Internationally generally not required
- Considered inappropriate for life insurance business in Canada

Different experience for reinsurer and writer
- Different expenses
- Reinsurer will have mortality pooled from many writers
- Different investments
- Experience may diverge as time passes

However, without mirroring reinsurer and writer may have different concept of the risk transferred
- Need communication
- Particularly with customized contracts
- No safeguards in principle-based reserving
- Data integrity is key
- Need data validation process

13. United States

Learning Objectives:

> **3 –** Evaluate various forms of reinsurance, what the financial impact is of each
> form, and describe the circumstances that would make each type of
> reinsurance appropriate.

Solution:

(a)

Range of coinsurance percentages

Ceded Premium = Gross Premium × Coinsurance %
Total Ceded Benefit Costs = Ceded Reserve Increase
$\qquad\qquad\qquad\qquad$ = Gross Reserve Increase × Coinsurance%
Total Ceded Benefit costs are 85% of ceded premium
$\qquad$ (850 / 1000 × Coinsurance%)

Minimum Reinsurance Allowance Required by Direct Co in Year 1 to bring gain
from operations to zero or higher:
$\qquad$ = Ceded Premium – Ceded Benefits + loss from Operations (before
$\qquad\quad$ Reinsurance)
$\qquad$ = 15% of Ceded Premium + 50

Re Co:
Investment Income (before reinsurance)
$\qquad$ = Total Liabilities and Capital × Interest Rate
$\qquad$ = Initial Surplus × Earned Rate = 500 × 10% = 50
Maximum Reinsurance Allowance Payable by Re Co in Year 1 to maintain
surplus at initial level of 500:
$\qquad$ = Ceded Premium – Ceded Benefits + Investment income (before
$\qquad\quad$ Reinsurance)
$\qquad$ = 15% of Ceded Premium + 50

Re Co has maximum allowance of 15% of Direct Co Gross Premium
$\qquad$ = 15% × 1000 = 150.
Maximum Ceded Premium is such that 50 + 15% of Ceded Premium = 150.
Maximum Ceded Premium is (150 – 50) / 0.15 = 666.67
Maximum Coinsurance Percentage is 66.67%

Minimum Coinsurance Percentage is 20% (Re Co constraint)

13. continued – United States

(b)

Year 1 gain from operations with 50% coinsurance (direct co)

Gross Premium: 1,000
Ceded Premium = Gross Premium × Coinsurance % = 1,000 × 50% = 500
Net Premium = Gross Premium – Ceded Premium = 1,000 – 500 = 500

Investment Income on Surplus = 0
Investment Income on Reserves = 0

Reinsurance Allowance Required by Direct Co in Year 1 to bring gain from operations to zero or higher:

= Ceded Premium – Ceded Benefits + loss from Operations (before Reinsurance)
= 15% of Ceded Premium + 50
= 15% × 500 + 50 = 125

Total Revenue = Net Premium + Investment Income + Reinsurance Allowance
= 500 + 0 + 125 = 625

Gross Reserve Increase = 850
Ceded Reserve Increase = Gross Reserve Increase × Coinsurance %
= 850 × 50%
= 425
Net Reserve Increase = Gross Reserve Increase – Ceded Reserve Increase
= 850 – 425
= 425

Claims and Surrenders = 0

Total Benefits = Net Reserve Increase + Claims and Surrenders
= 425 + 0
= 425

First Year Expenses = 150
All Year Expenses = 5-

Total Expenses = First Year Expenses + All Year Expenses
= 150 + 50
= 200

Gain from Operations = Total Revenue – Total Benefits – Total Expenses
= 625 – 425 – 200
= 0

13. **continued – United States**

(c)

Insolvency usually occurs due to a combination of fraud, excessive asset risk, mismanagement or inexperience, under-reserving, or uncontrollable external event

When discussing insolvency, the focus is usually on the ceding company insolvency

Model Act defines insolvency as inability to pay obligations when due, or having admitted assets that do not exceed the sum of all liabilities plus the greater of statutory RBC or par value of capital stock

Distribution classes are created under an insolvency and the reinsurer is generally Class 6 (higher if a trust is used)

Use Insolvency Clause in treaty
- Reinsurer must pay its proportionate share of the claim even if direct company is insolvent
- Clause is required for a treaty to generate reserve credit

Avoid attempting to Cut-Through as may have to pay claim twice

Clarify Offset or Set-Off provisions in treaties
- Allows for netting of amounts due arising out of different reinsurance transactions

Reinsurers primary tools are to carefully draft the treaty and thorough underwriting of clients

Contract Provisions (not previously mentioned) might include requiring quarterly or monthly reports

