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**Actuarial Society of India**

**EXAMINATIONS**

*June 2005*

*ST2 – Life Insurance*

**Indicative Solution**

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**Answer 1(a)**

Profit Test

- Technique that involves discounting future cash flows arising under a contract for assessing profitability of a contract. [1]
- The profit test can measure profitability as a percentage of first year's premium or commission.
- Can be used to determine premium rates or charges.

Return on Capital

- The return on capital is often measured as the internal rate of return on the capital that is required to write a contract [[½ mark for each point, max 2]
- The required return on capital is often determined by shareholders as the ultimate suppliers of capital
- Arises in the context of product pricing.
- Company usually needs capital to write new business.
- Expected return on capital will influence whether or not the company writes particular types of business and the price at which it will write them.
- The expected level of return will depend on the expected levels from other uses of the company's capital.

**Answer 1 (b)**

Profitability, conflicts with marketability and competition risks

- Need to compete may lead the management to take decisions which increase the risk to the insurer.

Actions may be taken to increase marketability but which conflict with profitability objectives:

- May reduce the premium rates or charges under new business contracts. [1/2 mark for each point, maximum 2]
- May offer additional guarantees and options
- May increase salaries or commissions to the respective distribution channels.

Impact of the above decisions on the available resources will be compounded if greater volume of new business than expected result.

However, the greater new business volumes may improve profitability because of fixed costs and reaching critical mass

**Answer 1(c)**

Index Linked deferred annuity

- Main risk is the investment risk. [½ mark for each point, max 5]
  - May not be able to invest to match the benefit that it is being guaranteed.
  - Reputation risk in case the benefits to the policyholder is reduced in line with the index.
  - As the constituents of the index change, the company will have to buy and sell stocks accordingly.
  - In practice, it will broadly match the movements of the index with a carefully selected reduced number of stocks to reduce the broker charges. To this extent, there is investment risk from which the company may lose or gain.
  - The company may choose to mismatch more aggressively. This would be a risky strategy.
  - The initial reserves needed to cover the risks may lead to a capital strain at entry.
  - If some of the index stocks are not actively traded, it may be impractical or
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expensive to exactly match the weightings in the index.

- Conversion rates which allow for expenses and mortality during deferment will expose the company to expenses and mortality costs being higher than anticipated as the price is effectively being set at the time the premium is paid.
- There is an investment risk if the surrender penalty is not always applied, or does not fully reduce the withdrawal benefit to the value of the backing assets.

### Answer 2(a)

#### Asset Share

- Accumulation of premiums paid less deductions at actual rate of investment return based on allocated assets.
- Smoothing.
- Cost of capital and cost of guarantees.
- Surrender profits/losses on with profit policies.
- Expense overruns.
- Allocation of miscellaneous profits and profits from without profit contracts if appropriate.
- Run off / contribution to free estate.
- Cohort of policies - the asset share per policy is the total asset share for a cohort of policies divided by the number of survivors out of the cohort.
- Assuming that we are calculating asset shares at the end of the year and the cash flows occur in the middle of the year, using a recursive formula:

[½ mark for each point max 4]

$$(AS)_t = (AS)_{t-1} + (1+i)^{1/2}(P_t - C_t - E_t - T_t) - M_t - S_t$$

$$(AS)_0 = 0$$

(AS)<sub>t</sub> = retrospective asset share at time t

(i)<sub>t</sub> = actual gross investment return

(P)<sub>t</sub> = premiums received during year t

C<sub>t</sub> = actual claims in the year t

E<sub>t</sub> = actual expenses incurred including overheads and commission paid in the year t

T<sub>t</sub> = actual tax paid plus allowance for deferred tax

M<sub>t</sub> = miscellaneous adjustments for profits or losses, cost of guarantees, options and capital support in year t

S<sub>t</sub> = transfer to shareholders during year t if a proprietary company

[1 mark for formula and 1 mark for describing terms]

### Answer 2(b)

#### Asset Shares and Bonuses

- The distribution of profits should reflect the investment, expense and mortality experience of the group of policies.
  - The asset share represents the maximum amount that the insurance company has available in respect of a policy to pay maturity and surrender payments if it is not to make a loss. (shareholders transfers would be funded from asset share)
  - Treatment of negative asset shares at early durations – may require use of an
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accumulation rate that reflects the costs and risks of funding negative amounts

