# RET FRC Model Solutions
# Spring 2022

## 1. Learning Objectives:

5. The candidate will understand how to evaluate and apply regulatory policies and restrictions for registered retirement plans.

**Learning Outcomes:**

(5a) The candidate will be able to describe and apply regulation pertaining to plan design.

(5g) The candidate will be able to describe and apply regulation pertaining to reporting requirements.

(5j) The candidate will be able to describe and apply regulation pertaining to individual savings plans.

(5k) The candidate will be able to describe and apply regulation pertaining to coordination of individual and employer sponsored retirement plans.

**Sources:**

Canada Revenue Agency PA Guide

Canada Revenue Agency PSPA Guide

**Commentary on Question:**

*Commentary listed underneath question component.*

**Solution:**

(a) Calculate the Past Service Pension Adjustment (PSPA).

**Commentary on Question**:

*Most candidates performed well on this question and were able to correctly calculate the PSPA.*

(A) Calculate the benefit earned and pension credits for all years covered by the past service event: 2020: 1.5% x $75,000 = $1,125
Pension credit = 9 x $1,125 – 600 = $9,525

## 1. Continued

(B) Calculate the benefit earned and pension credits based on benefits provided immediately before the past service event
Additional pension credits = $0 *(The member did not earn any benefits before the amendment as this is new service)*

(C) Qualifying transfers = 0

(D) Excess money purchase transfers = 0

PSPA = A – B – C + D = $9,525 – 0 – 0 + 0 = $9,525

(b) Describe in words the options that are available to the member to have the PSPA certified.

**Commentary on Question**:
*Full credit was given to candidates that provided at least 6 acceptable answers. Most candidates performed well but did not provide enough answers to obtain full credit.*

*The following are acceptable answers:*

Qualifying Withdrawal:
- A qualifying withdrawal represents an amount a member has withdrawn from an RRSP, in order to have a PSPA certified.
- The member has not designated the amount for any other PSPA certification.
- If the member has withdrawn the amount in the current year or in either of the two previous calendar years, this withdrawal may also be considered a qualifying withdrawal.

Qualifying Transfer:
- A qualifying transfer reduces the amount of the PSPA related to a PSPA event.
- It is an amount that the member transfers to a defined benefit plan directly from an RRSP, DPSP, MPP.
- The transfer occurs no later than 90 days after the later of 1) the day the administrator receives the PSPA certification and 2) the day the administrator receives notification that the plan is registered.

- Wait and buy back the service at a later date when they have sufficient RRSP room.
- Buy back a partial year of service.

## 2. Learning Objectives:

5. The candidate will understand how to evaluate and apply regulatory policies and restrictions for registered retirement plans.

**Learning Outcomes:**

(5i) The candidate will be able to describe and apply regulation pertaining to contributions and benefits.

**Sources:**

Pension Adjustment Guide - Canada.ca

Canadian Pensions and Retirement Income Planning, Willis Towers Watson, 6th Edition, 2017 (Ch. 5-8)

**Commentary on Question:**

*This question is to test candidate's understanding of how maximum contribution under the defined contribution component is determined when the company is offering both defined benefit and defined contribution benefits (Combination Plans and Hybrids).*

**Solution:**

(a) Calculate the maximum contribution, in dollars, to the defined contribution provision that Company XYZ may make for Member A in 2022.

**Commentary on Question**:

*Many candidates were able to determine the maximum total DC contribution, but not the maximum allowed Employer DC Contribution.*

Maximum PA Rule
= minimum (18%*2022 T4 Earnings, 2022 Money Purchase Limit)
= minimum (18%*$250,000, $30,780)
= minimum ($45,000, $30,780) = $30,780

DB Pension Credit
= 9 x minimum (2022 DB Limit, 2022 DB provision Benefit earned) – 600
= 9 x minimum ($3,420, 1.2% x $200,000) – 600
= 9 x $2,400 – 600 = $21,000

Maximum Total DC Contribution
= 2022 Money Purchase Limit – DB Pension Credit
= $30,780 – $21,000 = $9,780

DC EE Required contribution = 2% x 200,000 = 4000
Maximum allowed Employer DC Contribution = 9,780 – 4,000 = 5,780

## 2. Continued

(b) Company XYZ decides not to change the defined contribution provision. Calculate the maximum total contribution (employee and employer) to the DC plan plus to Member A's personal Registered Retirement Savings Plan (RRSP) for 2022.

**Commentary on Question**:
*Many candidates were trying to calculate the RRSP room, when the maximum contribution to personal RRSP was provided in the question.*

Maximum Total DC Contribution
= minimum (2022 Money Purchase Limit – DB Pension Credit, 3% x 2022 pensionable earnings)
= minimum ($30,780 – $21,000, 3% x $200,000)
= minimum ($9,780, $6,000) = 6,000

Maximum contribution to Member A's personal RRSP is $3,500

## 3. Learning Objectives:

1. The candidate will understand how to analyze data for quality and appropriateness.

7. The candidate will understand how to apply the standards of practice and professional conduct guidelines.

**Learning Outcomes:**

(1b) Assess data quality.

(1d) Comply with regulatory and professional standards pertaining to data quality.

(7b) Explain and apply the Professional Conduct Guidelines.

(7d) Demonstrate compliance with requirements regarding the actuary's responsibilities to the participants, plans sponsors, etc.

**Sources:**

ASOP 23

CSOP 1440 & 1700

**Commentary on Question:**

*Commentary listed underneath question component.*

**Solution:**

(a) Identify potentially incorrect, missing, or incomplete data required for each valuation.