Conditions regarding asset liability matching, investment restrictions, types of assets ceding co may purchase

Secure reserves through a trust, though this adds complication and expense to the transaction

13.   continued – United States

Underwriting for Insolvency
- Obtain and review 3-5 years of statutory and GAAP financial statements
- Obtain, if possible, the last two financial examination reports by any regulator
- Rating agency and industry reports on the company
- Examine the surplus position
- Review the company structure
- Evaluate confidence in the management
- Understand the various products which the company has sold and is selling
- Understand legal liabilities that could affect the company's financial position
- Quality and mix of assets, particularly assets invested in affiliates

Underwrite the business to be reinsured, review design and pricing, and past experience

13. Canada

Learning Objectives:

2 – Understand and apply valuation principles of individual life insurance and annuity products issued by Canadian life insurance companies.

Solution:

(a)

(i)
The amount of policy liabilities under CALM for a particular scenario is equal to the amount of supporting assets at the balance sheet date which are forecasted to reduce to zero at the last liability cash flow in that scenario.

The term of liabilities should take account of any renewal, or any adjustment equivalent to renewal, after the balance sheet date if the insurer's discretion at that renewal or adjustment is contractually constrained, and policy liabilities are larger as a result of taking account of that renewal or adjustment.

Forecasted liability cashflows should take into account policyholder reasonable expectations.

Forecasted liability cashflows should include policyholder dividends other than the related transfer to the shareholders account and other than ownership dividends, in the comprised cash flow from benefits.

The actuary should calculate policy liabilities for multiple scenarios and adopt a scenario whose policy liabilities make sufficient but not excessive provision for the insurer's obligations in respect of the relevant policies.

The assumptions for a particular scenario consists of:
- Scenario-test assumptions, which should include no margin for adverse deviation; and
- Other needed assumptions (e.g. mortality, lapse, expenses ...) should have best estimate consistent with the scenario-tested assumptions and which should include margin for adverse deviations.

The scenario-tested assumptions should include at least the interest rate assumptions.

The scenarios of interest rate assumptions should comprise a base scenario, each of the prescribed scenarios in a deterministic application, ranges which comprehend each of the prescribed scenarios in a stochastic application, and other scenarios appropriate for the circumstances of the insurer.

13. continued - Canada

(ii)

The actuary would usually apply the Canadian asset liability method to policies in groups which reflect the insurer's asset-liability management practice for allocation of assets to liabilities and investment strategy.

Asset-Liability Management Practice
- CALM is generally performed for each asset-liability segment
- When notional segments are managed like factual segments, may consider notional allocation for CALM

Persistency of interest rate risk synergies
- Results may be aggregated if synergies exist among segments
- Need to consider:
    - Is it the practice of portfolio managers to offset one portfolio's mismatch with opposite position in another portfolio?
    - Are offsets permanent and inherent to opposing portfolios?
- Permanent synergy is one that is consistently observed over time and expected to persist
- Appropriate to reflect permanent synergy for aggregation purposes
- Temporary synergy is not expected to be sustainable over time
- Would not be recognized beyond period during which they are likely to persist
- Potential for synergies is limited when segments operate under different interest rate environments
- Unless actuary can demonstrate movements in different environments are highly correlated
- Potential for synergies is limited if funds cannot circulate freely between portfolios (i.e. par versus non-par)

(iii)

PfAD = reported liability – base scenario liability
Reported liability = liability for most adverse scenario

Reserve depends on level of aggregation chosen. Below are three alternative approaches:

Total company aggregation
- Reported liability = Scenario B for all segments
- Reported liability = 472
- Base liability = 415
- C3 PfAD = 472 – 415 = 57

13. continued - Canada

Assume No Synergies between Asset Segments
- Report liability = Scenario B for Segment 1 + Scenario C for Segment 2 + Scenario B for Segment 3
- Reported Liability = 195 + 205 + 85 = 485
- Base liability = 150 + 185 + 80 = 415
- C3 PfAD = 485 – 415 = 70

Assume Permanent Synergy between Segs A & B only
- Reported liability = Scenario C for Segments 1 & 2 + Scenario B for Segment 3
- Reported liability = 390 + 85 = 475
- Base liability = 335 + 80 = 415
- C3 PfAD = 475 – 415 = 60

(b)

In addition to the prescribed scenarios, the actuary would also select other scenarios which are appropriate to the circumstances of the case.
If deterministic modeling is used:
- If the current rates are near or outside the limits of the prescribed range defined, then additional scenarios would include rates that are outside the prescribed range;
- Scenarios that include parallel shifts up and down, as well as flattening/steepening of the yield curves;
- Scenarios in which the default premium risk ranges from 50% to 200% of the actual premiums at the balance sheet date.