- A bonus reserve valuation, BRV, would be calculated on a realistic basis and allowing for future bonuses on a consistent basis
- The results of the BRV would be compared with the asset shares to check whether the bonuses are affordable
- The comparison would also check that the bonuses give a reasonable pay out by means of reversionary bonus to different generations and classes of with profit policyholders.
- The bonuses would take into account Policyholder Reasonable Expectations.
- Sometimes companies may declare bonuses greater than the asset share can support and sometimes may under-distribute in case of exceptional movements in asset shares
- The availability and use of asset shares ensures the extent of such departures are kept under control .
- It is used as a guide to determine the rate of terminal bonus. Terminal bonus rates set to be equal to difference between asset shares and benefits guaranteed to date on maturing policies,
- The TB rates would be smoothed so that the pay outs reduce the impact of fluctuations in the investment market.
- Asset shares may be a part of the company's formal bonus declaration policy.
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[1/2 for each point – max 5]

### Answer 3(a)

Data

Types

- Mortality
- Investment
- Expenses
- Tax
- Withdrawals, paid-ups, dormancy
- New business mix – product type, age and term profiles
- In force data and policy movements

[½ for each point – max 3]

Purposes

- Internal investigations generally so as to give proper advice to the company.
- Valuation of the actuarial liabilities – statutory, financial reporting
- Embedded or appraisal values.
- Product pricing.
- Bonus determination.
- Unit pricing.
- Surrender values.
- Market value adjustments.
- Operational and strategic projections.
- Capital planning..

[½ for each point – max 4]

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- Company's strategic decision making.
- The investigations based on accurate data help us to compare the expected experience with the actual experience and help the management to take remedial actions if necessary. – the Control Cycle

**Answer 3 (b)**

Term insurance options

- These options eliminate a selection process.
- In case of options, there is a cost to the company as the company is offering terms in advance to be selected by the policyholder.
- There is a risk to the company of determining the actual cost of these options.
- The cost to the company has to be covered by loading in the future premiums.
- The main risk to the company arises from mortality as the option to convert the term assurance or to renew it.
- In case of conversion options to a permanent plan, anti selection may be less onerous than in renewal options as the policyholder is opting to pay higher premium due to the savings element.
- There will be significant anti selection risk at the time of renewal of term assurance option at the end of the term.
- As renewal may involve lower initial expenses, there may be savings on the initial cost loadings in the premiums to compensate for the expected extra mortality.
- The additional mortality risk depends also on the original term of the policy and whether these options are exercisable during the entire term of the policy or for any shorter period in case of conversion options to a permanent plan.
- Limiting the sum assured to the original sum assured may offer some protection against extra additional mortality to the company.
- This again depends whether these options will be vigorously advertised and actively followed up.
- There is also a mortality risk on withdrawals as withdrawing policyholders may have better than average mortality.
- There is also a risk that any additional premiums charged for the entire term of these options are not realized.
- Additional solvency margin requirements for both the options may be significant. [Deletes? – I don't think this is a risk ]
- Charging of extra premiums for these options may not be viewed favorably in the market and more healthy lives may opt to go for cheaper term assurance policy without options.

[½ mark for each – max 7]

**Answer 3(c)**

[1]

Option Cost

[½]

Excess of premium that should have been charged over normal charge in the light of full underwriting information

[½]

- Some lives no cost.
- Lives who perceive themselves to be in poor health more likely to take up option and those who perceive themselves to be in good health less likely to do so; the net effect can be a considerable cost to the office.

**Answer 3(d)**

[1 mark for each accurate description,

Option – Pricing methods

- Assumptions – probability that option will be exercised and expected mortality of

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those who do.

