# INSTITUTE AND FACULTY OF ACTUARIES

# EXAMINERS' REPORT

April 2016

## Subject ST2 – Life Insurance Specialist Technical

### Introduction

The Examiners' Report is written by the Principal Examiner with the aim of helping candidates, both those who are sitting the examination for the first time and using past papers as a revision aid and also those who have previously failed the subject.

The Examiners are charged by Council with examining the published syllabus. The Examiners have access to the Core Reading, which is designed to interpret the syllabus, and will generally base questions around it but are not required to examine the content of Core Reading specifically or exclusively.

For numerical questions the Examiners' preferred approach to the solution is reproduced in this report; other valid approaches are given appropriate credit. For essay-style questions, particularly the open-ended questions in the later subjects, the report may contain more points than the Examiners will expect from a solution that scores full marks.

The report is written based on the legislative and regulatory context pertaining to the date that the examination was set. Candidates should take into account the possibility that circumstances may have changed if using these reports for revision.

F Layton
Chair of the Board of Examiners
July 2016

## A. General comments on the *aims of this subject and how it is marked*

1. The aim of the Life Insurance Specialist Technical subject is to instil in successful candidates principles of actuarial planning and control, and mathematical and economic techniques, relevant to life insurance companies. The student should gain the ability to apply the knowledge and understanding, in simple situations, to the operation, on sound financial lines, of life insurance companies. The life insurance products covered by this subject exclude health and care insurance products covered by the Health and Care Specialist Technical subject.

2. The Examiners' Report covers more points than would be expected to get full marks. This is so that alternative approaches to questions by different candidates can be accommodated. Candidates are expected to show knowledge of the relevant content of the Core Reading, but those who tailor their answer to the specifics mentioned in the question will score more highly than those who answer in a more generic way.

## B. General comments on *student performance in this diet of the examination*

1. As with previous papers, questions that focussed on knowledge of the Core Reading were generally well answered. In the non-standard questions, candidates often tended to restrict themselves by generating only a narrow range of points rather than thinking more widely. Stronger candidates considered the specifics of the questions and used these in their answers, e.g. question 4 part (i).

2. Candidates should use Examiners' Reports to practise applying their knowledge to the situations set.

## C. Comparative Pass Rates for the past 3 years for this diet of examination

| *Year* | *%* |
|---|---|
| April 2016 | 46 |
| September 2015 | 41 |
| April 2015 | 45 |
| September 2014 | 39 |
| April 2014 | 46 |
| September 2013 | 43 |

**Reasons for any significant change in Pass Rates in current diet to those in the past:**

The Pass Rate for the current sitting is consistent with recent sittings**.**

## D. Pass Mark

The Pass Mark for this exam was 60%.

## Solutions

**Q1** The terms after alteration should be supportable by the earned asset share at the date of alteration so as to avoid the company making a loss.
Ideally the profit expected from the contract after alteration should be the same as that before. Or alternatively the profit expected should be the same as the expected amount had the policy been written originally on its altered terms.

The alteration should be consistent with boundary conditions. For example, as the outstanding term tends to zero, the premiums charged should look consistent with the difference between the surrender value and the maturity value. Or the premium after alteration should approach zero as the sum assured approaches the paid-up sum assured.

If the benefits are to be increased, this should be on terms consistent with the additional premium which would be charged for a new policy with a sum assured equal to the proposed increase.
If the policy term is to be extended, the terms should reflect the current premium basis so far as the period of extension is concerned.

Any methods adopted should be stable in that small changes in benefits should result in small changes in premium (if expenses of alteration are ignored).
Alternatively, an alteration method should ideally reproduce the existing terms if a policy is altered to itself (ignoring the impact of the cost of the alteration).

The terms offered after alteration should avoid the option of lapse and re-entry.
Any increase in benefit may be subject to additional evidence of health, depending in part on the scale of the alteration and when it occurs in the policy's lifetime.
The costs associated with carrying out an alteration should be recovered.
The alteration should be easy to calculate, document and explain.

This question was answered fairly well by most candidates. The strongest candidates focussed on alteration principles rather than the similar core reading on surrender value principles and also expanded on the boundary conditions points.

**Q2** (i) It is important for a life insurance company not just to be solvent at the current date but to have confidence in its ability to remain solvent.

