

# **Institute of Actuaries of India**

## **Subject ST2 – Life Insurance**

**May 2008 Examination**

### **INDICATIVE SOLUTION**

#### **Introduction**

The indicative solution has been written by the Examiners with the aim of helping candidates. The solutions given are only indicative. It is realized that there could be other points as valid answers and examiner have given credit for any alternative approach or interpretation which they consider to be reasonable.

1. (i) Gross Premium  
 Investment income  
 Realised capital gains/losses  
 Unrealised capital gains/losses  
 A share in the profits from without profits business sold by the with profit fund  
 Initial commission  
 Renewal commission  
 Expenses associated with acquiring and setting up new policies  
 Ongoing administration expenses (maintenance and claim)  
 Investment expenses  
 Cost of any death benefits  
 Cost of any further benefits under the policy (e.g. waiver of premium)  
 Surrender profits or losses  
 Charges for any options or guarantees  
 Tax  
 Contribution to the transfer of profits to the shareholders  
 Cost of capital to the contract  
 Contribution to free assets to support a smoothing policy

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## 2.

(i) Surrender value = Present value of {Benefits + Claims expenses + Renewal expenses – Premiums} – Alteration expense

$$\begin{aligned} \text{Present value of benefits} &= 500,000 * A_{55:10} \text{ at } 6\% \text{ p.a.} \\ &= 500,000 * 0.56922 \\ &= 284,610 \end{aligned}$$

$$\begin{aligned} \text{Present value of claims expenses} &= 0.5\% \text{ of present value of benefits} \\ &= 0.005 * 284,610 = 1423.05 \end{aligned}$$

$$\text{Expense inflation} = 1.92\% \text{ p.a.}$$

Since  $1.0192/1.06 = 1/1.04$ , can use annuity factor at 4% p.a. to allow for future inflation of renewal expenses.

Assume renewal expenses are incurred annually in advance, in line with premium payments.

$$\begin{aligned} \text{Present value of renewal expenses} &= 200 * \ddot{a}_{55:10} \text{ at } 4\% \text{ p.a.} \\ &= 200 * 8.219 \\ &= 1,643.8 \end{aligned}$$

$$\begin{aligned} \text{Present value of premiums} &= 10,000 * \ddot{a}_{55:10} \text{ at } 6\% \text{ p.a.} \\ &= 10,000 * 7.610 \end{aligned}$$

$$= 76,100$$

$$\text{Alteration expense} = \text{Rs.}500$$

$$\begin{aligned} \text{So surrender value} &= 284,610 + 1423.05 + 1,643.8 - 76,100 - 500.0 \\ &= \text{Rs.}211,076.85 \end{aligned}$$

(ii) Let the paid-up sum assured be denoted PUSA.

This is then calculated from:

$$\text{Surrender value} = \text{Present value of \{Paid-up benefits + Paid-up claims expenses + Paid-up renewal expenses\}}$$

$$\begin{aligned} \text{Present value of paid-up benefits} &= \text{PUSA} * A_{55:10} \text{ at } 6\% \text{ p.a.} \\ &= \text{PUSA} * 0.56922 \end{aligned}$$

$$\text{Present value of paid-up claims expenses} = 0.005 * \text{PUSA} * 0.56922$$

$$\begin{aligned} \text{Present value of paid-up renewal expenses} &= 20 * \ddot{a}_{55:10} \text{ at } 4\% \text{ p.a.} \\ &= 20 * 8.219 \\ &= 164.38 \end{aligned}$$

$$\text{Surrender value from part (i)} = 211,076.85$$

So:

$$211,076.85 = \text{PUSA} * 0.56922 * 1.005 + 164.38$$

$$\begin{aligned} \text{PUSA} &= \{211,076.85 - 164.38\} / \{1.005 * 0.56922\} \\ &= \text{Rs.}368,685.49 \end{aligned}$$

(iii) The change in risk exposure should be considered:

The maturity benefit under this policy is guaranteed whereas the value of equity shares is volatile. This risk is increased if the equities purchased are not well diversified. This means that there is greater downside risk if investing in shares. But there is also greater upside potential.

If the policyholder decides to surrender the policy and invest the proceeds into equities then he loses the whole guarantee. If he decides to make the policy paid-up and invest future premiums into equities then he retains part of the guarantee.

The policyholder therefore needs to take into account his attitude to risk.