**Commentary on Question**:

*Most candidates did well on this part of the question. Those who didn't get full points did not list sufficient data queries for active and inactive members.*

<u>Active Members</u>

- ID 8225: Member record is missing. Should be included in data query.
- ID 9877:
    - Member age at 1/1/2021 is over 71 years of age -- should query if member is still actively employed
    - Should inquire about credited service decrease from 42 to 26
- ID 8625: New Entrant, but has 2 years of service as of 1/1/2021 -- should inquire about correct date of hire

## 3. Continued

- ID 7005:
  - Salary decreased from prior valuation -- request breakdown of earnings (base and bonus) to verify
  - Date of Birth looks incorrect as of January 1, 2020 (member would be age 97 and still an active employee)
- Should request any lump sum payment information (potentially for member missing from data)
- Request additional data for completeness:
  - Salary history and breakdown of earnings between base and bonus
  - Employee contribution data for determination of 50% rule

Inactive Members

- ID 2001: As of 1/1/2021, member is over 65 years of age and has not commenced pension
- ID 5005:
  - Member's status changed to "Beneficiary", but pension amount did not change (form of pension is J&S 60%)
  - Spouse DOB is the same as the Pensioner's DOB. Should confirm with client if Spouse DOB is correct, or if one of the records requires modification
- ID 9156: Member retired during 2020, but pension amount reported in data ($425) appears to be too low compared to estimated pension based on 1/1/2020 data (2% * 125,000 * 25 / 12 = $5,208)
- ID 3101: Date of Birth as of January 1, 2020 must be incorrect. Should query with client about corrected DOB as of January 1, 2021
- ID 4400: Spouse DOB changed from 8/5/1949 to 8/5/1939 between the two datasets. Should confirm which DOB is correct
- Request data for deferred members or the confirmation that the deferred members from the prior valuation have been paid out and that there are no new deferred members
  - If deferred members have been paid out, request data on lump sum payments and date of payment

(b) Describe the process you would follow to address the errors in the January 1, 2020 valuation, taking into account professional standards.

**Commentary on Question**:
*Candidates did not perform as well in this part of the question. Some candidates inadvertently described what assumptions they would make for missing data if performing the valuation at January 1, 2020.*

## 3. Continued

- Data should be reviewed for reasonableness and consistency as such review seems both necessary and practical.
- Should make an attempt to request new data from client:
    - Request full or partial data highlighting errors found in 1/1/2020 and 1/1/2021 valuation datasets
    - May assist in identifying systematic issues with data to avoid current and future data issues
- Determine if the errors in data were material to the valuation results (i.e. funding requirements) at January 1, 2020
    - If the errors are not material, no further action is necessary and the errors can be corrected in the next valuation
- If the errors are deemed material, engage your colleague who completed the valuation to discuss the situation
    - If after this discussion there is rationale for the data (supporting documentation etc.), no further action is necessary and the errors can be corrected in the next valuation
    - If there is agreement that the errors are material, the colleague should revise their report and/or communicate the impact to users of the reports
- If there is no resolution, the apparent non-compliance should be reported to the Professional Conduct Board (Rule 13)
- You may also ask questions to a member of the CIA in confidence regarding the matter
- Data errors should be corrected for the valuation as at January 1, 2021

(c) List the required disclosures regarding the data in accordance with the Standards of Practice.

**Commentary on Question**:
*Candidates generally did well on this part of the question but some did not list sufficient disclosure items to get full marks.*

- Source of data
- Extent of reliance on data supplied by others
- Confirmation that data was reviewed and that tests were applied for internal consistency and for consistency with previous valuation and that results were satisfactory
- Any adjustments or modifications made to the data OR description of any adjustments and methods used in respect of insufficient or unreliable membership data

## 3. Continued

- Any limitations on results due to uncertainty regarding the data quality OR should disclose if a review was not completed and any resulting limitation if actuary feels review was not necessary
- Any unresolved concerns about the data that may have a material effect on the results
- Materiality of highly uncertain or potential bias due to imperfect data and potential magnitude
- Any conflicts arising from complying with applicable law, regulation or biding authority
- Data was not verified or audited OR data was reviewed for suitability only
- A summary of the membership data
- Comparison of membership data with prior valuation
- Date on which data was compiled
- Statement of opinion regarding the membership data OR confirmation that data is sufficient and reliable

## 4. Learning Objectives:

3. The candidate will understand how to apply/synthesize the methods used to value pension benefits for various purposes.

5. The candidate will understand how to evaluate and apply regulatory policies and restrictions for registered retirement plans.

6. The candidate will understand how to apply the regulatory framework in the context of plan funding.

**Learning Outcomes:**

(3b) Perform periodic valuations of ongoing plans, calculating normal cost and actuarial liability, using a variety of cost methods.

(3f) Calculate actuarially equivalent benefits.

(5g) The candidate will be able to describe and apply regulation pertaining to reporting requirements.

**Sources:**

Canadian Pensions and Retirement Income Planning, Willis Towers Watson, 6th Edition, 2017 Ch. 15 (excluding Section 1525)

Morneau Shepell, Handbook of Canadian Pension and Benefit Plans, 17th Edition, 2020 Ch. 3 and 6

Pension Mathematics for Actuaries, Anderson, Arthur W., 3rd Edition, 2006 Ch. 1-4 and 7

Guidance on Selection and Disclosure of Plausible Adverse Scenarios, CIA Educational Note, Feb 2019

**Commentary on Question:**

*Candidates were asked to perform full going concern and wind-up valuations including gain and loss and determination of contributions. While candidates were able to successfully complete some portions of the question, candidates struggled with other portions. Minor calculation errors were tracked through and resulted in minimal deductions if the rest of the calculations were done correctly.*

**Solution:**

(a) You are asked to perform the actuarial valuation as at December 31, 2020.

(i) Calculate the funded status of the plan on a going concern basis.

(ii) Calculate the funded status of the plan on a solvency basis.

## 4. Continued

(iii) Calculate the minimum contribution requirements for 2021 and 2022 based on the December 31, 2020 valuation.