This in turn will give confidence to external stakeholders including regulators, who are concerned with policyholder protection (for which the ongoing solvency of the company is a key component), any potential investors or shareholders or the financial markets and credit rating agencies.

The company needs to understand its risk exposures and may use solvency projections for risk management. The company therefore needs to assess its ability to withstand future changes in both the economic environment and in the company's own experience.

Determining the future level of solvency will also enable the company to assess its ability to write future new business i.e. to meet the future development costs of the new contracts and the capital requirements.

Solvency projections can be used to help set investment strategy.
For example, they may enable the company to adopt a less restrictive investment policy and enhance investment returns.

Solvency projections are used to assess the company's needs for future capital injections.

Similarly, they can be used to demonstrate whether there are high levels of internal capital which could be used for other purposes to generate higher returns, e.g. through projects or acquisitions etc.

It might be a regulatory requirement to perform solvency projections.

The can also be used to inform management decision making and allow management to take correct action. As well as assessing the effect of risk management strategies e.g. reinsurance.
For with profits business they can be used to assess possible bonus strategies.
If the company is closed they can be used to assess the run-off of the business.
Solvency projections can measure the probability of ruin.

(ii) Model points may be used rather than doing projections on a policy by policy basis.

Firstly the company should consider the reason why it is projecting its future solvency as this will dictate the basis on which the future solvency should be projected. A supervisory basis may be used if it is assessing the company's ability to meet the supervisor's regulatory requirements in the future. Alternatively a realistic or best estimate basis may be used if the company is assessing its ability to withstand future volatility in experience.

The company may want to project its future solvency using a deterministic approach with best estimate assumptions combined with assumptions with margins to test the effect of adverse future experience or stress and scenario testing. For example, a deterministic approach may be used to assess the future solvency allowing for a 10% increase in expenses or for changes to future mortality improvements on annuity business.

An alternative approach is to use stochastic assumptions with simulation. This allows assessment of the level of probability of adverse circumstances occurring.

The most likely assumptions to model stochastically are investment returns and inflation. Assumptions would be required for volatilities and correlations. It would be calibrated to real world scenarios. For example, a stochastic

approach may be used to assess the probability of insolvency from making changes to the investment strategy of the company.
Mortality may also be modelled stochastically e.g. for immediate annuities.

The company needs to decide how many simulations to run.

And also at what confidence level it wishes to assess future solvency e.g. expected future solvency would be the average across all simulations or it might prefer to look at percentiles, i.e. being confident in remaining solvent with *x*% confidence.

The company needs to decide whether to allow for future new business. Allowing for future new business provides the most useful assessment of ongoing solvency unless the company is planning to cease writing new business. However it can introduce volatility as future new business levels can be subjective.

The projection period would need to be chosen. The company may be investigating its ability to remain solvent for a given period e.g. 10 years. Or it may be investigating its ability to remain solvent until the last policy has left the books.
The frequency of the projection should be considered.

The solvency projection should include projecting both the assets and the liabilities of the company. The assets and liabilities should be projected on a consistent basis, e.g. the liabilities would need to use a valuation basis that is consistent with the economic environment at the valuation date.

Using a stochastic approach would mean that the valuation basis would need to be dynamically linked to the scenario being run, e.g. withdrawals and investment returns linked in a scenario. Management actions should also be allowed for.

Solvency levels are determined by differencing or ratioing assets and liabilities. Can project future capital requirements if required, depending on the purpose of the projection.

Projecting balance sheets using a stochastic basis can present significant modelling challenges and might necessitate the use of approximations such as a proxy model or a closed form solution (e.g. the Black-Scholes method).

Part (i) was answered well by most candidates, with the strongest candidates producing the required breadth of points to score well. Part (ii) was not answered as solidly, with many candidates focussing on detailed points on how to calculate the solvency capital requirement rather than considering deterministic and stochastic projection approaches.

**Q3** (i) For both methods, the calculations should ideally be done on a policy by policy basis in order to avoid cross-subsidising maturity payments between policies which are in- and out-of-the-money within the same model point and thus not reflecting accurately all of the guarantees which bite.

**Option pricing techniques**

This type of maturity guarantee corresponds to a put option on the investment funds. It would be a European style option.

