Institute of Actuaries of India

Subject ST2 – Life Insurance

May 2013 Examination

INDICATIVE SOLUTIONS

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.

Solution 1 :-

a.

- Company should make an allowance for future mortality improvement, during pricing and while determining the reserves.
- Company should closely monitor and investigate its experience and compare with what was assumed at pricing stage. If it is quite different, may look to re-price the existing product(s).
- Company also specializes in selling term product. Hence, longevity risk may already be diversified to an extent in its portfolio. If not, may push to increase the new business of term product.
- Diversification is also possible across different target markets (eg: socio-economic groups, regions, etc.)
- Company should determine its risk tolerance and accordingly choose to accept the longevity risk in its books by placing a limit on the new business volumes.
- Company may reinsure its longevity risk, if not already doing so.
- Company could start selling with-profit annuities so that some of the risk is passed on to the policyholders.
- Company may use longevity bonds, mortality swaps, etc., subject to availability and permitted by regulations.

(4)

b.

- The results from stochastic mortality model are subject to three types of risk: model risk, parameter risk and random fluctuations risk.
- Model risk exists when there is a choice of model to use.
- The model should be chosen with regard to goodness of fit to the data and any features that the actuary requires (eg: no negative mortality rates).
- Even if the model used is correct, there would be risk that the parameters used with the model may not reflect the future experience of the class of lives insured.
- This can be measured by estimating the distribution of the parameter estimates.
- Both the model and parameter risk may be reduced by collecting more and more data.
- Data over a long time period is required to assess trends and on a large number of lives to give credible results.
- Random fluctuations risk exits because the actual number of deaths each year is inherently random. Even with the correct model and parameters, the actual deaths in any given year would be different to the deaths predicted by the model.
- The difference between the actual and predicted deaths as a proportion of the total lives reduces as the number of lives increases. Hence, random fluctuations risk is smaller for larger annuity portfolios.

(4)
[Total 8 Marks]

2.a.

Solution 2 :-

a)

Appropriation price is the price at which the company will create a unit. i.e. it is the amount of money that the company should put into the fund in respect of each unit it creates in order to preserve the interests of the existing unit-holders.

It can be determined as:

- the market "offer price" value of the assets held by the fund
- plus the expenses that would be incurred in the purchase and any stamp or other duty payable in respect of such a purchase
- + value of any current assets, such as cash on deposit or investments sold but not yet settled
- – the value of any current liabilities, such as investments purchased but not yet settled or loans to the fund
- + any accrued income, such as interest income from fixed-interest securities and deposits, net of any outgo, such as fund charges
- – any allowance for accrued tax, if applicable **(4)**

b)

- Ensuring equity principle is met
- Level of variable charges to be deducted
- Rectifying any errors in unit pricing
- Appropriately compensating the unit-holders of any errors in unit pricing
- Terms offered for fund switches (if not guaranteed)
- Setting investment policy for the linked funds
- Using market price of assets from a reputable source while determining the unit price
- Setting the rule of rounding the unit price and number of units
- Provision of appropriate customer information
- Corporate governance including appropriate management systems and controls
- Customer service standards, eg: responding to queries and requests for information, processing purchase and sale of units accurately **(4)**

c)

- Equity principle, which states that all unit-holders not involved in a transaction should be unaffected by that transaction, should always be adhered to.
- If a unit fund is expanding, then the net transaction is a purchase of units and so the price of each unit should be based on the offer market price of the underlying assets plus the buying costs - "offer" basis.
- If a unit fund is contracting, then the net transaction is a sale of units and so the price of each unit should be based on the bid market price of the underlying assets less the selling costs - "bid" basis.

[0.5]

- The choice of "offer" or "bid" basis is a matter of discretion. In deciding when to move from one basis to the other, the company should determine whether a fund is generally expanding or contracting.
- If this were to be looked at on a daily basis, there might be frequent changes in basis, which might produce more unit price volatility than would represent fair treatment of unit-holders.
- To reduce such volatility, companies often maintain a "management box", which is used to buy and sell excess of units in the short term, rather than actually creating or cancelling units.
- This would also help to reduce the dealing costs. **(4)**

[Total 12 Marks]

Solution 3 :-

A. The reserves should be sufficient to meet all liabilities

They would be sufficient to meet the surrender benefit only in the last few years.