**Commentary on Question**:
*Overall parts i) and ii) were done well by candidates, but candidates struggled in determining the minimum contribution requirements in iii)*

*(i) Most candidates did not determine the actuarial value of assets correctly but were awarded some points for trying to calculate smoothed assets. Most candidates calculated the going concern liabilities correctly but forgot to calculate the non-indexed liabilities for the purpose of determining the PfAD.*
*(ii) Overall most candidates determined the deferred and retiree liabilities correctly, but some struggled in correctly determining the age that creates the maximum value for active and deferred members.*
*(iii) This part of the questions was done poorly overall. Most candidates were able to calculate the correct normal cost for each member. They however did not calculate the non-indexed normal cost in order to properly apply the PfAD. Candidates also did not include explicit expense allowance or PfAD in most cases. The special payments were also done poorly as candidates did not apply the going concern surplus to completely remove the Going concern special payments. The solvency special payments were overall done well however candidates did not apply the blended solvency rate.*

(i)

| | |
|---|---|
| **Actuarial Value of Assets** | **1,130,887** |
| | |
| **Going concern funding target** | |
| Going concern liabilities: | |
| Active members | 260,474 |
| Deferred pensioners | 258,069 |
| Pensioners | 375,760 |
| Subtotal | 894,304 |
| PfAD | 85,511 |
| **Total** | **979,815** |
| | |
| **Funding excess (shortfall)** | **151,072** |

## 4. Continued

- Calculation of smoothed assets:

Unrecognized capital gains (losses) realized or unrealized (from question):

| | |
|---|---|
| 2020 | 28,900 |
| 2019 | (100,000) |

| | |
|---|---|
| MVA 31/12/2020 | 1,116,820 |
| Yr 1 (2/3 of Unrecognized capital gains (losses) realized or unrealized for 2020) | (19,267) |
| Yr 2 (1/3 of Unrecognized capital gains (losses) realized or unrealized for 2019) | 33,333 |
| **AVA 31/12/2020** | **1,130,887** |

- Calculation of going concern liabilities:

Active Members:

| | | | | |
|---|---|---|---|---|
| Member ID | ID1 | Earnings | 2018 | 55,000 |
| Current age | 49 | | 2019 | 58,000 |
| Service | 4.00 | | 2020 | 61,000 |

| | Age | Years to Decrement | Projected earnings | Projected pension | QxT | QxR | tPxV | Factor (indexed) | Factor (non-indexed) | AL (indexed) | AL (non-indexed) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Termination | 49 | 0 | 58,000 | 4,060 | 3% | 0% | 1.0000 | 7.4 | 6.0 | 906 | 731 |
| EURD=NRD | 65 | 16 | 95,064* | 6,654 | 0% | 100% | 0.4512* | 16.0 | 12.9 | 48,039 | 38,732 |
| | | | | | | | | | | **48,946** | **39,463** |

*where:
95,064 = AVERAGE(61000*(1+0.03)^16,61000*(1+0.03)^(16-1),61000*(1+0.03)^(16-2))
0.4512 = (1-0.03-0)/(1+0.049)^16

| | | | | |
|---|---|---|---|---|
| Member ID | ID2 | Earnings | 2018 | 68,000 |
| Current age | 54 | | 2019 | 72,000 |
| Service | 12.00 | | 2020 | 74,000 |

| | Age | Years to Decrement | Projected earnings* | Projected pension | QxT | QxR | tPxV* | Factor (indexed) | Factor (non-indexed) | AL (indexed) | AL (non-indexed) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Termination | 62 | 8 | 91,037 | 19,118 | 0% | 50% | 0.6820 | 17.3 | 13.8 | 112,785 | 89,967 |
| EURD=NRD | 65 | 11 | 99,479 | 20,891 | 0% | 100% | 0.2954 | 16.0 | 12.9 | 98,744 | 79,612 |
| | | | | | | | | | | **211,528** | **169,579** |

*where:
91,037 = AVERAGE(74000*(1+0.03)^8,74000*(1+0.03)^(8-1),74000*(1+0.03)^(8-2))
99,479 = AVERAGE(74000*(1+0.03)^11,74000*(1+0.03)^(11-1),74000*(1+0.03)^(11-2))
0.6820 = 1/(1+0.049)^8
0.2954 = (1-0-0.5)/(1+0.049)^11

## 4. Continued

Deferred Members:

| | Indexed AL | | Non-indexed AL | |
|---|---|---|---|---|
| | ID3 | ID4 | ID3 | ID4 |
| Age | 39 | 60 | 39 | 60 |
| Service | 5.00 | 20.50 | 5 | 21 |
| Lifetime pension | 8,600 | 12,000 | 8,600 | 12,000 |
| EURA | 65 | 60 | 65 | 60 |
| Lifetime factor | 16.00 | 18.2 | 12.9 | 14.3 |
| **AL** | **39,669** | **218,400** | **31,983** | **171,600** |

Pensioners:

| | Indexed AL | | Non-indexed AL | |
|---|---|---|---|---|
| | ID5 | ID6 | ID5 | ID6 |
| Age | 63 | 68 | 63 | 68 |
| Spouse Age | n/a | 64 | n/a | 64 |
| Lifetime pension | 12,100 | 9,900 | 12,100 | 9,900 |
| Lifetime factor | 16.9 | 17.3 | 13.5 | 13.8 |
| **AL** | **204,490** | **171,270** | **163,350** | **136,620** |

Summary of liabilities:

| | |
|---|---|
| **Indexed** | **894,304** |
| Active | 260,474 |
| Deferred | 258,069 |
| Pensioners | 375,760 |
| **Non-Indexed** | **712,595** |
| Active | 209,042 |
| Deferred | 203,583 |
| Pensioners | 299,970 |