- Description of N. American method – double decrement table for lives who have not exercised and a mortality table for those who have; and the cost of the benefits for those who exercise the option over and above normal costs are measured directly and then related to all policyholders surviving up to the option dates.
- Description of Conventional method – all lives eligible to take up option do so and mortality experience of those who take up the option will be the ultimate experience which corresponds to the Select experience that would have been used as a basis if underwriting had been completed as normal when the option was exercised.
- Difficult to obtain data for N. American method.
- Conventional method relies upon Select and Ultimate Mortality in original pricing basis only.
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½ mark for each advantage / disadvantage with max of 1 and overall max 3]

#### Answer 4 (a)

##### Modelling methodology

- Allow for all cash flows that may arise for the company.
- Cash flows will depend on the nature of contracts sold in terms of their premium, benefit structures, options and guarantees and any discretionary benefits.
- Allow for any supervisory requirements to hold reserves and adequate margin of solvency.
- Provide for interactions between various items of cash flow in the model. Such as between bonus rates, valuation rate of interest, expenses inflation and investment returns.
- First step is selection of model points to represent the business of the company.
- Existing business grouped in to a manageable number of homogeneous groups to help in the selection of model points
- Model points selected should be representative of the group so that the result through the model point can be scaled up to get the results for the whole group.
- Number of groups for the purpose will be optimal depending on cost and time factor.
- Future new business projections should start from the new business mix for the current year and take in to account the company's future plans.
- Parameters like mortality rate, interest rate, expense level, new business growth, withdrawal rate should reflect the company's experience.
- Asset modeling
- Consistency of assumptions with each other
- Modeling will require subsidiary models like policy liability model, sales model, expenses model etc. linked to each other.
- Sales model projects number of new policies sold in each future year and premium income for the period.
- Starting point for the expenses model is the budget for the year and the expenses are projected using company's future plans.
- Assumptions are required to be made for sales model and other sub models based on company's experience and future plans.
- Combine results from these sub models
- The company's future balance sheet and cash flow are drawn with the use of these

[½ mark for each point, maximum 8]

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models.

- The balance sheet thus drawn for each of the future years will help the actuary to manage the solvency requirements and infusion of capital in future.
- The company's share of future profits arising are discounted at appropriate rate of risk discount rate to give expected present value of share of profits to the shareholders as a measure of the business performance by the company

**Answer 4(b)(i)**

Long term solvency – deterministic or stochastic

- Range of assumptions needed for stochastic methods is more extensive and the reliability of stochastic results will only be as good as the reliability of the assumptions
  - A single deterministic result using average assumptions will give the results for a particular scenario only given little insight as to the extent of the risks to which the company is exposed.
  - A series of deterministic calculations based on amended assumptions may give upper and lower bounds to the results expected. This gives the sensitivity of the outcome to the different parameters and would be adequate for certain purposes
  - A deterministic model will not give adequate information about resilience of the company to fluctuations in its experience, Ex. investment returns ,given a certain level of guaranteed benefits.
  - The impact of financial guarantees can better be assessed by use of stochastic models.
  - The impact of financial guarantees can only be assessed by examining a probability distribution of the scenarios that trigger the guarantees.
  - Stochastic model can help in determining the company's resilience to possible future scenarios.
  - The future values of the parameters are assumed to vary together as a dynamic set.
  - In a stochastic process, a number of runs of the model are made changing one or more future variables according to some probability distribution.
  - Need to consider management actions in extreme scenarios esp if modeling wp business
  - The results can be tabulated to assess the resilience given the company's capital position and find the probability of ruin.
  - Some times time and cost and computing constraints may suggest a deterministic approach to assess the future scenarios.
- [½ mark for a definite view with acceptable rationale, 1 mark for specific mention of financial guarantees and their distribution, ½ mark for each point max 3 ½ and overall max 5]

**Answer 4(b) (ii)**

Long term solvency – presentations to Directors

- Concept of a sample path
  - Explain assumptions and judgments
  - Explain sensitivities
  - Use diagrams to illustrate principles
  - Indicate extent to which ratio of assets to liabilities fell below benchmark.
  - Probability of potential future insolvency of a particular investment strategy.
- [1 mark for each or equivalent valid point – max 3]
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**Answer 5(a)**

Initial Expenses – UL Products

- Low, or zero, allocation rate for a short period at the start of the contract followed by higher allocation rate.
  - Risk - marketability
- A moderately reduced allocation rate throughout the term.
  - Risk - failure to recoup in the event of termination
- Capital units and accumulation units - units allocated in the early years carry a higher management charge than the units allocated in the subsequent years.
  - Risk - administrative complexity
  - Risk – customer understanding

[1/2 mark for each method and risk – maximum of 3]