However, they would be adequate to fund the maturity benefit .

The reserve calculation does not take into account the fact that only a small proportion of the policyholders are expected to die. They hence might or might not be sufficient to meet the death benefit on portfolio level. Overall, the approach is only partially consistent with this principle.

B. The reserves should be calculated prudently and the basis should contain margins

The only assumption in the reserve calculation is the interest rate for discounting the outstanding policy fee. Given the current GRY of backing assets as 7.5% p.a., the discount rate of 7.5% p.a. doesn't imply any prudence.

C. The reserves should take credit for future premiums if contractually due to be paid.

The reserve calculation only takes credit of the future policy fee. Since there is no obligation to pay future premiums, this approach looks more reasonable.

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

10-year term policies are backed by 10-year G.Secs. Depending on the decrements, the discounted mean term between the asset and the liability will be different. The approach is hence inconsistent with this principle.

E. The interest rate used for calculating the reserves should take into account the currency and yields on the assets.

The interest rate used in the reserving formula is the same as the GRY of the backing assets. The approach is hence consistent with this principle.

F. Allowance for future expenses

The reserving formula makes no allowance for future expenses and is hence inconsistent with this principle.

G. The valuation calculations should not suffer discontinuities arising from arbitrary changes.

There will not be any discontinuities due to arbitrary changes if the method remains the same year on year.

H. The use of approximations should be allowed.

The reserving formula seems like an approximation and hence can be considered to be consistent with this principle. However the level of approximation is quite significant in this scenario.

I. The valuation method used should recognize the emergence of profit appropriately

During most part of the policy duration, significant losses could arise since the reserves would be insufficient to meet the liability outgo (surrenders, expense, etc.).

J. Valuation basis and method should be disclosed.

The approach seems consistent with this as the method is simple and there is only one assumption (interest rate) to be disclosed. **[Total 10 Marks]**

Solution 4 :-

a.

- Bonuses are added annually in relation to the premiums payable to date plus previously declared bonuses, typically while determining the unit price.
- A terminal bonus may be added on maturity, death or surrender.
- The policy may specify a guaranteed minimum rate of addition.
- On death, the benefit will depend on the type of contract and could, for example, be a guaranteed sum assured, a return of premiums, or a return of the fund value.
- On surrender, apart from surrender penalty, the company may also apply a MVR.
- On maturity, value of units become payable.
- Premiums may be payable as a single lump sum, recurring lump sums, or as regular monthly or annual amounts.
- Charging structure may be a combination of policy charge (% of premium or fund), allocation charge, bid-offer spread, risk cover charge, annual management charge.
- Or, the charges may be taken implicitly through the bonus rate.

(4)

b. There are two ways in which the unit fund of the contract could operate:

i. Price per unit remains constant

- The company allocates additional units to each contract, usually annually at the bonus declaration.
- These are made up of a guaranteed addition, which could be zero, and a "bonus" addition which could also be zero, especially if there are guaranteed additions.

ii. The company, instead of allocating additional units, changes the price of a unit, usually on a daily basis.

The increase is made up of a, possibly zero, guaranteed part and a bonus part.

- Main difference between the above two approaches and unit-linked is the discretion available with the company over the bonus to be distributed where as there is no such discretion under unit-linked.
- Under the unit-linked business, the unit-price fully reflects the market value of the unit-linked assets.
- Under unitized with-profits, the company typically takes a long term view of the investment return and smooth the bonuses.

(4)

c.

The design should be such that the cost to the company of providing the guarantee/option is not excessively high and still the product is sufficiently attractive for the customers.