The change in protection cover should be considered:

This policy is not just a savings policy, it is also a protection policy: the death benefit is considerably higher than the surrender value. If the policyholder decides to surrender the policy then he loses this extra death benefit cover. If he makes the policy paid-up then it reduces significantly.

Depending on his personal circumstances, this protection might be important.

Other issue to consider:

It will be necessary to consider the tax implications of the surrender and investment in equities.

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3. (i) The factors by which the data could be analysed are as follows:

Usually the withdrawal experience would be measured separately for each product

Partial withdrawals would be analysed separately

Duration in force — withdrawals rates are generally higher near the start of the contract, but this will depend on any point guarantees or surrender penalties on the contract.

Target market — the degree of care taken ensuring that a suitable product is sold may depend on the target market. The more suitable the product, the lower the withdrawal experience.

The size of premium and original term of contract would also be considered

The data would also be split by sales channel and advisor. Customer data may also be split by sex and age if its expected that experience varies by these factors

Care would be taken not to sub-divide the data so much that there are insignificant amounts in each cell – consideration would be given to grouping data into say 5 year bands in such circumstances

The process the company would use is to first split the data into the above homogenous groups. The number of contracts issued in the last financial year is then divided into the corresponding number that survive in force until the first policy anniversary to give a first year persistency rate.

The first year withdrawal rate can be determined as one less the persistency rate. Alternatively look at the number of withdrawals divided by the exposed to risk. Deaths and maturities should be excluded from the investigation (if material). A similar process can be adopted to obtain the second year, third year etc. withdrawal rates.

(ii) Other investigations the company might do include the following:

The company's profits will be sensitive to policies being made paid-up and to premiums being reduced, as well as to withdrawal rates. An analysis of policies that are made paid-up could be done as a subsidiary part of the withdrawal analysis.

One issue that the company faces is to determine when the policy was made paid-up since the premiums can stop for 12 months before becoming paid-up.

An analysis of premium reductions could also be performed. However this could require data which is not readily available. Also there is the issue that someone may be reducing a premium back to a previous level after a recent increase and so a decision should be made as to whether this really constitutes a reduction.

In addition some people may make one off payments, and reverting back to their normal monthly level should not constitute a reduction in the premium

An analysis of premium holidays could also be performed (both frequency of premium holiday and length of the holiday), but data as to the duration of the premium holiday would be required.

Generic problems with the above are that low levels of data could mean results are spurious. These analyses will however be important in understanding the analysis of surplus and its limitations. The results may also help with setting pricing assumptions and reserving assumptions.

The benefits of extending the analysis should be estimated to ensure that they justify the cost.

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#### 4.

(i) The amount of the reserves should be calculated by a suitably prudent actuarial valuation of all future liabilities, including options and guarantees, for all existing policies.

Where no explicit allowance is made for future bonuses, the valuation rate of interest should be reduced

The rate of interest used in the calculation of the reserves should be chosen, taking into account the currency in which the policy is denominated, and having regard to the yields on corresponding existing assets and to the yield which it is expected will be obtained on sums invested in the future

The elements of the statistical basis (demographic, withdrawal) should be chosen taking into account the type of insurance, country where insured people live

The valuation should take account of the nature, term and method of valuation of the corresponding assets

The method of calculation of the reserves from year to year should be such as to recognise profit in an appropriate way over duration of each policy, and should not be subject to discontinuities arising from arbitrary changes to valuation basis

Each life insurance company should disclose the methods and bases used in the valuation

If the valuation method defines expense to be used in the valuation, the amount should not be less than prudent estimate of relevant future administration and commission costs

The reserves should be subject to a minimum of zero.

**(ii) Suitably prudent method**

The Net Premium method is suitably prudent because:

guaranteed benefits are valued directly by the net premium method

bonuses which have already been guaranteed, whether described as vested, declared or allotted are valued directly

options: the net premium method would not allow for the cost of options and so an additional reserve would be needed

Future premiums: the method takes credit for future premiums by valuing the net premium.

**Future Bonuses**

Allowance is made for future bonuses through a reduction to the valuation rate of interest.

The difference between the office and net premium may also include a margin for future bonuses, although this margin would usually be used as an allowance for future expenses.

Terminal bonus is not reserved for explicitly. However, the method is used with a book value of assets, so that investment appreciation is taken to an investment reserve, and not brought into the comparison between assets and liabilities when surplus is determined.