- Calculation of PfAD:

| **Determine PfAD** | |
|---|---|
| 1) 5.0% for a closed plan | 5.00% |
| 2) Provision based on Combined Target Asset Allocation for Non-Fixed Income Assets | 7.00% |
| 3) BDR > GC DR | 0.00% |
| **PfAD** | **12.00%** |

PfAD = 12.00% x 712,595 = 85,511

## 4. Continued

(ii)

| | |
|---|---|
| **Solvency assets** | **966,820** |
| Solvency Liabilities for: | |
| Active members | 394,464 |
| Deferred pensioners | 389,820 |
| Pensioners | 596,750 |
| **Total solvency liability** | **1,381,034** |
| **Solvency excess (shortfall)** | **(414,214)** |

- Calculation of solvency assets:

| | |
|---|---|
| MVA 31/12/2020 | 1,116,820 |
| Termination expenses | (150,000) |
| **Solvency assets 31/12/2020** | **966,820** |

- Calculation of solvency liabilities:

Active Members:

| | | | | | | |
|---|---|---|---|---|---|---|
| Member ID | ID1 | Earnings | 2018 | 55,000 | | |
| Current age | 49 | | 2019 | 58,000 | | |
| Service | 4.00 | | 2020 | 61,000 | | |
| Not entitled to grow-in since less than 55 points. | | | | | | |
| | Best Age | FAE3 | Reduction | Accrued pension | Factor LS | AL |
| LS | 65 | 58,000 | 0% | 4,060 | 18.2 | **73,892** |

| | | | | | | |
|---|---|---|---|---|---|---|
| Member ID | ID2 | Earnings | 2018 | 68,000 | | |
| Current age | 54 | | 2019 | 72,000 | | |
| Service | 12.00 | | 2020 | 74,000 | | |
| Entitled to grow-in, unreduced at age 62. Best Age = EURA (will reach 20 pts at age 62). | | | | | | |
| | Best Age | FAE3 | Reduction | Accrued pension | Factor LS | AL |
| LS | 62 | 71,333 | 0% | 14,980 | 21.4 | **320,572** |

## 4. Continued

Deferred Members:

| | ID3 | ID4 |
|---|---|---|
| Age | 39 | 60 |
| Service | 5.00 | 20.50 |
| Lifetime pension | 8,600 | 12,000 |
| LS max age | 65 | 60 |
| Reduction | 0% | 0% |
| Lifetime factor LS | 11.7 | 24.1 |
| **AL** | **100,620** | **289,200** |

Pensioners:

| | ID5 | ID6 |
|---|---|---|
| Age | 63 | 68 |
| Spouse Age | n/a | 64 |
| Lifetime pension | 12,100 | 9,900 |
| Lifetime factor AP | 26.9 | 27.4 |
| **AL** | **325,490** | **271,260** |

(iii)

| | |
|---|---|
| **2021 Employer Minimum Contribution Requirements** | |
| Employer current service cost contributions | 83,143 |
| Special payments | 43,200 |
| **Minimum required contributions for 2021** | **126,343** |
| | |
| **2022 Employer Minimum Contribution Requirements** | |
| Employer current service cost contributions (roll forward with interest) | 84,748 |
| Special payments | 40,628 |
| **Minimum required contributions for 2022** | **125,376** |

## 4. Continued

- Calculation of normal cost:

| | | | | |
|---|---|---|---|---|
| Member ID | ID1 | | | |
| Current age | 49 | | | |
| Service | 4.00 | | | |
| | Age | Projected pension (NC) | NC (indexed) | NC (non-indexed) |
| Termination | 49 | 5,075 | 227 | 183 |
| EURD=NRD | 65 | 8,318 | 12,010 | 9,683 |
| | | | **12,236** | **9,866** |

4.0000000

| | | | | |
|---|---|---|---|---|
| Member ID | ID2 | | | |
| Current age | 54 | | | |
| Service | 12.00 | | | |
| | Age | Projected pension (NC) | NC (indexed) | NC (non-indexed) |
| EURD | 62 | 20,711 | 9,399 | 7,497 |
| NRD | 65 | 22,631 | 8,229 | 6,634 |
| | | | **17,627** | **14,132** |

- Calculation of elements of Total Employer Current Service Cost:

| | **2021** | **2022** |
|---|---|---|
| Total Normal Cost | 29,864 | 31,327 |
| PfAD on Non-Indexed CSC | 2,880 | 3,021 |
| **Total Current Service Cost** | **32,743** | **34,348** |
| Explicit Expense Allowance | 45,000 | 45,000 |
| PfAD on explicit expense allowance | 5,400 | 5,400 |
| **Total Employer Current Service Cost Contributions** | **83,143** | **84,748** |

- Calculation of Special Payments

Discount Rates for Amortization
GC = 4.90%
Solvency = 1.88% (Blended Discount Rate

Going Concern Deficit = $0
Solvency Deficit = $414,214
Reduced Solvency Deficit = $207,059

## 4. Continued

**Existing Special Payments Schedule (from previous valuation schedule)**

| Type | Start | End | Monthly Amount | Remaining Months |
|---|---|---|---|---|
| GC existing | 1/1/2020 | 12/31/2020 | 4,000 | 12 |
| GC consolidated | 1/1/2021 | 12/31/2030 | 1,500 | 120 |
| Solvency One | 1/1/2017 | 12/31/2021 | 1,200 | 12 |
| Solvency Two | 1/1/2021 | 12/31/2025 | 2,400 | 60 |

**New Special Payments Schedule**

| Type | Start | End | Monthly Amount | Remaining Months | Solvency PV (5 years) |
|---|---|---|---|---|---|
| GC **none** | | | | | |
| Solvency One | 1/1/17 | 12/31/21 | 1,200 | 12 | $14,256 |
| Solvency Two | 1/1/21 | 12/31/25 | 2,400 | 60 | $137,407 |
| Solvency Three **new** | 1/1/22 | 12/31/26 | 986 | 60 | $55,396 |
| | | | | | $207,059 |

(b)

(i) Calculate the funded status of the plan on a going concern basis.