The insurance company should select options written on an underlying that most closely represents the assets within the unit fund(s), e.g. options written on market indices for equities and bonds.

The time to maturity of the options should be as close as possible to the outstanding duration of the maturity guarantee and the exercise price should correspond to the fixed minimum maturity guarantee. The nominal should be based on current unit fund values and regular premiums should be allowed for if required.

When determining the notional amount required, allowance can be made for the fact that not all existing policies will reach the maturity date, i.e. the amount of options required can be reduced by expected decrements (mortality, persistency).

If the options chosen are traded in the market (and the market is sufficiently deep and liquid) then the market price of these options produces the market consistent liability.

However, if such market prices are not available then it may be necessary instead to use a closed form solution (e.g. Black-Scholes formula) to put a theoretical price on the options. The assumptions underlying this formula would need to be market consistent e.g. using risk-free rates observed in the market and volatility assumptions derived from the market (such as implied volatilities from other option prices).

**Stochastic simulation**

A stochastic model of rates of return on investments is used to simulate the future price of assets. Projecting the unit fund value to the maturity date allowing for charges.

A "risk neutral" approach may be taken whereby the expected investment return is set as the risk-free rate irrespective of the underlying asset type. "Risk-free" rates may be determined based on government bond yields or on swap rates. In either case, it may be appropriate to make a deduction to allow for credit risk. It would generally only be appropriate to use swap rates if there is a sufficiently deep and liquid swap market in that country.

Investment return volatility assumptions will be required and these will be dependent on the actual underlying asset type(s) and they should be calibrated to market observations. Similarly for modelling correlations between asset types.

However, not all will reach maturity and so assumptions are also required for the demographic elements of the projection basis, i.e. mortality and persistency. Dynamic links between assumptions should be modelled e.g. between lapses and investment returns. It may be more difficult to obtain a "market consistent" assumption for these elements. And the starting point for such assumptions would be best estimate.

It may be decided to include a risk margin in each assumption due to the inherent uncertainty. Or an overall risk margin could be used which would reflect the compensation required by the "market" in return for taking on those uncertain aspects of the liability cashflows.
Alternatively, an overall reserving margin in respect of these risks could be determined using the "cost of capital" approach.

A large number of simulations is needed in order to obtain reliable estimates of the guarantee liability.

For each simulation and each maturing policy, the model needs to calculate the excess of the fixed guaranteed benefit over the projected unit fund at the maturity date. If this is negative, it should be set to zero or take the higher of the above amount and zero.

The present value of the liability can then be determined by discounting these simulated costs of the guarantee. For a risk neutral valuation, this would be discounted using a risk-free rate.

Repeated simulation will generate the probability distribution of the present value of the cost of the option. The average of these across all simulations will give the market consistent liability.

(ii) Advantages of option pricing approach relative to stochastic simulation:

- If suitable traded options are available, no need to set any economic assumptions.
- May be less time-consuming to perform.
- May be less costly to perform.
- May be easier for others to understand.
- Better if relatively few policies have this guarantee, so not worth investing in a stochastic model.
- Less modelling expertise is required.
- Less computational power is needed.
- Could help the company to find hedging assets.

Advantages of stochastic simulation relative to option pricing approach:

- May already use stochastic modelling for other purposes so little extra work required, e.g. already used for regulatory capital requirements.
- May be difficult to identify appropriate traded options particularly of sufficiently long term.
- Allows more sophisticated modelling, for example duration dependent demographic assumptions.
- Could have dynamic interactions between the assumptions.
- Allows more sophisticated allowance for correlations between asset types in the economic scenarios.
- Could also allow for asset volatilities varying over time, if required.
- And a risk-free yield curve (rather than the constant risk-free rate assumed within Black-Scholes).
- Outputs give information not just on the average liability but on the probability distribution of possible outcomes.
- And hence can set liabilities at different confidence intervals.

The basic points of part (i) were covered by most candidates, with the strongest candidates also covering the risk neutral approach and the Black-Scholes alternative. Part (ii) was similar with most candidates covering a few points for each of the methods and stronger candidates taking the practical considerations a step further.

## Q4 (i) Data risk

There is a risk that the data provided to the insurance company is of poor quality, i.e. that it is incomplete or inaccurate / contains errors.
This relates to both the annuity data and the asset data.

