ACTUARIAL REFERENCE No (ARN)						

INSTITUTE AND FACULTY OF ACTUARIES

EXAMINATION BOOKLET

May 2015

CA2: Model Documentation, Analysis and Reporting

Paper 2

DO NOT OPEN UNTIL INSTRUCTED TO DO SO.

Examination instructions

1. You should periodically save all the files you are working on onto the PC's hard drive.

   You will be given instructions for submitting your work at the end of the examination.

   It is your responsibility to ensure your work is adequately saved.

2. At the end of the allotted time, or when you have completed your exam, you need to submit your work.

   Your filenames must include your ARN (**e.g. Summary_ARN.docx)**. Ensure that your spreadsheet model and summary are clearly labelled and also contain your ARN as a header or footer on at least one page.

   Please note that you should use your ARN and NOT your name on all of the material you submit for marking.

   The work you submit MUST be saved in Microsoft 2007 format, i.e. using docx (Word) or xlsx (Excel) file extensions. Do not embed documents in your spreadsheet.

3. You must submit your spreadsheet model and summary by the end of the stated exam time. By submitting your files you are confirming that all material is entirely your own work and you wish this to be taken into account for this assessment.

   It is your responsibility to ensure that a complete electronic copy of your work is submitted.

   You must stop working after this time as failure to do so could result in your exam not being marked.

4. You must also hand in this examination booklet, together with any other materials from the examination. This includes handing in any planning or rough notes that you have made during the examination, and any print-outs that you have done of your work.

Professional behaviour is mandatory and no material relating to the exam may be taken from the exam room nor disclosed or discussed with others.

Failure to comply with this will be deemed to be a breach of examination regulations and may result in disciplinary action.

A spreadsheet model has been provided electronically.

You should use the first 15 minutes of the exam as reading and planning time.

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Exam requirements

1. Read the background document, which describes the scenarios that have been modelled and documented for this project. Technical assistance for the modelling work, should you require it, can be found in the additional guidance contained in this booklet.

No marks will be deducted for the use of this guidance.

2. Read the audit trail which has been written by your colleague, another actuarial student, for the calculations that they performed. This will assist you in following and understanding the calculations performed in the Excel model provided.

You are not required to add to or amend the audit trail.

3. Expand the spreadsheet model to produce the required additional calculations for the proposed approach. You should ensure that the additional work you undertake on the spreadsheet contains appropriate self-checks.

(i) Allow for the new investment strategy.

(ii) Allow for the individual's fund to continue to achieve the stated investment returns following their retirement.

(iii) Allow for the individual to withdraw a fixed annual income each year following their retirement.

(iv) Calculate the annual income that an individual could afford if they were to retire at 65 and were assumed to die between ages 87 and 88.

You should assume that your colleague's calculations have been checked and are correct. [7]

4. Illustrate the following using four suitable charts:

- The annual contributions to each asset class in each projection year under the current approach.
- The annual contributions to each asset class in each projection year under the proposed approach.
- The progression of the individual's fund under the current approach, split by asset class.
- The progression of the individual's fund under the proposed approach, split by asset class, assuming they take the maximum level of affordable annual income from retirement (as calculated in part 3. (iv)) and die between ages 87 and 88. [8]

5. Prepare a summary document of around five to seven pages, capturing the main features and results of the work done by you and your colleague. You can assume that the summary is being prepared for your boss, a senior actuary, who will present the work to the client.

Your summary should include the following:

- purpose of the project, data, method and assumptions used by you and your colleague
- results, including charts
- commentary on the results, key conclusions and suggested next steps

The summary should cover the full scope of the project, including the current approach which was modelled in the spreadsheet provided.

You are not required to add to or amend the audit trail.

Marks available for the summary:

Methodology (including purpose, data, method and assumptions):	**[20]**
Results, including charts	**[10]**
Commentary on results and conclusions	**[20]**
Next steps	**[25]**
Drafting	**[10]**

[Sub-total 85]

[Total 100]

Background

The Retirement Strategist for the Government of Actuaria, William Easton, has been asked to put forward a new, more flexible, approach to the way people in Actuaria can use their retirement savings.

Current approach

Under the current approach, individuals save throughout their working life. Both the individual (the employee) and their employer pay contributions into a fund that is invested in three asset classes: equities, bonds and cash.

The fund is rebalanced each year on the individual's birthday according to a specified investment strategy. Under the investment strategy the percentage invested in each asset class changes in relation to the number of years until retirement.