(ii) Calculate the sources of gain/(loss) of the going concern liabilities from December 31, 2020 to December 31, 2021.

**Commentary on Question**:
*This question was asking candidates to do similar calculations as in a), but a year later. Similar to a) i) the AVA was calculated poorly. Most candidates forgot to calculate the non-indexed liabilities for the purpose of determining the PfAD. A few candidates forgot to reflect that member ID3 has been paid out, and that the member's liability is nil. Only a few candidates thought about indexing the retiree's pensions and/or reflecting the death of member ID6 and the continuation of 60% of the pension to the spouse.*

## 4. Continued

(i)

| | |
|---|---|
| **Actuarial Value of Assets** | **1,141,933** |
| | |
| **Going concern funding target** | |
| Going concern liabilities: | |
| Active members | 409,808 |
| Deferred pensioners | 249,600 |
| Pensioners | 345,980 |
| Subtotal | 1,005,388 |
| PfAD | 94,814 |
| **Total** | **1,100,202** |
| | |
| **Funding excess (shortfall)** | **41,731** |

- Calculation of smoothed assets:

Unrecognized capital gains (losses) realized or unrealized (from question):

| | |
|---|---|
| 2021 | 260,000 |
| 2020 | 28,900 |

| | |
|---|---|
| MVA 31/12/2021 | 1,324,900 |
| Yr 1 (2/3 of Unrecognized capital gains (losses) realized or unrealized for 2021) | (173,333) |
| Yr 2 (1/3 of Unrecognized capital gains (losses) realized or unrealized for 2020) | (9,633) |
| **AVA 31/12/2021** | **1,141,933** |

- Calculation of going concern liabilities:

Active Members:

| | | | | |
|---|---|---|---|---|
| Member ID | ID1 | Earnings | 2019 | 58,000 |
| Current age | 50 | | 2020 | 61,000 |
| Service | 5.00 | | 2021 | 70,000 |

| | Age | Years to Decrement | Projected earnings | Projected pension | QxT | QxR | tPxV | Factor (indexed) | Factor (non-indexed) | AL (indexed) | AL (non-indexed) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Termination | 50 | 0 | 63,000 | 5,513 | 0% | 0% | 1.0000 | 10.8 | 8.6 | 0 | 0 |
| EURD=NRD | 65 | 15 | 105,912* | 9,267 | 0% | 100% | 0.5883* | 18.4 | 14.6 | 100,317 | 79,599 |
| | | | | | | | | | | **100,317** | **79,599** |

*where:

105,912= =AVERAGE(70000*(1+0.03)^15,70000*(1+0.03)^(15-1),70000*(1+0.03)^(15-2))

0.4512 = (1-0-0)/(1+0.036)^15

## 4. Continued

| | | | | |
|---|---|---|---|---|
| Member ID | ID2 | Earnings | 2019 | 72,000 |
| Current age | 55 | | 2020 | 74,000 |
| Service | 13.00 | | 2021 | 76,220 |

| | Age | Years to Decrement | Projected earnings* | Projected pension | QxT | QxR | tPxV* | Factor (indexed) | Factor (non-indexed) | AL (indexed) | AL (non-indexed) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Termination | 62 | 7 | 91,037 | 20,711 | 0% | 50% | 0.7807 | 20.2 | 15.8 | 163,306 | 127,735 |
| EURD=NRD | 65 | 10 | 99,479 | 22,631 | 0% | 100% | 0.3511 | 18.4 | 14.6 | 146,185 | 115,994 |
| | | | | | | | | | | **309,491** | **243,729** |

*where:

91,037 = AVERAGE(74000*(1+0.03)^8,74000*(1+0.03)^(8-1),74000*(1+0.03)^(8-2))

99,479 = AVERAGE(74000*(1+0.03)^11,74000*(1+0.03)^(11-1),74000*(1+0.03)^(11-2))

0.7807 = 1/(1+0.036)^7

0.3511 = (1-0-0.5)/(1+0.036)^10

Deferred Members:

| | Indexed AL | | Non-indexed AL | |
|---|---|---|---|---|
| | ID3 (Paid out) | ID4 | ID3 (Paid out) | ID4 |
| Age | 40 | 61 | 40 | 61 |
| Service | 5.00 | 20.50 | 5.00 | 20.50 |
| Lifetime pension | 8,600 | 12,000 | 8,600 | 12,000 |
| EURA | 65 | 61 | 65 | 61 |
| Lifetime factor | 0 | 20.8 | 0 | 16.1 |
| **AL** | **0** | **249,600** | **0** | **193,200** |

Pensioners:

| | Indexed AL | | Non-indexed AL | |
|---|---|---|---|---|
| | ID5 | ID6 | ID5 | ID6 |
| Age | 64 | 65 | 64 | 65 |
| Spouse Age | n/a | n/a | n/a | n/a |
| Lifetime pension | 12,342 | 6,059 | 12,342 | 6,059 |
| Lifetime factor | 19.0 | 18.4 | 15.0 | 14.6 |
| **AL** | **234,498** | **111,482** | **185,130** | **88,458** |

## 4. Continued

Summary of liabilities:

| | |
|---|---|
| **Indexed** | **1,005,388** |
| Active | 409,808 |
| Deferred | 249,600 |
| Pensioners | 345,980 |
| **Non-Indexed** | **790,117** |
| Active | 323,329 |
| Deferred | 193,200 |
| Pensioners | 273,588 |

- Calculation of PfAD:

| **Determine PfAD** | |
|---|---|
| 1) 5.0% for a closed plan | 5.00% |
| 2) Provision based on Combined Target Asset Allocation for Non-Fixed Income Assets | 7.00% |
| 3) BDR > GC DR | 0.00% |
| **PfAD** | **12.00%** |