### **Expenses and Commission**

The margin between the office and net premium allows for future expenses. A Zillmer adjustment may be used to allow for initial expenses. Though being implicit, this may not be adequate, in which case an additional reserve would be held, or the net premium restricted to a maximum % of the office premium.

There is no explicit allowance for inflation so this needs to be taken into account in assessing the adequacy of the margin between the office and net premiums

### **Statistical Basis**

The mortality used in the valuation is set prudently, by reference to current and expected future experience.

### **Interest rate**

The valuation interest rate used in the Net premium method is related to the yield on the assets.

### **Recognition of Profit**

The method produces a smooth emergence of profits, if used in conjunction with assets taken at book value.

### **Disclosure**

The net premium method and basis are simple to describe for disclosure purposes.

(iii) The impact of a decrease in the value of assets on the valuation basis depends on the mix of assets and how much of the fall in assets is absorbed by the free estate.

If the decrease in value of assets is primarily in the value of equity investments then this would probably be absorbed by a reduction in the investment reserve and would have a much reduced impact on the liabilities

If the decrease were accompanied by an increase in interest rates this would decrease the value of the liabilities because the valuation interest would also rise (but not necessarily by the same amount). However, this would not necessarily mean that the value of liabilities would decrease by the same amount as the assets because:

the assets and liabilities are unlikely to be completely matched so the assets and liabilities will move by different amounts (although the impact on liabilities would only be less other things being equal if the assets were of longer duration)

The valuation interest rate change also changes the amount of the net premiums meaning that the liabilities are less sensitive than assets of a similar term

Any changes to the implicit allowance for future bonus will have an impact the increase in the valuation rate may be limited by any restrictions in the maximum reinvestment rate allowed

The impact of the change in net premiums would be impacted by any restrictions on the net premium as a proportion of office premium

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5. The company will have to decide whether to offer just one of the charging structure options, or whether to offer both as alternatives.

### **Profit Testing**

For each chosen version, it will have to perform profit testing to determine what level of charges will be sufficient to cover its expenses and provide a profit margin in line with target requirement.

If the result of these tests is that a charge which is acceptable to the insurance company exceeds  $x\%$  and/or  $y\%$ , then it may have to accept that one or both is not a viable option.

### **Assumptions**

In order to perform profit testing, the company will have to make assumptions regarding future experience, particularly the level of future premiums and persistency.

The company will have to consider the fact that past persistency experience might not be relevant to the new charging structure. For example, the absence of explicit surrender penalties and the standardisation of charging structures means that employers might transfer their policies more readily.

Persistency and premium level experience might also differ between version (a) and version (b) of the charging structure.

### **Selection**

As two charging structures will be available, employers could select against providers. For example, if they do not expect to be paying significant levels of future premium then they might be more likely to opt for a version (b) product. If they expect the term of investment of each premium to be relatively short, then they might be more likely to opt for version (a).



If the company offers both versions of the product, in order to reduce the impact of anti-selection it will have to decide whether it should introduce restrictions regarding the extent to which employers can switch between the two versions. However, such a restriction could reduce the attractiveness of the product to the market.

It might not be permissible under the new regulations.

It might also encourage employers simply to switch to other providers.

### **Market/Competition**

The company should, if possible, monitor what competitors are intending to offer, and set charge levels which are not out of line with these other products.

As the charging structure is so transparent, these products are likely to be purchased primarily on price. Hence the charges should be set as low as possible (whilst maintaining an adequate contribution to profit).

The company needs to evaluate the optimal pricing strategy by taking into account the interaction between margin and volumes.

The company should consider the size of the potential market and whether there is sufficient market demand for the product

If the target profit requirement is not met, the company will have to decide whether to offer either option for commercial reasons, despite the fact that it does not meet profit criteria

### **Expenses/Charges**

The company should consider the financing requirement of each design. This should be in light of the level of its free assets and capital available (e.g. the use of financial reinsurance) . The better matched the charges and expenses, the lower the risk, and this should therefore reduce the capital requirement (depending on the nature of the regulatory environment).

However, the fixed level of charges means that it is not possible to have an increased initial charge to cover initial expenses so it will be important to assess the capital requirement of this product, taking into account likely business volumes – and the potential loss on future surrenders.

Charges expressed as a proportion of premiums might be expected to increase broadly in line with maintenance expenses, if the premiums paid are based on a percentage of salaries. Charges expressed as a proportion of funds under investment might be expected to increase at a rate in excess of expense inflation, but better match investment fees charged as a proportion of funds under management.