There is also a risk that the annuity data does not adequately reflect the benefits, for example there could be indexation on some of the pensions or second life benefits, which are not clear from the data.

**Mortality risk**

The key risk is that these annuitants live for longer than expected in particular future mortality improvements could be underestimated in the mortality basis used to determine the amount of assets to transfer across to the insurance company in respect of this portfolio.

The insurance company may have to rely on mortality experience analyses performed by the pension scheme and there is a risk that the analyses have not been done correctly.

Future prediction of mortality may be incorrect due to:

- Model risk – the probability distribution may be inappropriate or contain errors.
- Parameter risk – the risk that the parameters chosen do not reflect the future experience of the business.
- Random fluctuations – the risk that future experience does not reflect the model or parameters chosen even though these adequately reflect the lives insured, e.g. due to low volumes of data.

**Investment risk**

There is a risk that the assets transferred across perform poorly relative to what was allowed for when determining the amount to be transferred across. There is a risk that the insurance company has to accept some very poor quality assets as part of the transfer which it is then unable to sell.

The extent of risk arising will depend on how close the matching is by cashflow duration, by nature e.g. whether index-linked bonds to match any indexed benefits and by currency.

If some of the assets are corporate rather than government bonds then there will be related counterparty risk i.e. risk of default of coupons and/or maturity payments.

**Expense risk**

There is a risk that the company has underestimated the expenses involved in administering this business. Or the expenses that will be involved in undertaking the transaction itself e.g. legal / advisor costs.

The company could also have underestimated future expense inflation (in relation to the expenses involved in administering the business).

**Operational risk**

There is a risk of a failure of management systems or controls relating to the transaction, for example the transferring of the data and/or assets may be complex, therefore errors may occur.

If the company does not currently administer annuities then there is a risk that suitable management systems or controls may not be put in place or may be inadequate, for example, new processes put in place to validate that the annuitants are alive may not be sufficiently robust. Poor servicing could lead to reputational risk.

**Concentration of risk**

There may be a correlation between some of the risks above or with risks the company already faces, for example, the company may already write a lot of immediate annuity business and so may be adding to the concentration of this longevity risk.

**Other risks**

Counterparty risk: there is a risk that the other party to the transaction pulls out at the last minute thus wasting money (and time) for the insurance company.
Action of competitors: if other insurance companies are interested in the portfolio, it might mean that the company pays too much for the transaction.
Action of directors: the board of directors may be willing to "pay more" (i.e. accept a lower asset transfer) to ensure business targets are achieved.
Regulatory risk: changes to the regulatory e.g. regulatory change may allow withdrawals or tax environment for annuities could make this business less profitable in future.
There is a legal risk that the terms of transfer are left open to interpretation.
There is a risk that the transaction is delayed and things change in the meantime, e.g. markets crash.
Fraud: there is a risk that the pension scheme has deliberately withheld information about the liabilities / misrepresented the liabilities.
There is also customer fraud risk, e.g. they don't notify of death.
There is the risk that a reinsurer defaults if reinsurance is used.

(ii) **Data**

Ensure that the agreement with the pension scheme covers the costs of any data errors which are the fault of the pension scheme even if these are discovered after the transfer of business. Ensure good understanding of all the data fields.
Perform careful due diligence checks on the data before agreeing a "price" (i.e. the amount of assets to be transferred).
Use an external expert reviewer to help with this, if needed.

**Mortality**

Review the provided experience analyses carefully and ensure they are signed off by the Scheme actuaries.
Ensure that the expected future mortality experience used to determine the "price" of the transaction allows for appropriate levels of future mortality improvements which is tailored to the nature (e.g. socio-economic status) of the lives in the portfolio or consider using industry data.
Undertake continual monitoring of the model/parameters against experience.
Take out reinsurance for instance, quota share or excess of loss or enter into a longevity swap.

**Investment**

Review the quality of the investment portfolio carefully before the transaction and refuse to accept very poor quality assets.
Improve the portfolio matching after the transaction has taken place, e.g. sell some assets and replace them with others or switch them around with assets already held against other business.
Ensure that the value placed on non-secure assets during the transaction negotiations reflects fully the expected default risk.
Monitor corporate bond performance carefully by credit rating and use credit derivatives if felt necessary or currency hedges.