PfAD = 12.00% x 790,117 = 94,814

## 4. Continued

(ii) Gain & Loss

| | |
|---|---|
| **Funding excess (shortfall) at December 31, 2020** | **151,072** |
| PfAD at December 31, 2020 | 85,511 |
| **Funding excess (shortfall) before PfAD** | **236,583** |
| Interest on the excess/deficit | 11,593 |
| Special Payments to fund the deficit with interest | 51,210 |
| PfAD contributions with interest | 8,480 |
| Net experience gains (losses) | |
| Normal Cost Contributions Not as Expected | (897) |
| Investment | 12,465 |
| Expense | (308) |
| Salary | (7,411) |
| Mortality | 72,290 |
| Termination & Inactive Cash out | (84,612) |
| Retirement | 16,856 |
| Misc | 0 |
| Total experience gains (losses) | **8,383** |
| Assumption Changes - Going Concern discount rate | (179,704) |
| **Funding excess (shortfall) at December 31, 2021 before PfAD** | **136,545** |
| PfAD at December 31, 2021 | 94,814 |
| **Funding excess (shortfall) at December 31, 2021** | **41,731** |

(c) Calculate the funded position on a going concern basis including PfAD, under the following two Plausible Adverse Scenarios. Use duration to estimate the change in liabilities.

(i) Interest Rate Shock: 90 bps drop in discount rate and 7% increase in fixed income portion of assets.

(ii) Equity Market Shock: Discount rate shift of 0% and 15% drop in equity market.

**Commentary on Question**:
*This question was testing candidates' ability to apply the new plausible scenario disclosures given the changes in assumptions. Candidates struggled to complete this question and often did not apply the correct shock to the assets and/or liabilities.*

## 4. Continued

### (i) Interest Rate Shock

| | Interest rate risk |
|---|---|
| Actuarial value of Assets | 1,154,299 |
| Going concern liability | 1,163,737 |
| PfAD | 108,553 |
| Going concern funding target | 1,272,290 |
| Funding excess (shortfall) | (117,990) |

- Calculation of Market Value and AVA of assets after shock

| | | |
|---|---|---|
| Increase in Fixed Income Assets | | 7.00% |
| Portion of Assets in Fixed Income | | 40.00% |
| Increase in total Market Value of Assets | | 2.80% |
| Market Value after Shock = 1,324,900 * 1.028 = | | $1,361,997 |

***Smoothed assets***

| | | |
|---|---|---|
| Unrecognized capital gains (losses) realized or unrealized | **2021** | 297,097 |
| | **2020** | 28,900 |
| Market Value after Shock | | 1,361,997 |
| Yr 1 (2/3 of Unrecognized capital gains (losses) realized or unrealized for 2021) | | -198,065 |
| Yr 2 (2/3 of Unrecognized capital gains (losses) realized or unrealized for 2020) | | -9,633 |
| AVA after Shock | | **1,154,299** |

- Calculation of Liabilities after shock

| | |
|---|---|
| Discount Rate Drop | 0.90% |
| Discount Rate Before Shock | 3.60% |
| Discount Rate After Shock | 2.70% |

| ***Liabilities*** | ***GC (with Indexing)*** | ***GC (Non-Indexed)*** |
|---|---|---|
| Current DR | 1,005,388 | 790,117 |
| Duration | 17.5 | 16.1 |
| Updated DR | 1,163,737 | 904,605 |
| | = (1,005,388 * (1+17.5*(0.009))) | = (790,117 * (1+16.1*(0.009))) |

PfAD = 12.00% x 904,605 = 108,553

## 4. Continued

### (ii) Equity Market Shock:

| | Equity market shock |
|---|---|
| Market value of assets | 1,102,186 |
| Going concern liability | 1,005,388 |
| PfAD | 94,814 |
| Going concern funding target | 1,100,202 |
| Funding excess (shortfall) | 1,984 |

- Calculation of Market Value and AVA of assets after shock

| | | |
|---|---|---|
| Decrease in Equity Portfolio | | -15.00% |
| Portion of Assets in Equity | | 60.00% |
| Decrease in total Market Value of Assets | | -9.00% |
| Market Value after Shock = 1,324,900 * 0.91 = | | 1,205,659 |
| ***Smoothed assets*** | | |
| Unrecognized capital gains (losses) realized or unrealized | **2021** | 140,759 |
| | **2020** | 28,900 |
| Market Value after Shock | | 1,205,659 |
| Yr 1 (2/3 of Unrecognized capital gains (losses) realized or unrealized for 2021) | | -198,065 |
| Yr 2 (2/3 of Unrecognized capital gains (losses) realized or unrealized for 2020) | | -9,633 |
| AVA after Shock | | **1,102,186** |

- Calculation of Liabilities after shock – None – Equity Shock does not impact the liabilities.

## 5. Learning Objectives:

2. The candidate will understand how to analyze/synthesize the factors that go into selection of actuarial assumptions for funding purposes.

3. The candidate will understand how to apply/synthesize the methods used to value pension benefits for various purposes.

**Learning Outcomes:**

(3e) Perform valuations for special purposes, including:
- (i) Plan termination/wind-up/conversion valuations
- (ii) Hypothetical wind-up and solvency valuations
- (iii) Open group valuations
- (iv) Share risk pension plan valuations

**Sources:**

CIA Revised Educational Note: Alternative Settlement Methods for Hypothetical Wind-Up and Solvency Valuations

FR-150-21: Alberta Treasury Board and Finance – EPPA Update 13-01 Alternative Settlement Methods for Hypothetical Wind-up and Solvency Valuations

**Commentary on Question:**

*Commentary listed underneath question component.*

**Solution:**

(a) Describe when it would be appropriate to use an alternative settlement method for a hypothetical wind-up valuation, in accordance with the Revised CIA Educational Note on Alternative Settlement Methods for Hypothetical Wind-Up and Solvency Valuations.