The number of additional interest rate scenarios would depend on:
- The pattern of forecasted cash flow in the Base Scenario is such that the classification of scenarios between favourable and unfavourable is unclear
- The range of the present value of forecasted net cash flow is wide, suggesting exposure to mismatch risk
- Investment policy does not control mismatch risk
- ALM is loose
- Flexibility for managing assets or liabilities is limited

If stochastic modeling is used, the actuary would ensure that the stochastic model includes scenarios that generate policies outside the range produced by application of the prescribed deterministic scenarios.

(c)

Process for calculating policy liabilities under CALM is iterative
Income tax cash flows depend on the projected GAAP policy liabilities, which depend on future tax cash flows.

13. continued - Canada

Might not be practical to do this iteration for large blocks of business from a computer run-time perspective

Method 1
- Conduct CALM Analysis ignoring income and capital taxes
- Obtain the interest rate vector to use with a seriatim discount approximation
- Add a full projection of tax cash flows to the analysis, and determine a final set of interest rates
- Result is iterating in only one scenario
- Must ensure that after adding taxes the selected scenario remains appropriate

Method 2
- Conduct CALM Analysis ignoring income and capital taxes
- Use traditional spreadsheet techniques to quantify tax cash flows
- Ensure that the addition of these tax cash flows does not materially change risk profile
- Ensure that the discounting approach reflects the selected adverse scenario

14. United States

Learning Objectives:

    4 – Explain and apply the basic methods, approaches and tools of financial management in a life insurance company context.

Solution:

(a)

Benefits of SOE
- Accounting format of earnings difficult to follow
- SOE is much better way of presenting earnings
- Decomposes Change in Reserves into a comparison of actual to expected
- Highlights areas where results deviate from expected
- Allows more detailed review of causes of deviation
- Highlights problem areas or areas of opportunity
- Quantifies financial impact of problem/opportunity areas
- Reflect understanding of how administrative versus accounting and reserving systems operate
- Helps understand earnings
- Presents actual results compared to expectations
- Provides a built in check of reasonableness of pricing assumptions
- Allows correction of pricing assumptions through feedback of results
- Instills a disciplined approach to pricing
- Serve as a communication tool

Challenges of presenting SOE
- What level of detail
- Balancing between what is expected and what is demanded
- How long to keep actuarial assumptions current and when to update
- How to treat non-deferable development costs
- Treatment of investment income between internal SOE and external
- Avoid communication of irrelevant information
- Whether to publish Stat or GAAP SOE

(b)

Net GAAP Benefit and Expense Premium
    = (PV Benefits + expenses) × Gross Premiums / PV of Future Gross Premiums
    = (21,436 + 1,732) × 6,000/27,276 = 5,096.35

Reserve at time *t*
    = Present Value of Future Benefits and Expenses – PV of Future GAAP Premiums

14. continued – United States

Time 2008 Reserve = $(21{,}435 + 1{,}732) - 27{,}276 \times 5096.35 / 6{,}000 = 0$
Time 2009 Reserve = $(18{,}508 + 1{,}418) - 22{,}339 \times 5096.35 / 6{,}000 = 951.45$

Source of Earnings
- Premiums (or Premium Loading) = Gross Premiums – Net Premiums
- Interest Component = Actual Interest – Expected Interest
- Benefits = Expected Benefits – Actual benefits
- Expenses = Expected Expenses – Actual Expenses

Source of Earnings 2009
Premium Load = $6{,}000 - 5{,}096.35 = 903.65$

Expected Interest = Expected Interest $\times$ (Opening Reserve + Net Premium
           – BOY expenses)
Expected Interest 2009 = $0.05 \times (0 + 5{,}096.35 - 0) = 254.82$
Interest Component = $315 - 254.82 = 60.18$

Expenses = $400 - 250 = 150$
Benefits = $4{,}000 - 4{,}300 = -300$
Sum of components = $903.65 + 60.18 - 300 + 150.00 = 813.83$

Source of Earnings 2010
Premium Load = $6{,}000 - 5{,}096.35 = 903.65$

Expected Interest 2010 = $0.05 \times (951.44 + 5{,}096.35) = 302.39$
Interest Component = $347.57 - 302.29 = 45.18$

Expense = $400 - 400 = 0$
Benefits = $4{,}000 - 4{,}000 = 0$

14. Canada

Learning Objectives:

4 – Explain and apply the basic methods, approaches and tools of financial
management in a life insurance company context.