Option i

- Since this is a retirement product, the policy terms would be long. Providing annuity rate of 4% p.a. at maturity could be risky since the future interest rates for such long duration cannot be predicted with any certainty.
- In order to reduce this risk, the company may determine the guaranteed annuity rate using a very prudent assumption of the interest rates prevailing at the time of maturity.
- OR…retain the guaranteed annuity rate of 4% p.a. and hold sufficient reserves for this guarantee from day 1. Though, the company needs to then consider the capital requirements.
- OR…may decide to remove the guaranteed annuity rate.
- The guaranteed annuity rate should not apply to units bought with premiums within (say) two years before retirement.
- Alternatively, the company could charge a guarantee charge during the accumulation period to cover any shortfall due to falling interest rates.
- However, this could make the product costly so it would be better to offer it as an option and only those opting for the guaranteed rates pay the guarantee charge.

Option ii

- Even if the product is a with-profits product, there is an inherent investment guarantee to at least meet the guaranteed policyholder's benefits, company's expenses, etc. The investment strategy of the fund would be such that it also takes into account the above. If policyholders have the option to defer/pre-pone the maturity age which could be as high as 10 years, this could lead to investment losses in the fund, which would be inequitable for the other with-profits contracts.
- There is a financial anti-selection tendency with this option. If there is a sudden change in the economic environment closer to the maturity date, a policyholder may choose to defer the maturity date since the bonus rates wouldn't be immediately cut by the company due to PRE/smoothing policy.
- Determining the cost of providing this option will be difficult since it would require an assumption of the take-up rate, etc.
- There is an expense incurred each time a policyholder opts to change the maturity date.
- To minimize the cost of the option, the units could be switched out of the with-profits fund at the originally chosen retirement date and terminal bonus added at that point...
- And the fund for the policies in deferment may be unit-linked fund.
- The company may choose to remove this option or provide the facility to exercise this option at a certain point of time only (eg: 5 years before the chosen retirement age) or restricting to change the retirement age by not more than say 2 years.

Option iii

- The mortality rate under its term products will not necessarily reflect the mortality of the annuitants because of variety of factors such as:
  - No experience in writing annuity business
  - Target market of term and annuity may be completely different
  - Mortality experience under term would depend on the underwriting practice whereas there will be no underwriting under annuity, etc.
- Further, it is not clear whether the mortality assumption under its term products allow for future mortality improvements which should be there under annuitant mortality.
- Reinsurer's assistance might prove to be helpful in setting the assumption for annuity along with any previous experience of the senior actuaries.

General

- The cost of all the guarantee/option needs to be determined, preferably stochastically or on a wide range of investment scenarios if doing deterministically.

- This cost needs to be adjusted in the bonus declarations under this product and in the asset share calculations.

(8)

[Total 16 Marks]

Solution 5 :-

- The company would invest so as to maximize the overall return on the assets, subject to the risk being taken on being within the financial resources available to it.
- The assets and liabilities would have been valued consistently i.e. if statutory liabilities are being considered, the assets should also be valued on statutory basis (eg: not considering the inadmissible assets). It is most likely that statutory basis would have been taken since the concern is w.r.t. the solvency ratio.
- The company's total assets and the conventional fund's liabilities would have been projected into the future.
- The model office projection would have taken the inforce business as on the date of investigation as well as the future new business expected over the projection term.
- Appropriate projection term, say 5 years or 10 years, would have been chosen to project the assets and liabilities into the future.
- Also, appropriate projection period would have been chosen, eg: yearly, monthly.
- The liability projection would have included:
  - all the future benefit payments (death, surrender, maturity, etc.)
  - future commissions and expenses allowing for expense inflation
  - future premium income
  - tax, if applicable
- If the company is experiencing expense overrun, it also needs to be accounted for.
- The liability outgo in any time period (yearly, monthly, etc.) would have been after taking into account all the relevant decrements.
- The projection assumptions used would have been best estimate.
- For projection of the total assets, the company would have used assumptions regarding the future investment returns based on the asset mix.
- The basis used for the liability valuation at any time would have been consistent with the projected economic conditions at that particular time.
- The projection would have been either on deterministic or stochastic basis.
- If deterministic, it would have included sensitivity tests on the key assumptions, eg: on investment returns.
- If stochastic, it would have included hundreds of simulations (eg: 2000, 5000) for generating the future economic scenarios and might have included dynamic rules of changing the asset mix under certain economic conditions.
- Once the assets and liabilities would have been determined in each future time period, a comparison of both would have been done. This comparison might have included whether assets at any point of time are less than the liabilities (insolvent) or assets are close to the value of the liabilities (close to insolvency), etc.
- The investigation is likely to have revealed that the company's solvency ratio would have continued to reduce and perhaps there is a chance of the company becoming insolvent over the next few years, and hence the current investment strategy is no longer viable.
- The projections would have been done using multiple investment strategies i.e. using different asset mixes. The Appointed Actuary would have then chosen the one which meets the company's business criteria most closely.