**Commentary on Question**:

*A number of candidates were able to reasonably describe the appropriate usage of alternative settlement methods. However, there were also a significant number of candidates who either wrote very little or gave incorrect responses to this portion of the question.*

- An alternative settlement method for hypothetical wind-up can be considered for plans with very large liabilities
- These plans may have difficulty purchasing a single group annuity due to capacity constraints within the Canadian group annuity purchase market
- This would apply to non-indexed or indexed annuities

## 5. Continued

- Guidance on the description of 'large' from the most recently published educational note on "Assumptions for Hypothetical Wind-up and Solvency Valuations" guidance note
  - $750 million for non-indexed annuities ($1,000M from June 30, 2021 onward)
  - $250 million for indexed annuities ($300M from June 30, 2021 onward)
- Should also consider regulatory limitations on alternative settlement methods

(b) Describe the considerations for building a replicating portfolio for use with the alternative settlement method.

**Commentary on Question**:
*Candidates performed a little better on this section, often mentioning several relevant considerations.*

- Replicating portfolio approach is to establish a portfolio of assets that produces cash flows that match the expected benefit payments to plan members
- Expected benefit cashflows considerations:
  - Reflect plan-specific mortality experience
  - Reflect the experience of groups with similar characteristics such as occupation, demographics and pension size
  - Make an appropriate allowance for future mortality improvements on a fully generational basis
  - Make reasonable best-estimate assumptions regarding the exercise of any remaining options by the plan members
- Considerations related to the assets:
  - Assume the primary asset class used is investment-grade fixed-income investments, including a substantial allocation to high-quality fixed-income investments
  - Timing of some benefit cash flows are likely to extend beyond the maturity of available fixed-income investments
  - Consider how additional fixed-income investments to match these later cash flows would be obtained through re-investing cash flows
  - Make reasonable assumption on the level of expenses that would be associated with establishing and maintaining such a portfolio and administering the ongoing payment of benefits

- Other considerations:
  - Under the replicating portfolio approach, there would typically be no recourse to additional funding from the plan sponsor or any other entity if the initial assets set aside prove to be insufficient to provide the benefits
  - Include a margin for adverse deviations to ensure a high probability that the benefit promises will ultimately be met

## 5. Continued

- The margin would include provisions for contingencies such as, but not necessarily limited to, longevity experience, inflation experience, asset defaults and/or downgrades, and reinvestment risk due to cash flow mismatches
- In the absence of legislative requirements or an applicable regulatory policy, the actuary would make an assumption regarding the size of the margin that the regulator would likely require in an actual wind-up scenario, considering any precedents or indications from regulators

(c) Describe the required disclosures in the valuation report when using the alternative settlement method for the purpose of calculating the hypothetical wind-up liabilities.

**Commentary on Question**:
*Candidates did not perform as well in this portion of the question, many only listing a few relevant disclosures, if any.*

- The actuary would provide meaningful disclosures regarding benefit security implications of the settlement method based on either stochastic modelling or stress testing
  - A quantification of the probability of all the benefit promises being met based on the size of the selected margin and the assumed distribution of outcomes; or
  - The effect of adverse experience, with respect to each material assumption, on benefit security
  - Where the material assumptions would generally include longevity, inflation, asset defaults/downgrades, and reinvestment rates. For example, a meaningful disclosure may be whether the asset portfolio would be sufficient to pay all the benefits if the life expectancy of members was one year higher than assumed, with all other experience being exactly in accordance with the valuation assumptions
- The actuary would discuss the effect of the approach on the benefits promised to plan members, the risks associated with this settlement method, and any intergenerational differences in the level of security
- If an alternative settlement method is contemplated, the actuary would:
  - Provide a clear description of the applicable legislative requirements and/or regulatory policies for settling benefits upon wind-up;
  - Provide a detailed description of the hypothesis for the method in which benefits would be settled and the rationale for using this method;
  - Note the existence of any permissive regulatory policy, relevant precedents, or discussions with the regulators if the alternative settlement method is not expressly permitted under legislation;

## 5. Continued

  - Acknowledge any conflicts with legislative requirements for settling benefits on windup;
  - Provide comments on changes to the nature of member entitlements, if any, as a result of the alternative settlement method; and
  - Discuss the implications of the alternative settlement method on the benefit security of members, relative to a single annuity purchase
- The actuary would also disclose the liabilities determined under the prevailing guidance with respect to annuity purchase pricing, as published by the PPFRC, calculated on the basis that there were no capacity constraints

## 6. Learning Objectives:

2. The candidate will understand how to analyze/synthesize the factors that go into selection of actuarial assumptions for funding purposes.

**Learning Outcomes:**

(2a) Describe and apply the techniques used in the development of economic assumptions for funding purposes.

(2b) Evaluate and recommend appropriate assumptions for funding purposes.

**Sources:**

Determination of Best Estimate Discount Rates for Going Concern Funding Valuations, CIA Educational Note, Dec 2015

**Commentary on Question:**

*Most candidates performed well on this question, using the building block approach to recommend a discount rate assumption. The candidates who received maximum points provided explanations for how the various components were developed and applied a cap to the risk premium on global equities as it was high. Successful candidates also noted how the best estimate may need to incorporate a margin.*

**Solution:**

Recommend the going concern discount rate, net of all expenses. Justify your recommendation.

Use the building block approach to determine the discount rate based on expected future investment returns.

As this is not a very mature plan, a time frame of 20 years is appropriate. The risk premium for Global Equities is capped at 5% since 8.5% is likely excessive.