Solution:

(a)

Benefits of a SOE
- Important control on the integrity of the company's reported earnings
  - By providing insight into the validity of the company's data,
    systems, processes
- Provides stakeholders with a better understanding of the business and
  financial results
- May identify opportunities for improving profitability
- Unexplained variances may provide direction in identifying financial or
  system irregularities
- Consistent gains/losses from any element should help in setting
  assumptions or adjusting procedures

Challenges of presenting SOE
- Consistency in the classification and quantification of items over time and
  between lines of business

- Ongoing refinements can be problematic
  - Restatement is complex
  - Leads to credibility issues
  - Go forward basis only leads to inconsistency
- Unusual transactions require high maintenance
  - Requires procedures so it is classified correctly in the future
- Good documented practices on pads versus expected reserves
- Good experience studies
- Reserve movement breakdowns
- Good disclosure can be evolutionary (repetition required, hard to get it
  right the first time)

- SOE was developed as a subjective management tool and evolved into an
  objective set of financial metrics without losing its usefulness

14. **continued - Canada**

(b)

Income Statement

Reserve at time t = PV Benefits × (1 + mfad) and Maintenance Expenses × (1 + mfad) less PV Premium

Time 0 Reserve = (21,436 + 1,732) × (1 + 0.20) – 27,276 = 525.60
Time 1 Reserve = (18,508 + 1,418) × (1 + 0.20) – 22,339 = 1,572.20
Time 2 Reserve = (14,934 + 1,089) × (1 + 0.20) – 17,156 = 2,071.60

Pre-Tax Ops Inc at time t = Premium + Investment Income – Benefits – Expenses – Change in Reserves
Investment Income at time t = (Opening reserves + Premiums – BOY Expenses) × Interest

Investment Income at time 2009 = (525.60 + 6,000) × 0.0525 = 342.59
Pre-Tax Operational Income 2009 = 6,000 – 4,300 – 250 + 342.59 – 1,046.60
= 745.99
Investment Income at time 2010 = (1,572.20 + 6,000) × 0.05 = 378.61
Pre-Tax Operational Income 2010 = 6,000 – 4,500 – 400 + 378.61 – 499.40
= 979.21

(c)

Components of SOE Calculation

Expected Profit
- Based on achievement of best estimate assumptions
- Therefore equals release of margins

Impact of New Business – Point of Sale

Experience Gains and Losses
Experience gains/losses = Variance in Actual Benefits, Expenses and Interest over expected

Changes in Assumptions and other Changes

Expected Profit 2009 = 0.2 × (4,000 + 400) = 880

Experience gains/losses 2009
= (Expected Benefits – Actual Benefits) + (Expected Expenses – Actual Expenses) + (Actual Interest – Expected Interest)

= (4,000 – 4,300) + (400 – 250) + (0.0525 – 0.05) × (525.60 + 6,000)
= -133.69

14. continued - Canada

Changes in Assumptions and other Changes 2009 = 0

New Business 2009 = 0
Sum of Components = 880 – 133.69 = 746.31
     – essentially equal to net income

Expected Profit 2010 = $0.2 \times (4{,}500 + 400) = 980$
All other components of SOE for 2010 are equal to 0.

15. United States

Learning Objectives:

5 – Understand the Risk Based Capital (RBC) regulatory framework and the principles underlying the determination of Regulatory RBC.

6 – Understand the principles underlying the determination of Economic Capital.

Solution:

(a)

According to the IAA's paper, "A Global Framework for insurer solvency assessment," risks to be considered in Economic Capital (EC) can be categorized into five types.

Underwriting Risk:
- This is the risk associated with the perils covered by the specific line of insurance
- RBC covers underestimating liabilities on business already underwritten or inadequate pricing on new business – C -2
- Additional underwriting risks that should be considered in EC:
  - Product design risk, claims risks, underwriting process risk, economic environment risk, net retention risk, policyholder behavior risk and reserving risk

Credit Risk:
- Credit risk relates to the possibility of loss or adverse change in the company's financial situation due to non-fulfillment of contractual obligations by third parties
- RBC covered asset default risk on debts risk or fluctuations in the fair value of equities – C-1
- Additional credit risks that should be considered in EC
  - Downgrade risk/spread risk: Related to the change of spread (due to movement of credit curve or downgrade) which in turn leads to a change in market value of the assets
  - Counterparty default risk: The risk of default by counterparties to reinsurance contracts or over-the-counter risk mitigating derivative contracts
  - Concentration risk: Additional risk of partial or total losses of value due to large exposure to the same issuer
  - Migration risk, spread volatility risk and settlement risk