[Total 12 Marks]

Solution 6 :-

a. Negative non-unit reserves

- Under unitized contracts, the reserve is made-up of two parts – unit and non-unit reserve. The unit reserve represents its liability in terms of units under the contracts. The non-unit reserve under unitized contracts is the amount required to ensure that the company is able to pay claims and meet its continuing expenses without recourse to further finance.

Conditions and considerations the regulators might have imposed before allowing for negative non-unit reserves:

- A negative non-unit reserve can be held for a policy under which future charges are expected to be more than sufficient to meet future non-unit liabilities (including expenses)
- The sum of the unit and non-unit reserve for a policy should not be less than any guaranteed surrender value
- The negative non-unit reserve represents a loan from other contracts which have positive non-unit reserves. The future profits arising on the policy with the negative non-unit reserve need to emerge in time to repay the loan.
- After taking account of the future non-unit reserves, there are no future negative cashflows for the policy i.e. there should be no future valuation strain
- In aggregate, the sum of all non-unit reserves should not be negative.
- There should be prudence in taking credit of future profits i.e. cashflows should be projected prudently.
- Hence the projections of the future positive cashflows should be lower than best estimates, the rate of interest used to discount them should be higher than best estimate, and we should assume that survival rates are lower than best estimates.
- Note how this differs from the calculation of prudent positive non-unit reserves, for which a lower than best-estimate discount rate would be used.

(4)

b. Zillmerisation

- The key idea behind Zillmerisation is to allow for the fact that the office premium usually contains a loading for initial expenses; the capitalised value of this loading can in effect be used to reduce the net premium valuation reserve.
- The rationale is:
    - The future office premiums include a (level annual) loading which, over the lifetime of the contract, pays for the initial expenses
    - this part of the future gross premium should not be needed to cover the (much lower) regular renewal expenses

- so we can increase the value of our assets at the valuation date by the expected present value of these future initial expense loadings
- or, equivalently, we can reduce the value of the liabilities by the same amount.

- Zillmerisation is achieved by increasing the net premium in the net premium valuation, the amount of the increase in the net premium being termed the "Zillmer adjustment".

Conditions and considerations the regulators might have imposed before allowing for Zillmerisation:

- Limit the value of loading of initial expenses assumed for amortization.
  - so that it is not greater than that used in the calculation of the office premium, or the actual initial expenses incurred, or both.
- Limit the size of the Zillmerised net premium to ensure that the remaining cashflow available to cover renewal expenses is large enough.
  - This can be done through capping the calculated net premium to certain percentage of office premium, say 80% or 90%.
- Not allowing Zillermisation for policies with single premium , though this is obvious

(4)

c. Allowing bonus in reserving

- The amount of the reserves should be calculated by a suitably prudent actuarial valuation of all future liabilities for all existing policies, including bonuses which have already been guaranteed, whether described as vested, declared or allotted.
- All past guaranteed bonuses should be allowed explicitly in both gross premium valuation and net premium valuation
- A supervisory valuation should allow for future bonuses on conventional with-profits contracts to the extent that some level of future bonuses is thought to be consistent with policyholders' reasonable expectations.
- These future bonuses would include regular reversionary bonuses and may include terminal bonuses

- The reasonable expectations involved are those that policyholders would have if the valuation basis were to be borne out in future reality.
- Allowance should be made for smoothing from current bonus rates, into the supportable future rates under valuation conditions.
- To allow for future regular reversionary bonuses, the valuation method and assumptions should be chosen so that:
  - all guaranteed benefits to date, including bonuses allocated to date, are reserved for,
  - on the supervisory valuation assumptions, future surpluses are projected to emerge in a suitable pattern and amount so as to match the assumed future regular bonus.