The insurance company will have to decide whether or not to make the charges fixed or variable up to the given maximum. Fixed charges might be more attractive to the market, but this would increase the risk to the insurance company and therefore is likely also to increase the capital requirement (depending on the regulatory environment).

The insurance company will have to consider what form and level of commission it should pay to the insurance intermediaries. For example, under version (a) it might prefer to offer fund based renewal commission, but premium based commission under

(b), as this better matches the charging structure.

The company should consider whether other distribution channels may be more appropriate

The company will also need to consider the rules for commission clawback in the absence of surrender penalties.

### **Sensitivity**

The company should test the sensitivity of profit to variations in future experience. For example, version (a) will be sensitive to future investment returns, and if  $x < y$  then version (a) will also be more sensitive to early withdrawal experience.

Since both options will result in a cross-subsidy from large to small policies, the company should consider whether to impose a minimum case size.

### **Administration/Cross Subsidies**

It should also take into account any limitations on product design as a result of its administration systems. If its existing products are similar to one or both of the proposed charging structures, then this will facilitate development.

### **Treating customers fairly**

The company must consider TCF issues when deciding product design

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## **6.**

The cost of the guarantee is such that the insurer will have to meet the difference between the guaranteed maturity value and the unit fund only if the unit fund is less than the guaranteed amount at maturity.

Hence the insurer is trying to measure the likely size of this gap between the guaranteed maturity value and the unit fund and the probability of the unit fund being less than the guaranteed maturity value.

The unit fund will need to be projected using best estimate demographic assumptions (e.g. for withdrawals, mortality). The modelling may use appropriate model points that represent the existing business.

Allowance would be made, however, for the fact that withdrawal rates may reduce as the guaranteed benefit becomes more valuable

The insurer will need to use a stochastic model to simulate the likely behaviour of the investments underlying the unit fund.

Care must be taken in setting up the model to ensure that it reflects the likely behaviour of the investments underlying the unit fund and also that the assumptions made in constructing the model also reflect the company's investment strategy.

A large number of simulations will be carried out so that a distribution of the likely outcomes at the maturity date is created.

For each simulation the present value of the liability can be determined by taking the difference between the guaranteed maturity amount and the expected fund size and, if bigger than zero, discounting it back at a suitable rate to the start date of the policy.

The repeated simulations allow the company to create a probability distribution of the cost of the option – and the distribution of the value of a unit of charge

The company will then set the charge for this guarantee having a present value that ensures that the expected present value of the average cost of the option is covered with an appropriate probability level.

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7. (i) The risks are:

The assumptions chosen do not reflect adequately the class of lives insured.

The assumptions chosen do not reflect adequately the expected future trend in mortality improvements.

Even if the assumptions chosen are appropriate, the company is still at risk from random fluctuations.

For this specific product, the key risk is that actual mortality will be lighter than expected.

However, if options are offered that accelerate benefits (e.g. through guaranteed periods) then this introduces a different type of mortality risk, which might to some extent offset the longevity risk.

The extent of the first risk depends on the reliability and applicability of any existing data.

As the company has been selling large volumes for several years, it may have credible internal data.

However, the first two risks cannot be eliminated, as the future can never be predicted with certainty.

The third risk will also be reduced as a result of the large volumes of in-force business, but cannot be removed entirely.

**(ii) Mortality by class of life**

The company should perform detailed experience analyses in order to set its pricing assumptions appropriately.

It should include adequate margins for risk in the mortality rates it uses in its pricing assumptions.

The company might decide to introduce differential annuity rates to allow for the expected mortality of lives e.g. in different states of health, different regions, different socio-economic group. They could then manage this particular risk using underwriting.

**Future mortality improvements**

The company should include appropriate allowance for future mortality improvements in its assumptions.

It should keep up to date with industry analyses and research.

The company could consider using mortality derivatives to reduce the risk of future mortality improvements

The company could sell lower volumes, thus reducing its exposure to future mortality improvements.

It could do this by withdrawing from the market, or by reducing its rates to a less competitive level.

**Random fluctuations**

It could try to sell even higher volumes in order to reduce its exposure to random fluctuations.

**General**

The company could take out reinsurance or use co-insurance. For example, on original terms, or the reinsurer could pay all annuity payments beyond a certain age, or beyond the age at which the policyholder is expected to live on a specified mortality basis.