15. continued – United States

Market Risk:
- Risk results from the volatility and uncertainty inherent in the market value of future cash flow from insurer assets and liabilities
- RBC covered changes in interest rate environment risk, market risk and health risk (C-3)
- Additional market risks that should be considered in EC:
  - Equity risk: Exposure from investments used to back liabilities and surplus, also from products with associated guarantees
  - Currency risk, reinvestment risk, concentration risk, asset and liabilities management risk, off balance sheet risk

Operational Risk:
- This is the risk of loss resulting from inadequate or failed internal process, people, or system, or from external events
- RBC covers general business risks, e.g. losses due to fraud, mismanagement and litigation
- Operational failure risk: Arises from the potential for failure in the course of operating the business
- Operational strategic risk: Arises from environmental factors such as a major political, tax and regulatory regime change

(b)

RBC Formula:
Required Capital = C-1 + C-2 + C-3 + C-4 – Covariance Adjustment

Or

$$\text{Required Capital} = \left[C\text{-}2^2 + \left(C\text{-}1 + C\text{-}3 \right)^2 \right]^{0.5} + C\text{-}4$$

C-1 Component = C-1 RBC Factor × Total Asset Amount

Using reserves as a substitute for assets,

$$C\text{-}1 = 0.008 \times 450 = 3.6$$

C-2 Component = C-2 RBC Factor × Net Amount At Risk
$$= 0.0023 \times (800 - 450) = 0.805$$

C-3 Component = C-3 Amount
$$= 5.0$$

C-4 Component = C-4 RBC Factor × Premium

15. continued – United States

Since a specific premium amount was not given, can use reserves, or death claims as a substitute. In this case, it was assumed premiums are $10 million:

$$C\text{-}4 = 0.0308 \times 10 = 0.308$$

RBC Required capital $= 3.6 + 0.805 + 5 + 0.308 - 1.5 = 8.213$

Or

$$RBC = \left[0.805^2 + (3.6 + 5)^2 \right]^{0.5} + 0.308 = 8.946$$

Economic Capital requirement using the approx Normal distribution at 1% VaR
$$= 11 + 2.325 \times 6.5$$
$$= 26.12$$

15. Canada

Learning Objectives:

> **5** – Understand the Risk Based Capital (RBC) regulatory framework and the
>   principles underlying the determination of Regulatory RBC.
> **6** – Understand the principles underlying the determination of Economic Capital.

Solution:

(a)

According to the IAA's paper, "A Global Framework for insurer solvency assessment," risks to be considered in Economic Capital (EC) can be categorized into five types.

Underwriting Risk:
- This is the risk associated with the perils covered by the specific line of insurance
- MCCSR covers the most important underwriting risks: mortality, morbidity, lapse and interest margin pricing risk
- Additional underwriting risks that should be considered in EC:
    - Product design risk, claims risks, underwriting process risk, economic environment risk, net retention risk, policyholder behavior risk and reserving risk

Credit Risk:
- Credit risk relates to the possibility of loss or adverse change in the company's financial situation due to non-fulfillment of contractual obligations by third parties
- MCCSR covers asset default (C-1) risk
- Additional credit risks that should be considered in EC
    - Downgrade risk/spread risk: Related to the change of spread (due to movement of credit curve or downgrade) which in turn leads to a change in market value of the assets
    - Counterparty default risk: The risk of default by counterparties to reinsurance contracts or over-the-counter risk mitigating derivative contracts
    - Concentration risk: Additional risk of partial or total losses of value due to large exposure to the same issuer
    - Migration risk, spread volatility risk and settlement risk

15. continued – Canada

Market Risk:
- Risk results from the volatility and uncertainty inherent in the market value of future cash flow from insurer assets and liabilities
- MCCSR covers changes in interest rate environment (C-3) risk
- Additional market risks that should be considered in EC:
    - Equity risk: Exposure from investments used to back liabilities and surplus, also from products with associated guarantees
    - Currency risk, reinvestment risk, concentration risk, asset and liabilities management risk, off balance sheet risk

Operational Risk:
- This is the risk of loss resulting from inadequate or failed internal process, people, or system, or from external events
- MCCSR does not explicitly cover this risk
- Operational failure risk: Arises from the potential for failure in the course of operating the business
- Operational strategic risk: Arises from environmental factors such as a major political, tax and regulatory regime change

(b)

MCCSR mortality component under new requirement (transition period ended Q3 2008)

$\qquad$ = Volatility component (S) + Catastrophe component (K)

Volatility component
$$S = 2.5 \times A \times B \times E/F$$

Where
A = s.d. of projected death claims (given) = 12

B = max (ln(Macaulay duration of proj death claims), 1)
$\qquad$ (product does not qualify for reduced factor
$\quad$ = max (ln(8.5), 1)
$\quad$ = max (2.14, 1)
$\quad$ = 2.14