**Expense**

Estimate expected expenses carefully, including a margin for uncertainty.
Put budget controls in place and continue to monitor expenses closely
Monitor actual experience against expected additional costs of the transaction.
Match expense liabilities using "real" assets e.g. index-linked bonds.

**Operational**

Ensure that appropriate controls are put in place. Test and check all systems used. Document clearly all processes. Train the relevant staff. Outsource administration.

**Concentration**

Consider writing more business with diversified risk e.g. protection business.
Reinsure out some of the concentrated business.

**Other/general**

There should be evidence of governance and challenge, and potentially internal audit, for any large new transaction that is entered into to ensure it is priced correctly.
Ensure that a relatively large margin for adverse outcomes is priced into the transaction.
And an appropriate risk margin in the reserves/capital held against these liabilities after transfer.
Use appropriate expertise when designing and delivering the transaction
Maintain a close relationship with regulators, keeping up to date with proposed regulations and lobbying where appropriate

Maintain claims management process, with active checks included

Mitigate some of the legal risk by ensuring watertight wording of the contract and obtain legal advice/review

Use highly rated reinsurers or collateral or spread across several reinsurers.

Part (i) was answered well by most candidates. The strongest candidates tailored their answer to the situation in question, for example excluding points about surrenders as they are not generally allowed for annuities. They also realised that it is only the inforce business that is subject to transfer, therefore not commenting on new business issues. A range of points were covered by most candidates in part (ii) with stronger candidates going past the basic point on each topic.

**Q5** (i) Regular reversionary bonus is declared normally each year.
Once declared, it cannot be taken away as long as contractual premiums continue to be paid.

The reversionary bonus can be:

- Simple: Bonus expressed as a percentage of the basic benefit.
- Compound: Bonus expressed as a percentage of the basic benefit plus any attaching bonuses.
- Super-compound: Bonus comprises two parts – a bonus expressed as a percentage of the basic benefit plus a bonus expressed as a percentage of the attaching bonuses (bonuses previously declared).

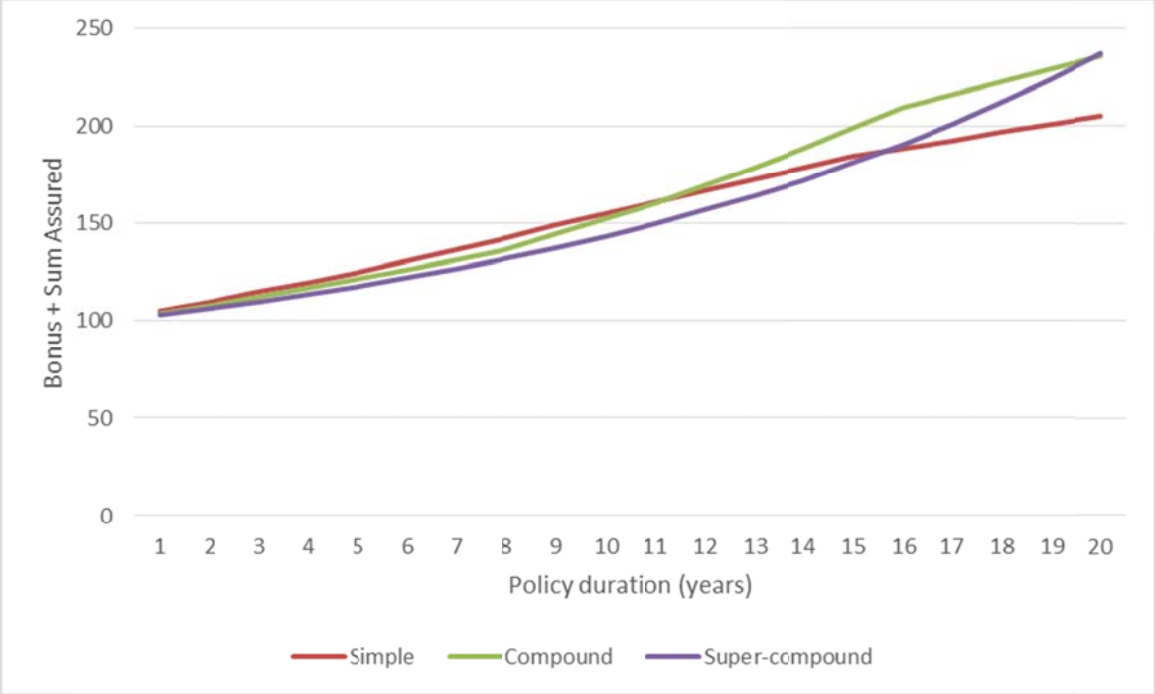
The bonus percentage declared on bonuses is usually higher than the bonus percentage declared on the basic benefit.
Terminal bonus is added when the insured event occurs.
The level of terminal bonus is discretionary / not guaranteed.
It may be added as a percentage of total attaching reversionary bonuses.
Or it may be determined as a percentage of the total claim amount.
The percentage is likely to vary by duration in-force.
A special reversionary bonus may be added.
This would be a one-off arising from a particular event (e.g. fund restructuring).