If the risk is currently borne fully by the shareholders of the company, then they could reduce this risk by writing the annuities into a with profits fund (if there is one) in order to share the risk with the with profits policyholders. This would depend on the relative appetites for risk of shareholders and policyholders.

Alternatively, the company could change the product design to with profits rather than without profits immediate annuities, and share the mortality risk with the annuitants through the bonus declarations.

It could launch or sell more products that have synergy with immediate annuities, i.e. they generate higher profits if mortality rates reduce. For example, term assurance written at similar ages.

It could market to classes of policyholder which are less likely to exhibit higher rates of mortality improvement

It could make sure it writes similar products to other players in the market to limit the impact of anti-selection eg through other companies writing impaired life annuities

(iii) Other risks are:

Mismatching and reinvestment risk: investment risk arising from imprecise matching of assets and liabilities.

Default risk on corporate bonds if these are used to back the liabilities. This is likely given that the company is a leading provider and so must be pricing competitively.

Market risk for the period between the issuing of the guaranteed quotation of the annuity rate and the investment of the premium

Renewal expenses being higher than expected.

Expense inflation being higher than expected.

Volumes sold being lower than expected, leading to a lower contribution to overheads and other fixed expenses.

Volumes sold being higher than expected, potentially leading to new business strains (e.g. reserving strains) that exceed available capital.

Volumes sold being higher than expected, leading to strain on administrative processes.

Change in mix of new business by size, i.e. more small policies.

Change in mix of new business by source, if assumption differences (e.g. commission, mortality) are not reflected in differential annuity rates.

Anti-selection risk, particularly if this company offers only one set of annuity rates and other companies introduce annuities targeted towards lives in poorer health.

Inaccurate or incomplete data.

Fraudulent claims, e.g. not notifying the company of the death of the annuitant.

If reinsurance is used, failure of a reinsurer.

Changes to the legal, fiscal or regulatory environment.

Changes in volumes and mix of business can be influenced by competitor actions (e.g. a new company entering the market, or targeting a different market) and can be influenced by management actions (e.g. incorrect decisions regarding annuity pricing).

(iv) For new business, there is some truth in this comment because the impact of mortality improvements would be discounted for a reasonably long period. However, the overall financial impact on the company could be significant given that they sell a large volume of new business.

There is also likely to be a large in-force portfolio, and the impact on existing business could also be considerable.

In particular, reserves must reflect a prudent expectation of future mortality. If the rate of future mortality improvements is reassessed as being higher than previously expected, then reserves would have to be increased to reflect this.

This could cause solvency problems, depending on how well capitalised the company is.

If the portfolio is cashflow matched, then unanticipated mortality improvements could result in mismatching losses, or would require rebalancing of the assets, which could be costly.

The problems are exacerbated if further expected mortality improvements are identified on a regular basis.

If the company were to write escalating annuities, then the potential cost would be greater than for level annuities.

If the company writes impaired life annuities, then the impact of mortality improvements within this class of life is proportionately of greater significance.

Overall, the company therefore should manage this risk carefully.

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## **8. Advantages of the suggested approach**

It will save a lot of time and money ( if the alternative is employing another actuary full time)

The cashflow results will probably be more reliable being produced by the model office “manufacturers” than by a newcomer to the system.

The actuary will be able to produce some useful results e.g.:

- Financial projections
- Capital requirements and return on capital
- Profitability (pvfp) of existing portfolio
- Other miscellaneous work (eg quantify total expense charges on new and existing business for expense budget)

It should also be possible to test the sensitivity of these results to differing levels of new business, or on different risk discount rates

### **Disadvantages of the suggested approach**

There is a risk that there is a misunderstanding between the actuary and the consultants and the cashflows aren't what the actuary thinks they are.

All of the above work will be based on a very limited number of model points. There will therefore be significant potential for model point error.

There is a problem if the mix of age/ term/ sex/ premium size of new business changes much from that initially assumed. It may not be possible to represent future new business adequately in model office projections (absence of suitable model points), nor to assess the value of new business actually written.

The actuary will be unable to test sensitivity to parameter variation.

It will not be possible to revise the parameters to reflect altering experience assumptions throughout the year (which might be important in a time of moving interest rates, for instance).

The cashflows will not be of much use for product development purposes, unless products being developed have a structure identical to that of some existing product which has been modeled.

They will not be of much use for pricing, because it will not be possible to revise the premiums in the model until the desired profitability criterion is achieved.

The actuary will not be able to do any stochastic work.

In general, anything requiring flexibility and changes will be impossible.

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