E = total amount at risk = total face amount – total reserve
$\quad$ = 800 – 450
$\quad$ = 350

F = total face amount = 800

S = 2.5 × 12 × 2.14 × 350/800
$\quad$ = 28.09

15. continued – Canada

Catastrophe component:
K = L × C × E/F

Where:
L = 0.1   (product does not qualify for reduced factor)

C = projected value of total death claims = 45

K = 0.1 × 45 × 350/800
  = 1.97

Total mortality requirement under MCCSR = 28.09 + 1.97 = 30.06

Economic Capital mortality requirement using the approx Normal distribution at
1% VaR
        = 11 + 2.326 × 6.5
        = 26.12

(c)

There are 3 dimensions in determining the level of EC
- The time horizon to use (e.g. one year or runoff)
- The measure of risk to use (e.g. VaR or CTE)
- The level of security to target (e.g. 0.5% or 0.1% VaR)

The liability runoff approach with VaR or CTE basis
- EC represents the current market value of assets required to pay all future policyholder benefits at the chosen security level less the current value of the liabilities

The one-year mark-to-market with CTE basis
- Same as the proposed method except for the security level basis chosen

(d)

Other modeling issues:

Stochastic analysis versus stress test
- Stochastic analysis is done by projecting future cash flow based on multiple scenarios of which probability distribution is defined.
- On the other hand, a stress test is done by projecting future cash flow based on a (set of) particular scenario(s) that could occur in some extreme environments but for which occurrence probability is not specific

15. continued – Canada

Real world technique versus risk neutral technique
- A real world technique is widely used and is a preferred method to calculate economic capital

Diversification effect
- The total capital requirement could be less than the sum of the capital required for individual risks to the extent that these risks are independent

Whether to allow negative cumulative surplus in the middle of the time horizon
- More capital is needed if negative cumulative surplus is not allowed

Whether to account for future new business
- Including future new business is likely to increase the required economic capital

16. United States

Learning Objectives:

1 – Understand the preparation of financial statements and reports of U.S. life insurance companies and be able to analyze the data in them.

Solution:

(a)

FAS 157
Risk Premium measures uncertainty in future cash flows
Risk Premium should not just be a "provision for adverse deviation," should represent the best estimate of the price a market participant would require for bearing such risk.

Cost of Capital approach may be used, but FAS157 does not specify a method

- Use observable inputs where available
- Most actuarial inputs (mortality, morbidity, lapse) are not observable market inputs
- Unobservable inputs should reflect the entity's own assumptions
- Reinsurance prices/quotes/capital market transfers may be used as observable information
- A risk margin should be considered it could affect the present value of cash flows

No requirement in FAS 157 that risk margins must be explicit

International Accounting Standards
    Risk Margin should
- Measure uncertainty of future cash flows
- Is explicit and unbiased
- Consistent with observable market price
- Measurement should be based on exit price
- Compensate market participants for bearing risk
- Not meant to be a shock absorber

    Risk margin should be estimated by
- Use cash flow scenarios to estimate the number of units of risk
- Estimate the margin per unit of risk
- Multiply the estimated margin per unit by the estimated number of units
- Reconciliation to test for errors and omissions

16. continued – United States

Risk Margins
- Are portfolio – rather than entity-specific
- Cannot be observed typically, so needs to be estimated
- Should not reflect risks that do not arise from the liability, such as investment or asset-liability mismatch
- Should be explicit – not implicit

There are two Implementations to estimate risk margin per unit:

Implementation A
- Estimate risk margin per unit as premium minus relevant acquisition cost
- No profit at inception

Implementation B
- Estimate what the market participant demands for bearing risk premium
- Profit may arise at inception
- IASB supports implementation B, but there is some support for implementation A

Use of explicit confidence levels preferred
Cost of capital models, percentile models, and capital-asset pricing models might be utilized, may use CTE

(b)

Initial capital is at least as great as potential change in FV under "severely adverse conditions"
Define adverse conditions as represented by the 99.5th percentile
Basic steps for quantifying potential change in FV liabilities:
- Specify solvency time horizon, such as one year
- Quantify BEL and MVM at $t = 0$
- Quantify potential change in BEL over 1 year at, say, 99.5th percentile for non-hedgeable insurance risks
- BEL ($t = 0$) + potential change in BEL = BEL ($t = 1$, distressed scenario – ds)
- Quantify the potential change in MVM over 1 year at, say, 99.5th percentile for non-hedgeable insurance risks
- MVM ($t = 0$) + potential change in MVM = MVM ($t = 1$, ds)
- Alt points: Potential change in FV

$$FV = FVL(ds, t = 1) - FV(t = 0)$$
$$= \left(BEL(t = 1, ds) - BEL(t = 0)\right) + \left(MVM(t = 1, ds) - MVM(t = 0)\right)$$