Mr Easton has provided details on the investment strategy including the expected annual investment returns for the three asset classes – equities, bonds and cash. (Your colleague has incorporated these into the model.)

At retirement at age 65 the individual must use the accumulated fund to purchase an annuity. The annuity will provide them with a guaranteed income for the rest of their lives.

Proposed approach

Mr Easton has put together a proposal for a more flexible approach.

Under his proposed approach, contributions will be invested in the following proportions which remain the same irrespective of the number of years to retirement:

- 40% equities
- 40% bonds
- 20% cash

A key difference with the proposed approach is that the accumulated fund will **not** be used to purchase an annuity. Monies will remain invested after retirement at age 65 and an annual income can be withdrawn from the fund. It should be assumed that the annual income will be withdrawn from the fund at the start of each year of age. The first withdrawal will occur on retirement at age 65.

As with the current approach the fund is rebalanced each year on the individual's birthday to maintain the specified split by asset class as set out above. This annual rebalancing continues after retirement.

Mr Easton hopes that the proposed approach will be introduced on 30 June 2015.

Modelling request

You are an actuarial student working for a consultancy in Actuaria. Mr Easton is a client of the consultancy and has asked your boss, a senior actuary, to help with modelling the changes that he is proposing.

Mr Easton wishes to analyse the impact of his proposed approach in comparison to the current approach for a typical individual who starts saving for retirement when the proposed approach comes into effect.

He has stated that the typical individual should be assumed to be born on 31 July 1975, to begin saving for retirement on 30 June 2015 and to retire at age 65. It should be assumed that the individual earns the average salary in Actuaria, currently $25,000, and that contribution levels of 5% for the individual (employee) and 10% for the employer are paid.

Mr Easton has also provided data showing that salary inflation has remained at 2.5% a year in Actuaria for several years.

Mr Easton is particularly interested in how the level of income that an individual could receive under the current and proposed approaches will differ. He expects that when an individual born on 31 July 1975 retires at age 65 they will, on average, live until between ages 87 and 88.

- Under the current approach, Mr Easton has stated that an annuity factor of 28.5 would be used to convert the accumulated fund to a fixed level of income at the time of retirement.

- Under the proposed approach, he would like to know the level of income that could be supported assuming the individual retires at age 65 and dies between ages 87 and 88.

Your boss has already asked your colleague to build a model that illustrates the income that can be secured under the current approach. These calculations have been completed and your colleague has also produced a first draft of his audit trail. A copy of the audit trail is contained in this booklet and an electronic copy of the model will be provided.

Your colleague is currently at a client meeting and cannot be contacted. In his absence your boss has asked you to enhance the model in order to model the new proposed approach. She would like the modelling changes implemented, including appropriate checks where necessary.

Additionally, your boss needs you to prepare a summary document covering both the current and proposed approaches.

You are not expected to include the additional modelling request in the audit trail, but your results should be included in the summary.

Additional guidance

Income

Income is only required from the age at which the individual retires.

For simplicity it can be assumed that income will be withdrawn at the start of each new year of age. Namely, it can be assumed that income will be withdrawn each year on an individual's birthday, including the date at which the individual retires.

Returns

Pre retirement the fund needs to reflect contributions and returns for each asset class.

Amount of Fund at Individual's Birthday in that Asset Class =

(Fund at Previous Birthday × % of fund in that Asset Class at Previous Birthday
× (1 + Return for that Asset Class)
+
(Amount Contributed into the Asset Class over the year of age)
× (1 + Return for that Asset Class)$^{0.5}$

Post retirement there will be no further contributions, but the fund needs to be used to pay the individual's income and also reflect further fund returns for each asset class.

Amount of Fund at Individual's Birthday in that Asset Class <u>before</u> taking Income =

([Fund at Previous Birthday **– Income taken on Previous Birthday**] × % of fund in that Asset Class at Previous Birthday)
× (1 + Return for that Asset Class)

You will need to decide whether you wish to model both the pre-retirement and post-retirement sections in a single projection. Alternatively you may prefer to perform a separate projection for the pre- and post-retirement sections.

Determining the affordable level of income

The age of death has been specified as between ages 87 and 88. You will need to vary the level of income until the fund at the birthday prior to the age of death is 0.

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Audit trail

The following audit trail should be read alongside the provided model.

Objective

The purpose of the spreadsheet is to project the annuity income that an individual can expect to receive at retirement based on a number of specified assumptions.

The individual and the individual's employer make regular contributions to an investment pot based on the individual's annual salary.

These contributions are invested in line with the investment strategy specified and achieve annual returns. The investment strategy varies according to the number of outstanding years to retirement.