**Answer 5 (b)**

Capital Units / Actuarial Funding

- Capital or initial units attract higher management charges than accumulation or ordinary units.
- Purchased by premiums paid in the early years.
- Used to reduce the first year's capital strain in certain circumstances.
- Actuarial funding can be done provided there is sizeable quantity of fund management charges to prefund -but only if the overall reserve is not reduced below the surrender value
- Factors take the form of  $A_{x+t:n-t}$  where  $t$  is the duration 0 to  $n-1$  and  $x$  is the age at entry, and at a suitable rate of interest.
- Actuarial funding factor calculated at a rate of interest equal to the excess of the capital unit management charge over the accumulation unit management charge.
- The assurance function is called the actuarial funding factor.
- The company will need the full amount of units only on a contractual claim like death or maturity.
- In case of deaths, the short fall is made good from non- unit fund.
- The actuarial funding method helps the company to hold a smaller number of units in the unit fund at inception than would be bought for the given amount of premium as per the terms of the contract
- Should have enough money in the non-unit fund to meet the payments on future deaths or maturities or on surrender.
- Actuarial funding method is suitable when the allocation percentage of the premiums to the unit fund are uniform through out the term but the units allocated in the first few years carry a higher management charge .

[½ mark for each point maximum of 6]

**Answer 6(a)**

Simplified Underwriting – email

- Agree streamlined approach would improve marketability of product.
  - Reduced underwriting expenses.
  - Increased contribution to fixed costs from higher volumes.
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- But could attract lives in poorer health to apply.
- Streamlined processes wouldn't pick up risks that would otherwise be picked up.
- Premium rates and / or bonus rates would need to reflect likely / actual experience both good and bad and overall effect could be higher price than might otherwise be possible.
- Reinsurance cost could be higher as general extent of reinsurance may need to be increased and all reinsurance includes reinsurers' cost and profit margins.
- Need to ensure fairness between policies with different types of underwriting and potentially different mortality experience.
- Streamlined underwriting could result in borderline cases being rejected whereas more extensive information could have resulted in acceptance.
- Mortality assumption more important for whole of life and need to ensure alignment of experience and pricing.
- Higher premium – higher sum insured – higher risk.
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- Increased overall uncertainty as to product mix, premium size, nb volumes etc leading to increased risk in managing the com[any generally.
- Potential for overall marketing/distribution costs to increase.

[1 mark for conclusion being given with acceptable rationale  
2 marks for email style  
½ mark for each point made max 3]

#### Answer 6(b)

##### Reinsurance - Changes

- Larger policies and shift to whole of life will increase sums at risk and volatility of claims – retention levels could be reviewed.
- Increased cover at older ages adding to uncertainty – my need age related retention scales not needed past
- Treaties may need to be revised to reflect new underwriting standards.
- Uncertainty as to future claim levels – new type of risk and lower underwriting standards – parameter risk – consider sharing with reinsurer.
- May need reinsurer's help in pricing and design of underwriting approaches.
- Expansion may impose capital strains that could be addressed via financial reinsurance.

[½ mark for each point made – max 2]

#### Answer 6 (c)

##### Reinsurance - Optimisation

- Estimate statistical distribution of mortality costs.
- Examine impact of retention levels on distribution.
- Target probability levels for degrees of departure from expected.
- Probability of insolvency below a specified level.
- Consider relevance of volatility of profit
- Stochastic methods can be used to simulate claims and derive probabilities of various solvency and profitability outcomes and how they are affected by varying retention levels.
- Consider alternative of mortality fluctuation reserve taking into account cost of financing.

[½ mark for each point made – max 3]

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- Consider cost of reinsurance offset by assistance form reinsurer and profit commission.
  - Minimise cost of financing fluctuation reserve and cost of reinsurance.

**Answer 6(d)**

Experience – Cycle

- The new operating model has the potential to change the company's experience in a number of areas which should be monitored continuously with outcomes used to revise assumptions made in a number of analyses and projections.
- Business written on new underwriting basis should be monitored as a homogenous risk group.
- Urban or non urban monitored to verify or otherwise that mortality experience is different.
- Medical / non-medical status.
- Size to verify that business from new sources is for larger amounts – relevant to expense assumptions used in pricing .
- Occupation to verify or otherwise that occupation class differences are present and driving experience.
- Product mix – relevant to corporate projections generally.
- Expenses – especially to verify expense assumptions made in conjunction with reduced underwriting costs and increase volumes.
- Withdrawals which may be different for business sourced in a different manner and so needs to be reflected in overall assumption set.