- BEL ($t = 1$, ds) and MVM ($t = 1$, ds) are conditional calculations based on the first year's adverse experience
- For MVM ($t = 1$, ds), intent is to capture RM that is appropriate after a distress event

16. continued – United States

(c)

Capital base for years 1 through 5 = Worst Case Liability (99.5^{th} percentile) – Expected (Best Estimate Liability)

	Worst Case Liability	BEL	Capital Base
Year 1	10.1	8.3	1.8
Year 2	9.3	7.7	1.6
Year 3	8.2	6.8	1.4
Year 4	7.0	5.8	1.2
Year 5	5.1	4.2	0.9

$$MVM = \sum (t = 1 \text{ to } N)\, PV\left(\text{Capital } t \times Rate\right)$$

Annual Cost of Capital Rate = 6%

Calculate "Annual Capital Charges" for each year:

	Capital Base	Cost of Capital Rate	Annual Capital Charge
Year 1	1.8	6.00%	0.108
Year 2	1.6	6.00%	0.096
Year 3	1.4	6.00%	0.084
Year 4	1.2	6.00%	0.072
Year 5	0.9	6.00%	0.054

Discount "Annual Capital Charges" at the risk free rate of 5% for 1 to 5 years

	Annual Capital Charge	Capital Base	Cost of Capital Rate
Year 1	0.108	$\left(\dfrac{1}{1.05}\right)^{1}$	0.103
Year 2	0.096	$\left(\dfrac{1}{1.05}\right)^{2}$	0.087
Year 3	0.084	$\left(\dfrac{1}{1.05}\right)^{3}$	0.074
Year 4	0.072	$\left(\dfrac{1}{1.05}\right)^{4}$	0.059
Year 5	0.054	$\left(\dfrac{1}{1.05}\right)^{5}$	0.042
MVM = Total			**0.364**

16. Canada

Learning Objectives:

1 – Understand the preparation of financial statements and reports of Canadian life insurance companies and be able to analyze the data in them.

Solution:

(a)

We require the difference between the Change in Tax Reserves and the Change in Statutory Reserves for 2008
- The methodology for Tax reserves for issues prior to 1996 is 1½ full preliminary term with a cash surrender value floor
- The methodology for Tax reserves for issues after 1995 is CALM
- The statutory reserve method for all issue years is the CALM
- Only 95% of the change in IBNR is deductible for Tax purposes

Statutory Reserves at 2007 = 4,500 + 8,700 = 13,200
Statutory Reserves at 2008 = 5,000 + 9,000 = 14,000
Change in Stat Reserves = 14,000 – 13,200 = 800
Change in Stat IBNR = 90 + 80 – 120 – 150 = -10

Tax Reserves at 2007 = max (6300, 4550) + 8,700 = 6,300 + 8,700 = 15,000
Tax Reserves at 2008 = max (6500, 5100) + 9,000 = 6,500 + 9,000 = 15,500
Change in Tax Reserves = 15,500 – 15,000 = 500
Change in Tax IBNR = 0.95 × (90 + 80 – 120 – 150) = -9.5

Difference = 500 – 9.5 – 800 + 10 = -299.5

(b)

Investment Income Tax = 15% of Taxable Canadian Life Investment Income
Where
> Taxable Canadian Life Investment Income = Life Investment Income – Amounts Reported to Policyholders – Loss Carry Forward

Non-participating and non-adjustable policies inforce on March 3, 1998 are exempt from IIT

Investment Income Rate for Block A is 65% of (Gov't of Canada Average Rate – Greater of Guaranteed Rate & 4%)

$$= 0.65 \times \left(0.075 - \text{maximum}\left(0.05, 0.04\right)\right)$$
$$= 0.65 \times \left(0.075 - 0.05\right)$$
$$= 0.65 \times 0.025$$
$$= 0.01625$$

16. continued – Canada

For all Blocks, applicable mean reserves is based upon 1½ full preliminary term

$$\text{Base Block A} = 0.5 \times (6,300 + 6,500)$$
$$= 0.5 \times 12,800$$
$$= 6,400$$

Block A Life Investment Income $= 0.01625 \times 6,400$
$$= 104$$

Investment Income Rate for Block B is 55% of Gov't of Canada Average Rate
$$= 0.55 \times 0.075$$
$$= 0.04125$$

$$\text{Base Block B} = 0.5 \times (9,700 + 10,000)$$
$$= 0.5 \times 19,700$$
$$= 9,850$$

