

INSTITUTE AND FACULTY OF ACTUARIES

April 2017

CA2: Model Documentation, Analysis and Reporting

Paper 2

Time allowed: 3 hours + 15 minutes reading time

INSTRUCTIONS TO THE CANDIDATE

1. You have 15 minutes reading time at the start of the examination in which to read the questions. You are strongly encouraged to use this time for reading only, but notes may be made. You then have 3 hours to complete the paper.
2. You must build your model from the beginning and not use an imported e-template.

Your file names must include your ARN, the name of the document and the paper sat (e.g. 9000000-Summary-Paper1) and each file should contain your ARN as a header or footer.

Please note that the content of this booklet is confidential and students are not to discuss or reveal the contents under any circumstances nor are they to be used in a further attempt at the exam.

If you encounter any issues during the examination please contact the Online Education team at online_exams@actuaries.org.uk T. 0044 (0) 1865 268 255

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Exam requirements

1. Read the background document, which describes the scenarios that have been modelled and documented for this project.
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.

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

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. The model should include the following:
 - updated member projections to reflect the new “low” assumptions (for the 11 identified members only)
 - determination of the total amount which could be contributed annually (i.e. the total of the company and Mr Potter's contributions), as a fixed, level amount, each year to Mr Potter's defined contribution (DC) pension fund so that the value of his total pension is projected to be equal to the projected Government's maximum allowance (GMA) when he retires (under the original assumptions)

[6]

4. Construct, for each of the following, a suitable chart to illustrate:
 - the 11 members' pension values at 31 December 2016 and projected values at 31 December 2018 using both the original and new “low” assumptions, compared with the GMA under each scenario at each of these dates.
 - how the 11 members' projected pension values, using the “low” assumptions, vary depending on the length of time the member has been in the Ginger and Pickles Pension Scheme (GP PS) up to 31 December 2018 (i.e. time from the date at which the member joined the scheme to 31 December 2018).
 - Mr Potter's projected pension plotted over time as compared to the GMA, under the original assumptions and original intended contributions.
 - Mr Potter's projected pension plotted over time as compared to the GMA, under the original assumptions but now reflecting the fixed, level pension contributions that target the projected GMA at retirement.

[9]

[Sub-total 15]

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 Mr Potter.

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
- suggested next steps

Commentary on the results should cover, but not be limited to:

- analytical comments on each stage of the results, including explaining patterns in the results and any unusual features.
- an explanation of the differences between the results under the various scenarios modelled.

Next steps need to be specific to the project, with some mention of why each is a valid next step.

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)	[25]
Results, including charts	[10]
Commentary on results and conclusions	[20]
Next steps	[20]
Drafting	[10]

[Sub-total 85]

[Total 100]

Background

In 2016 the Government of a developed country announced changes to the maximum value of pension benefits an individual can accumulate for their retirement, before a penalty charge would be imposed. The Trustees of Ginger and Pickles Pension Scheme (GP PS) asked Mr Potter, the pension scheme's manager, to investigate whether the directors of Ginger and Pickles Ltd (GP Ltd) are likely to be affected by the limit in the next few years.

You are an actuarial student working at Actuarial Calculations Ltd (AC Ltd), an actuarial consultancy firm. Mr Potter approached your boss, a qualified actuary, and asked her to provide assistance in projecting the directors' pension values so that he can report back to the Trustees.

Pension Scheme benefits

The GP PS provides two types of pension benefits to its members:

- a career average revalued earnings (CARE) pension
- a defined contribution (DC) pension fund

Each member has a CARE pension and a DC pension fund.

Members retire from the GP PS at the end of the calendar year in which they have their 60th birthday, and pension benefits can start to be taken at that point.

CARE pension

Members build up one unit of annual pension equal to 1.5% of their pensionable salary for each complete year that they are a member of the GP PS. The pension units that are built up each year are increased over the period up to retirement, in order to provide some protection against inflation.

There are two measures of inflation in this country: inflation A and inflation B. The pension that is built up in year n is first increased at the end of year $n+1$ by inflation A as measured in year $n+1$. It is then increased in line with inflation A at the end of every subsequent year until the member retires.

DC pension

The member's defined contribution pension fund builds up from contributions paid in by the member and by the company, and investment returns on the fund up to retirement.

Contributions are set at a percentage of pensionable salary, which varies depending on the age of the member at the beginning of the calendar year. When the member retires, the fund the member has built up can be used to provide benefits in their retirement.

The GP PS booklet states that contributions into the DC pension funds are as follows:

<i>Member's age</i>	<i>Member's contribution</i>	<i>Company's contribution</i>	<i>Total contribution</i>
0–29	2%	2%	4%
30–39	2%	3%	5%
40–49	3%	4%	7%
50+	4%	5%	9%

Government limits

The Government has imposed a limit on the value of the pension benefits that members can accumulate before they retire. This limit is known as the Government's maximum allowance (GMA). For 2016 the GMA was set at \$1m, and will be increased annually by inflation A, at the start of each subsequent year.