[½ mark for each point made – max 3]

**Answer 7(a)**

Supervisory Valuation Principles

- Guaranteed benefits
- Bonuses already guaranteed
- Options available to policyholder
- Future bonuses of all kinds including PRE
- Taking credit for premiums due to be paid
- Prudent includes appropriate MADs
- Take into account nature, term and method of valuation of assets
- Appropriate approximations should be allowed
- Prudent interest taking into account currency, yields on existing assets and yield expected to be earned in future
- Prudent elements in the statistical basis
- Prudent estimate of future expenses
- Reserves should recognise profit in an appropriate way over the duration of each policy and should not be subject to discontinuities arising from arbitrary changes to the valuation basis

[½ mark for each point – max 7]

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- Each company to disclose methods and bases
  - Allowance for company ceasing to write new business if that would increase the reserve.
  - Allow to the promised or because of PRE
  - Terminal bonuses should not have been promised
  - Terminal bonuses should not form part of PRE
  - Reserving for terminal bonuses reduces free assets
  - Future surpluses are projected to emerge in a suitable pattern and amount so as to match the assumed future regular bonus.

**Answer 7(b)**

Reserving and Solvency Margins

- Need to be viewed as a whole as conservatism in one element might be offset by a less conservative approach in the other and vice versa.
- No right answer and different countries have different approaches.
- There is assumed to be some relationship between size of reserves and the risk of the reserves being inadequate
- Balance can differ – solvency margin may in part be related to sum at risk
- But generally the solvency margin is proportional to the reserves in many supervisory regulations
- However different proportions may apply to the reserves for different types of products
- There may also be restrictions in reductions due to reinsurance

[½ mark for each point made – max 2]

**Answer 7(c)**

Stat. Reserves and Pricing

- Profit testing methods take into account the need to set up Statutory Reserves and Solvency Margins
- The higher these reserves and margins, the greater the need for capital to support the product.
- Profit testing will often target a minimum return on capital required by shareholders and the higher the capital required the higher the premium rate or charges will need to be
- Higher levels of reserve and solvency margin may reduce the present value of profits when these are discounted at a rate greater than the investment return assumed.
- Irrespective of return on capital, a shareholder might have limits or requirements on the amount of capital it can commit and these could influence product design for example by higher initial charges.
- Limits on capital plus the reserving and solvency requirements could cause constraints on the company's ability to invest in systems and marketing processes that go to make up an attractive product.

[½ mark for each point made – max 3]

**Answer 8(a)**

Principles of Investment

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- Nature, term and currency of liabilities
  - Maximise overall return
  - Income and capital gains are both components of investment to be managed appropriately.
  - Departures, to maximise return depend on free assets

[½ mark for each point – max 2]

**Answer 8(b)(i)**

Free Assets

- Assets not needed to cover liabilities
- Normally assets in excess of statutory reserves and / or solvency margin
- Could be excess over realistic liabilities or asset shares.
- Need to be clear about definition of assets –market or book value.

[½ mark for each point max 1]

**Answer 8(b)(ii)**

Directors Point of View

- Shareholder income not maximised.
- Implies underdistribution of bonuses to policyholders.
- Lazy capital with a portfolio rate of return only.
- Will invite unwarranted attention from media, regulators or disaffected shareholders or policyholders.
- Implies company has run out of uses for capital as it would otherwise seek to return free assets to shareholders or find an acceptable commercial use.

[½ mark for each point max 3]

**Answer 8(b)(iii)**

Reply to Director

- Potential statutory limits on transferring free assets out and timing issues
- Policyholders Reasonable Expectations – may be relying on the presence of free assets to facilitate a less constrained investment strategy leading to higher bonuses without compromising security.
- Policyholders Reasonable Expectations – security
- Marketing – some advisers may favour companies with higher levels of free assets because of greater security and the prospect of higher levels of bonus.
- Rating Agencies – ratings affected positively by relatively high free assets with consequent marketing benefits and potentially reduced cost of capital.
- Potential tax issues if assets are realized.
- Reduced risks to shareholders to support solvency
- Enhanced returns to shareholders via higher bonuses and dividends.
- Could constitute capital for future new business or business development generally so should be viewed in the context of the companies plans.

[½ mark for each point max 3]

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