- By a "suitable pattern and amount" of future surpluses means that we wish to control the way that our surplus emerges over time, in order to distribute profits over the policy term in the way that policyholders expect
- Considerations as to the future bonuses to include also depend on the asset valuation method

- The extent to which different types of future bonus should be allowed for depends, amongst other things, on their different nature. More account would probably be taken in the liabilities of future regular bonus distributions than terminal bonus.
    - This is because regular bonuses become guaranteed (or they are paid out as cash) as each future year passes. Terminal bonus never becomes guaranteed, however, right up to the day that it is paid out (which is at the end of the contract).
    - Different expectations of smoothing also play a part here. Regular bonuses tend to be more smoothed over time than terminal, so again more emphasis on the continuation of regular bonus distributions would be expected in the valuation.
- Gross premium valuation methods will need to value an explicit increase to benefits in respect of future reversionary and (possibly) terminal bonuses.
    - Care needs to be taken with the overall choice of method and assumptions to allow for the fact that the valuation method will capitalise differences between the interest and mortality assumptions of the valuation and those assumed in the calculation of the office premium
- Net premium valuations make an appropriate allowance for future reversionary bonuses (and sometimes terminal bonuses) by a suitable reduction in the rate of interest.
- Under net premium valuation, the valuation rate of interest chosen should be such there is a suitable pattern of investment surplus and loading surplus (difference between office premium and net premium after allowance for expenses) emerging over time
- A net premium valuation may be particularly suitable for conventional with-profits business as it does not result in the capitalisation of basis differences mentioned above for the gross premium method
- This is an important point, as it means that a company is less able to manipulate its valuations. For example, with a gross premium valuation, the actuary might assume a future bonus rate that is lower than the bonuses that are supportable by the business, on the valuation assumptions, thereby capitalising the additional profit expected to be earned from the future gross premiums.

- Using the net premium method, neither gross premiums nor future bonuses are valued explicitly, so this possibility cannot occur.

(8)

Solution 7 :-

a. <u>Factors to consider for reinsurance</u>

- Relationship with existing reinsurer
  - The existing relationship should be considered and how would the relationship be affected if a new arrangement for the same product is made.
  - Also, need to consider which all other products are reinsured with the existing reinsurer and how and whether they be affected with any new arrangement.
  - Are there any other treaties with this insurer such as catastrophe or stop loss reinsurance; how would that be affected.
- What is the general market view of the new reinsurer? What is its global presence and what experience does it have on the local market. This should be checked against existing reinsurer.
- How has been the credit rating of the new reinsurer over past few years and how does this compare to existing insurer.
- Would the new reinsurer provide any technical assistance such as on underwriting or on some new risks, assistance in sales strategy or in distribution channels and how are these compared to support from existing reinsurer.
- Expected amount of new business planned for next few years and thus, expected amount of sum reinsured and expected amount of reinsurance premiums paid. This will be the key driver.
- The actuary should consider the materiality of benefit of lower reinsurance rates by comparing the change the reinsurance premium outgo for future years.
  - Though need to allow for the fact that reinsurance rates may change after 3 years.
  - And that it may become a costly proposition than existing treaty in future
  - As there can be saving in reinsurance premium of 30% but then rates can go upto a maximum of 70%*150% = 105% of the current rates
  - Which there is a 5% loss in future years compared to existing treaty
  - Though also needs to consider that 50% is the maximum increase and the reinsure may not increase at all or increase a less percentage
  - And that the treaty is not obligatory after increase, so the insurer can shop around if it finds the rates to be too costly
- System issues including administrative issues should also be considered for changing reinsurance. This could be particularly important as the same product will have two difference reinsurers and policy will be reinsured based on date of commencement

- With lower reinsurance premium rates, company can price competitive term assurance products.