The Government defines the value of a member's pension benefits in year t to be as follows:

$$20 \times \text{annual CARE pension accrued to the end of year } t \\ + \text{DC pension fund at the end of year } t$$

If the value of the member's pension benefits in year t exceeds the GMA in year t then a penalty charge is applied.

Modelling request

The following request was made by Mr Potter in January 2017:

For the 10 directors at GP Ltd and Mr Potter, project forward their annual CARE pensions and DC pension funds to 31 December 2018 and compare these to the anticipated GMA at that date, determining how many directors exceed the GMA at 31 December 2016 and are projected to exceed the GMA at 31 December 2018.

In addition, Mr Potter would like his expected pension benefits projected forward for each year until his expected year of retirement and compared to the equivalent GMA for that year.

Mr Potter provided AC Ltd with the following details:

- The member identification (ID) numbers of the 11 members for whom projections were required (i.e. Mr Potter and the directors).
- Historically members have invested their DC pension funds fully in a default fund. Over the last five years, the default fund has returned on average 5.5% p.a. after charges.
- GP Ltd expects pensionable salaries to increase in line with inflation B.
- Inflation A can be assumed to be 3% p.a. and inflation B 4% p.a.

Using member data already held by AC Ltd, a student at the consultancy completed these projections. The completed calculations were checked and were found to be correct. A copy of the audit trail for the model is contained in this booklet and an electronic copy of the model will be provided.

The student who completed the original calculations no longer works for AC Ltd. In her absence, your boss needs you to perform some additional tasks.

Firstly, following unpredicted international events, the economic outlook is more uncertain than assumed at the start of the year. Your boss would therefore like you to recalculate the 11 members' pension values at 31 December 2018 (without over-writing the existing projections) assuming lower inflation assumptions and lower investment returns. There is no need to update Mr Potter's more detailed individual projections.

For the new projections you should assume the following, lower assumptions:

- Inflation A 2% p.a.
- Inflation B 3% p.a.
- Investment returns 3.5% p.a.

Secondly, Mr Potter is aware that, based on the original assumptions, his pension was projected to exceed the GMA before he retires. He would like to know, **under the original assumptions**:

- the projected value of his pension benefits at his expected retirement date (i.e. at the end of the calendar year in which he has his 60th birthday), and
- the total amount which could be contributed annually (i.e. the total of the company and Mr Potter's contributions), as a fixed, level amount (in \$), each year to his DC pension fund so that the value of his total pension is projected to be equal to the projected GMA when he retires. This additional modelling should be carried out without over-writing the existing projections.

Your boss would also like you to construct, for each of the following, a suitable chart to illustrate:

- the 11 members' pension values at 31 December 2016 and projected values at 31 December 2018 using both the original and new "low" assumptions, compared with the GMA under each scenario at each of these dates.
- how the 11 members' projected pension values, using the "low" assumptions, vary depending on the length of time the member has been in the GP PS up to 31 December 2018 (i.e. time from the date at which the member joined the scheme to 31 December 2018).
- Mr Potter's projected pension plotted over time as compared to the GMA, under the original assumptions and original intended contributions.
- Mr Potter's projected pension plotted over time as compared to the GMA, under the original assumptions but now reflecting the fixed, level pension contributions that target the projected GMA at retirement.

Finally, your boss needs you to prepare a summary document covering all elements of the work (both the original work your colleague completed and the additional modelling you are undertaking).

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 and key conclusions
- suggested next steps

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

Audit trail

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

Objective

In 2016 the Government introduced a maximum allowance (GMA) for the value of retirement benefits individuals can accumulate before they retire.

The purpose of the spreadsheet is to project the value of pension benefits for select members of the Ginger and Pickles Pension Scheme (GP PS) to a specified year end and to compare these to the projected GMA.

In addition, the spreadsheet projects forwards, on a year by year basis, the pension benefits for Mr Potter and compares the value of these to the projected GMA at retirement.

NB: Input cells are shown in blue. Cells shaded in orange do not copy down/across.

“Raw data” worksheet

This worksheet includes data for members of the GP PS.

AC Ltd held data for the 50 active members of the GP PS on file. This data is as at 31 December 2016 and consists of the members’ basic details, plus their accrued CARE pension and DC pension fund amounts. This data has been included on this worksheet.

“Parameters” worksheet

This worksheet details the inputs used in the projections.

Several data items are required in order to perform the projections.

Mr Potter, the pension’s manager provided:

- a table of the contribution rates which are age dependent.
- details of the benefits provided by the GP PS.

A senior colleague at AC Ltd has provided:

- details of the GMA.
- details of the inflation measures applicable.

NB: Where cell names have been defined these are shown in red next to the relevant cells.

Assumptions

The following assumptions are applied to the projections:

- The data held on file and provided by Mr Potter is correct.
- Inflation A and inflation B are assumed to remain constant over the course of each set of projections.
- Pensionable salaries are assumed to increase in line with inflation B, at the start of each year.
- The directors are assumed to remain employed and are assumed to continue to accumulate pension benefits within the GP PS for the duration of the projections.
- The benefits provided by the GP PS are assumed to remain unchanged for the duration of the projections.