Block B Life Investment Income $= 0.04125 \times 9,850$
$$= 406.313$$

Total Life Investment Income $= 104 + 406.313$
$$= 510.313$$

Taxable Canadian Life Investment Income $= 510.313 - 75 - 125 - 100$
$$= 212.313$$

Investment Income Tax $= 0.15 \times 212.313$
$$= 31.55$$

(c)

(i) Not valid
- Residence of insured at time of premium payment determines jurisdiction and applicable rate

(ii) Not valid
- Must include an imputed interest benefit in income
- Amount added to property cost which will decrease future taxable income

(iii) Not valid
- Must include loan repayments in income
- May deduct all policy loans incept during year from income

16. continued – Canada

      (iv) Possibly valid
- Assumed reinsurance premiums not subject to premium tax
- Exception in BC prior to 1998 for licensed insurers there

17. Canada

Learning Objectives:

2 – Understand and apply valuation principles of individual life insurance and annuity products issued by Canadian life insurance companies.

Solution:

(a)

(i)
Claims by gender

$Z = $ credibility factor

$$= \min\left(\left(\frac{N}{3007}\right)^{\frac{1}{2}}, 1\right)$$

$N = $ number of claims (solve for based on Z)

$$N(\text{male, medical}) = 0.18^2 \times 3007 = 97.43$$
$$N(\text{female, medical}) = 0.10^2 \times 3007 = 30.07$$
$$N(\text{total medical}) = 97.43 + 30.07 = 127.5$$

(ii)
Blending expected mortality ratios by gender
Blended expected mortality ratio
$= Z \times$ mortality ratio for Company $+ (1 - Z) \times$ mortality ratio for industry

Blended expected mortality ratio for male medical
$= 0.18 \times 0.62 \, (1 - 0.18) \times 0.74$
$= 71.84\%$

Blended expected mortality ratio for female medical
$= 0.10 \times 0.50 \, (1 - 0.10) \times 0.78$
$= 75.2\%$

(iii)
Total mortality ratio
Company expected claims at 100% Industry mortality
$= $ # of claims / Company mortality ratio

Company expected claims at 100% Industry mortality for male medical
$= 97.43 / 0.62 = 157.15$

17. continued – Canada

Company expected claims at 100% Industry mortality for female medical
$$= 30.07 / 0.50 = 60.14$$

Total $= 157.15 + 60.14 = 217.29$

Expected number of claims under blended mortality ratio
$$= \text{company expected claims at 100\% of industry} \times$$
$$\text{blended expected mortality ratio}$$

Expected number of claims under blended mortality ratio for male medical
$$= 157.15 \times 71.84\% = 112.90$$

Expected number of claims under blended mortality ratio for female medical
$$= 60.14 \times 75.2\% = 45.23$$

Expected number of claims under blended mortality ratio for total medical
$$= 112.9 + 45.23 = 158.13$$

Total Medical Ratio
$$= \text{Total Medical Expected Claims / Total Medical Expected Claims at}$$
$$\text{100\% industry mortality}$$

Total Medical ratio $= 158.13 / 217.29 = 72.77\%$

(b)

(i)
General Principles to consider in setting MfADs
- MfADs often based on historical data - the appropriateness of these are justified on a prospective basis
- Maintaining a margin for adverse deviations is subject to the same level of scrutiny as implementing a change
- Change in liabilities would not reflect a change in past experience that actuary believes is temporary
- Take account of effect of uncertainty of assumptions/data for the calculation on financial security of those affected
- Do not account for catastrophe or other implausible deviations
- Margin should account for all relevant contingencies
- Margin should increase policy liabilities
- The change in margin for adverse deviations would be supported by a change in the assessment of the level of risk

17.   continued – Canada

- Low margin for adverse deviations for the mortality rate per 1000 is an addition of $3.75 / e_x$
- High margin for adverse deviations for the mortality rate per 1000 is an addition of $15 / e_x$
- e_x is best estimate curtate expectation of life at the life insured's projected attained age

(ii)
Appropriate margin for new term product
- MfAD = at least the average of high and low margin whenever at least one significant consideration exists
- Significant considerations vary by type of assumption
- For Insurance Mortality, significant considerations include
    - Low Credibility
        - Future Experience Difficult to estimate
        - Lack of homogeneity
    - Unrefined derivation of the best estimate assumptions
- It is a new product designed for entering a new market, so future experience is difficult to estimate
- At least one significant consideration exists
- A MfAD for the mortality rate per 1000 of an addition of at least 9.375 is appropriate
- Underwriting practice change would lead to larger MfADs
- Recommend MfAD higher than average