(ii) Simple
Bonus at end of year 5 = $(100 \times 0.05 \times 5)$
$= 25$
Bonus at end of year 15 = $25 + (100 \times 0.06 \times 10)$
$= 85$
Bonus at end of year 20 = $85 + (100 \times 0.04 \times 5)$
$= 105$

Compound
Bonus at end of year 8 = $100 \times 1.04^8 - 100$
$= 36.86$
Bonus at end of year 16 = $(36.86 + 100) \times 1.055^8 - 100$
$= 110.03$
Bonus at end of year 20 = $(110.03 + 100) \times 1.03^4 - 100$
$= 136.39$

(iii) Super-compound
Each year a bonus of 100 × 0.03 = 3 is declared on the sum assured
This bonus is then increased by the bonus rate of 8% p.a.
So the value is equivalent to an annuity or accumulation factor, or a geometric series
Therefore the total attaching bonus at the end of the 20 year period is
$= 3 \times (1.08^{20} - 1)/0.08$
= 137.29, as required

(iv)




The graph needed to include axis and series labels, and include the basic sum assured throughout.
Simple line correct shape (fairly smooth, straightish line, correct end and intermediate points).
Compound line correct shape (particularly the kink after 16 years, correct end and intermediate points).
Super-compound line correct shape (i.e. more like a curve, correct end point).

(v) The asset share line could be approximate, but should have the following features:

The asset share should increase smoothly over time, but start at a negative point.
The finishing point should be higher than the other lines to reflect likely terminal bonus accrual.

(vi) The super-compound approach should be used.
The super-compound approach defers the distribution of surplus more than the two other approaches.

This can be seen in the graph, as the amount of guaranteed benefit payable is the lowest of all three of the approaches for the first 15 years.
The total guaranteed benefit payable after 20 years is broadly the same or slightly higher under the compound and super-compound approaches.
But the guaranteed benefit builds up less quickly for the super-compound approach.

Lower guarantees normally means lower reserves.
This improves the solvency position which is useful for this company, given that its solvency appears to be constrained.

(vii) Policyholders may not like this approach as policyholders generally prefer guaranteed benefits.

They may not like the low bonus rate on the sum assured and it may not compare favourably with other "headline" bonus rates available in the market.
The company may therefore sell lower volumes of new business.

However, this downside may be offset by the attraction of the high attaching bonus rate.
Policyholders may find the approach difficult to understand or it may be hard to explain.
There may therefore be reputational risks or a risk of mis-selling.

The application of this bonus approach may be administratively more complex than the others.

It is more time-consuming for the company to have to determine two bonus rates each year rather than one.

Shareholders may not like this approach as it defers distributions to them more.

This question was answered strongly by many candidates. The bookwork in part (i) was generally covered well, with stronger candidates covering the full range of points for the terminal bonus section.
The calculations in part (ii) were attempted by the majority of candidates, with many scoring full marks.
Part (iii) was only completed by the strongest candidates, with some completing the calculation in full rather than using the simplified approach in the solution. Both approaches could be awarded full marks.
The graphs for parts (iv) and (v) were competently drawn by most candidates, with the main errors being the relative positions of the three curves.
Most candidates covered the main points of part (vi) and in part (vii) the stronger candidates covered a breadth of points rather than only the basic policyholder considerations.

# END OF EXAMINERS' REPORT