“Projections” worksheet

This worksheet performs the projection of 11 members’ pension benefits, and compares these to the GMA.

The 11 member IDs, as provided by Mr Potter, are given in column A.

Using VLOOKUP functions, each member’s date of birth (column B), CARE pension (column D), DC pension fund (column E) and pensionable salary (column F) are brought through from the “Raw data” worksheet.

Each member’s age is found in column C as: (valuation date – member’s date of birth)/365.25.

The value of each member’s pension at 31 December 2016 is calculated, in column G, as:

$$20 \times \text{CARE pension (accrued to 31/12/2016)} + \text{Total DC pension fund (at 31/12/2016)}.$$

The GMA for 2016 is brought through from the “parameters” worksheet in column H. Then, for each member, the value of their pension benefits at 31 December 2016 is compared to the GMA at 31 December 2016, and an indicator is returned in column I. If the value from column G is greater than the GMA in column H it shows “exceeds” otherwise it shows “below”.

Pensionable salaries for each member for 2017 (pen sal 2017) and 2018 (pen sal 2018) are calculated in columns K and L. They are found by taking the previous year’s pensionable salary and increasing it by multiplying by a factor of $\{1 + \text{infl}_B\}$, where infl_B is the assumption for inflation B.

The additional CARE pension accrued (column M) in 2017 and 2018 revalued to 31 December 2018 is found as follows:

$$\text{accrual rate} \times \text{pen sal 2017} \times (1 + \text{infl}_A) + \text{accrual rate} \times \text{pen sal 2018}$$

The CARE pension accrued to 31 December 2016 is revalued to 31 December 2018 (column N) by increasing it by $\{1 + \text{infl}_A\}$ for a period of two years, where infl_A is the assumption for inflation A.

The CARE pension accrued to 31 December 2018 (column O) is the sum of the additional CARE pension and the revalued CARE pension.

The existing DC pension funds accrued at 31 December 2016 are revalued to 31 December 2018 to reflect two years' worth of investment returns by multiplying the fund at 2016 by $(1 + \text{investment return assumption})^2$ (column P).

The additional DC pension funds accrued (column Q) in 2017 and 2018 revalued to 31 December 2018 are found as follows:

$$\begin{aligned} & \text{age dependent cont rate} \times \text{pen sal 2017} \times (1 + \text{inv ret})^{1.5} + \\ & \text{age dependent cont rate (allowing for one year's ageing)} \times \text{pen sal 2018} \times (1 + \text{inv ret})^{0.5} \end{aligned}$$

The Total DC pension fund (column R) is the sum of the additional DC funds and the revalued DC pension fund.

The value of each member's pension at 31 December 2018 in column S is found by taking:

$$20 \times \text{CARE pension (accrued to 31/12/2018)} + \text{Total DC pension fund (at 31/12/2018)}.$$

The projected GMA (column T) is found by taking the 2016 value and increasing it by 2 years' worth of the inflation A assumption.

For each member, the value of each member's pension benefits at 31 December 2018 is then compared to the GMA at 31 December 2018, and an indicator is returned in column U, consistently with the calculation carried out in column I.

“Ind projection” worksheet

This worksheet performs the projection of Mr Potter's retirement benefits from 2016 on a year by year basis until he is expected to retire, and compares the value of these benefits to the GMA.

The member ID for Mr Potter is entered as an input at the top of this worksheet.

For the first row of calculations, which relate to 2016, the figures required are pulled through from the “Raw data” worksheet using VLOOKUP functions, and calculations are performed for age and total value, in a consistent manner to the “Projections” worksheet calculations.

For years 2017 onwards the following calculations are completed:

- the year and age are increased by 1 as compared to the previous year

- the pensionable salary (column C) is increased compared to the previous year by a multiple of $(1 + \text{infl}_B)$

- the CARE pension for year n (column D) is as follows:

$$\text{CARE pension}_n = \text{CARE pension}_{n-1} \times (1 + \text{infl}_A) + \text{accrual rate} \times \text{pensionable salary}_n$$

- the DC pension fund for year n (column E) is as follows:

$$\text{DC fund}_n = \text{DC fund}_{n-1} \times (1 + \text{inv ret}) + \text{cont rate}_{\text{age in yr } n} \times \text{pen sal}_n \times (1 + \text{inv ret})^{0.5}$$

- the total pension benefits value (column F) is found as $20 \times \text{CARE pension} + \text{DC pension fund}$
- the GMA (column G) is increased compared to the previous year by a multiple of $(1 + \text{infl}_A)$
- in column H, a comparator indicator returns “Yes” if the total value is greater than the GMA and “No” if the total value is less than the GMA

These calculations are undertaken until year 2040 as this is the year in which Mr Potter turns 60. If the member number were to be changed, the number of rows in which calculations are required may need to be updated.

END OF PAPER