At the individual's assumed retirement age the investment pot is used to purchase a level income which will be paid for the rest of the individual's life, however long that may be.

NB: Input cells are shown in blue. Cells shaded in red do not copy down.

Data and inputs

This worksheet details the data and inputs used in the projections.

Several data items are required in order to perform the projections. Mr Easton, the Retirement Strategist for the Government of Actuaria, has specified the following data items:

- The date of birth of the individual to be considered.
- The date at which the calculation is performed.
- Individual and employer contribution rates.
- The individual's current salary.
- The level of salary inflation is set to the level of salary inflation experienced in recent years.
- The retirement age of the individual.
- The annuity rate expected to be achieved at the individual's retirement age – used to convert the fund into an annual income.
- The fixed annual returns assumed to be achieved on the asset classes invested in.
- The investment strategy to be followed over the course of the individual's working life (i.e. between current age and retirement age), varying by number of years to retirement.
- The investments are rebalanced to reflect the splits set out in the investment strategy.

NB: Where cell names have been defined these are shown in red on the right of the relevant cells.

Assumptions

The following assumptions are applied to the benefit projections:

- Contributions are assumed to be made on average half way through the year of age.
- Salary is assumed to increase annually on the individual's birthday.
- 100% equities are assumed to be used for investment periods more than 11 years from retirement age.
- The individual is assumed to use all of the investment pot to purchase an income.
- The income calculated is as at the individual's retirement age i.e. it is given as a future value not in terms of today's prices.

Benefits projection

This worksheet performs the benefit projection

The individual's assumed date of retirement is calculated using their date of birth and increasing the year of birth by a number of years equal to the assumed retirement age.

The projection is performed on an annual year of age basis with the following calculations being performed each year:

- The first period of the projection is only a partial year which starts at the date of calculation and ends at the individual's next birthday (cells C8:E8).
- All other periods of the projection are complete years starting at the individual's birthday (column C) and ending at their next birthday (column D).
- In column E the proportion of the year which the individual is working is calculated as the difference between the end of year and start of year dates divided by a complete calendar year. This should be 100% up to the retirement date apart from the first time period, and then 0% after retirement.
- In column F the individual's annual salary is increased each year as follows:

  Current annual salary = Previous annual salary × (1 + salary inflation)

- The employee (the individual) and the employer's contribution percentages are brought into columns G and H respectively from the "Data and inputs" sheet. Since the contributions remain unchanged over time they are the same in each year of the projection.
- The percentage split of the fund to each of the different asset classes for the year in question is then brought into columns I, J and K from the "Data and inputs" sheet.

  This is found by looking up the investment allocation from the investment strategy in the "Data and inputs" sheet, based on the number of years between the individual's current age and their retirement age.

- For each asset class (columns L, M and N), the amount of money to be contributed over the year and allocated to that asset class is calculated as the individual's salary multiplied by the sum of the employee and employer contribution rates multiplied by the percentage of the fund allocated to the asset class in question, **multiplied by the proportion of the year over which contributions will be paid** (from column E).

- For the first period of the projection the total fund at the start of the year is 0. In subsequent years the fund at the start of the year is the previous year's fund at the end of the year.

- The fund at the end of the year, in each asset class, is:

    - The fund at the start of year of age in that asset class multiplied by $(1 + i)$ where i is the annual investment return that asset class is assumed to achieve

      plus

    - the amount contributed to that asset class over the year of age multiplied by $(1 + i)^{0.5}$.

    For the first period of the projection it is necessary to allow for the fact that only a proportion of a year is worked, so a more general formula is used, namely:

    Fund at year end in that asset class =

    (Total fund at previous year end × proportion of fund in that asset class) $\times (1 + i)^{(\%\text{ of year individual is working})}$
    +
    (Amount contributed into the asset class over the year) $\times (1 + i)^{(0.5 \times \%\text{ of year individual is working})}$

    These calculations are in columns P, Q and R.

- The total fund at the end of each year is calculated in column S as the sum of the amount within each asset class.

This process is repeated for each year of age between the date of calculation and the individual's assumed retirement date.

At the top of the sheet the total amount of contributions made into each asset class is determined by summing the contributions in columns L, M and N for equity, bond and cash respectively.

In the top right hand corner (cell S1) the total fund value at retirement is looked up from the projection. The annual retirement income is calculated (cell S2) by dividing the total fund value at retirement by the annuity rate (obtained from the "Data and inputs" sheet).

END OF PAPER