- Alternatively, given the company is already successful in this line of business, it may prefer to retain the savings due to change in reinsurance premium rates
- The company might consider providing business to the new reinsurer as a case of risk diversification. This could also help company to manage counterparty default risk to some extent.

- Regulatory constraints/considerations of changing the reinsurer need to be considered, particular for new business under existing products.
- Need to check if existing reinsurer can reduce its rates based on this new arrangement so as to not lose the new business. i.e. the chief actuary can consider renegotiating terms with existing reinsurer

- Company may find this as an opportunity to refine the treaty when negotiating with new insurer to make the treaty more clear in case, there were ambiguities in existing treaty.
- ….or can renegotiate terms which are more beneficial

(9)

b. <u>Reply to finance director in response to reinsurance comment</u>

- The finance director is correct in observing that reinsurance comes at a cost and there is merit in considering retaining the mortality risk.
- This would ensure that the mortality profit, if any is retained by the company which would enhance the margins in the long run.
- However before proceeding in that direction the company should assess that the mortality experience is real and the past is a good reflection of what will happen in the future.
- It is quite possible that the IBNR claims are pretty high and it is not reflected in the accounts.
- Once the company is convinced that the mortality experience is stable, then it is important to revisit the risk appetite of the company.
- If by not reinsuring, the insurance company would have to limit the maximum sum assured at a level lower than the current level then this would impact the volume of business written.
- Therefore while the margins in terms of percentage would be higher, the absolute margin would drop due to a drop in business.
- The insurance company would have to develop internal expertise for which it was earlier dependent on the reinsurer. This would increase costs which will impact profitability.
- Retaining all the mortality risk would also mean that the capital requirements of the company would increase.
- The increase would be a result of a little more conservatism in reserving basis as well as the increase in solvency margin.

- There may be years where the claim experience would be very bad due to a one off event.
- In these scenarios, the shareholders should be ready to put in additional capital if required.

Alternatives which the company can consider:

- The insurance company can incorporate Profit sharing in the reinsurance treaty which will ensure that a part of reinsurance profits are passed back to the insurance company.
- However this would also mean that the reinsurance rates would increase.
- The insurance company may look at increasing its retention limit which would ensure that majority of the risk is retained by the company.
- The insurance company could also only consider catastrophic treaty which will ensure that the one off claims do not affect the capital requirement.
- Alternatively, the insurance company could get into facultative treaty for large sum assured cases rather than restricting the maximum sum assured.

(9)

c. Impact of changes in regulations

- The impact would depend on the amount of risk retained by the company …
    - And the projected retention limit of the company for the next few years
- Given that company has been selling term assurance business successfully for past few years, the impact is expected to be material
- The quantification of impact depends on whether the company is already retaining the sum assured higher than minimum specified by regulation in amount terms
    - In which case, the company will only be impacted by retaining a minimum percentage of sum assured
- There will be an impact of the pricing and premium rates of the product
- There will be impact on the competiveness of the product
    - Though not material as the regulations apply to all companies
    - But the impact will be less severe for companies which meet the regulatory criterion
- There will be an impact of the capital requirements of the company
    - As the reserve requirements would increase
    - As well as increase in solvency requirements
- There will be an impact of the variability of claims payouts due to higher retention
    - Which in turn would make the profits of the company volatile
- The expected profits may increase in the long run as reinsurer's costs and profits paid out are reduced.

(0.5)

- Similarly, lower exposure to reinsurance would to lead to lower counterparty default risk

- System issues including administrative issues should also be considered for change in regulations particularly allowing for minimum percentage of sum assured at policy level.
    - This could be particularly important as the same product will have two difference reinsurance retention policy based on date of commencement

(8)

[Total 26 Marks]

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