Using the asset allocation and the 20-year risk premia given, the weighted average risk premium is calculated to be:
(5% * -1.0% + 40% * 0.3% + 30% * 4.1% + 25% * 5.0%) = 2.55% *(or 3.425% if the full risk premium of 8.5% is used for global equities)*

Add weighted risk premium to the expected return on long-term government of Canada bonds, the estimated return of the plan's portfolio is 2.2% + 2.55% = 4.75% *(or 2.2% + 3.425% = 5.625%)*

For this target asset mix, it is appropriate to add 0.4% per annum for the benefits of the diversification effect to get to 5.15% *(or 6.025%; anything between 0.3% and 0.5% is reasonable)*

## 6. Continued

Investment expense and active management: the outperformance in the past three years alone is not sufficient to support any assumption regarding future added value returns from active investment management in excess of the associated additional investment management fees. Therefore, should assume no more than 0.35% (0.60% - 0.25%) of additional returns for active management.

Since the additional return and the associated fees for active management offset each other, essentially, we just need to deduct an allowance of 0.25% (reflecting only passive investment management costs) from the discount rate to get to 4.9% *(or 5.775%)*.

Estimating the administrative expenses based on the average rate over the last three years, deduct another 0.8% to get to 4.1% *(or 4.975%; some candidates noted using an explicit expense allowance in the normal cost which was also acceptable)*.

Therefore, recommend a discount rate of 4.1% *(or 5.0%)*

Note that this best estimate assumption may need to be modified to incorporate margins for adverse deviations to the extent, if any, required by law or by the terms of an appropriate engagement.

## 7. Learning Objectives:

7. The candidate will understand how to apply the standards of practice and professional conduct guidelines.

**Learning Outcomes:**

(7d) Demonstrate compliance with requirements regarding the actuary's responsibilities to the participants, plans sponsors, etc.

**Sources:**

CSOP Section 1450, Use of models – CIA educational note

**Commentary on Question:**

*Though most candidates understood what constitutes a model and model risk, most candidates seemed to struggle to provide the detail of model considerations, risk and disclosure requirements requested in this question.*

**Solution:**

(a) Explain why your firm's new tool meets the definition of a model, as defined in the Canadian Institute of Actuaries' (CIA) Standards of Practice.

(CIA SOPs Sections 1120 and 1450; Use of Models 1.1 Background)
The new tool exhibits the following characteristics of a model:

- This tool is a model because it is a practical representation of relationships between various asset class returns (and potentially interest rates) that is typically built using a combination of statistical, financial and economic concepts.
- This tool is a model that uses methods and assumptions to simplify the complex system that is the economy. It produces results that provide useful information about how the economy would translate into asset class returns.
- This model has a specification, an implementation and at least one model run.
  - A model specification is the description of the components of a model and the interrelationship of those components with each other. This model will have been designed with various components and the interrelationship of those components (e.g. a fixed income module and an equity module).
  - A model implementation is one or more systems developed to perform the calculations for a model specification (i.e. computer programs, spreadsheets, database programs). This model will have been implemented with some sort of system (e.g. Excel)
  - A model run is a set of inputs and the corresponding results produced by a model implementation. In this model, expected returns, volatility and correlations, along with the asset mix, will be among the inputs.

## 7. Continued

(b) List three other examples of models that would meet the CIA's definition.

- Life annuity factors, where the actuary selects assumptions or makes decisions about simplifications *(this does not include life annuity factors where formula and assumption are prescribed by standards or regulations)*.
- Valuation software/systems used to calculate the present value of future benefits based on inputs and assumptions.
- Stochastic projections of economic assumptions to determine best- and worst-case cost scenarios.
- Forecasting capital requirements using a spreadsheet model.

*The list provided above is by no means exhaustive – points were awarded for other examples provided by candidates that meet the definition of a model.*

(c) Describe the steps you would take to assess and document the risk of the pension consulting practice using the new tool.

The tool has been developed by the firm's investment consulting practice, specifically CFA charterholders, therefore you have to determine the appropriate level of reliance on other experts, and should consider the following:

- Whether the individuals who created the model are considered experts in their field of practice;
- The extent to which the model has been reviewed by these experts; and
- The risk rating they have assigned to the model.
- You would need to make a reasonable attempt to understand the following:
  - The basic workings of the model, including inputs, outputs, and general approach;
  - The testing and validation work that was completed by the investement couslting practice; and
  - The model's complexity and the control framework used.

You would disclose, in the appropriate documentation and disclosures, any reliance on models created by other experts.

(d) Recommend the risk rating you would assign to this tool. Justify your recommendation.

## 7. Continued

The risk rating of the model is High

- The discount rate is a key assumption for the going concern valuation, and if the model fails it could have significant financial implications for the client.
- The tool is being proprosed for use by the whole pension consulting practice, and therefore it will be used frequently for multiple clients, so the same failure could be repeated many times until found.
- Pension actuaries do not necessarily have the investment accumen to notice if the model is broken, unless the error is obvious.
- There could be severe reputational impacts for the firm (i.e., decrease in share value, missed client opportunities).
- There could be severe regulatory risk for the firm (and its clients, i.e. misstated minimum funding requirements).

[The above list is not exhaustive]

(e) Explain whether or not disclosures related to the use of this new tool will be needed in external user reports, such as actuarial funding valuation reports.

- No disclosures related to the use of this tool are needed in external user reports, such as client actuarial funding valuation reports, except for the disclosure of any limitations identified in the model relevant to the intended purpose.
- The actuary may use a model to inform the opinion, but it is not relevant to the user how the opinion was formed as long as it was done in accordance with accepted actuarial practice (i.e., modelling is incidental to the engagement).
- The nature of the engagement (or assignment) will determine whether the model is mentioned in an actuary's user report.
- In most cases, an actuary is engaged to express a professional opinion, such as an actuarial liability associated with a pension plan.

## 8. Learning Objectives:

5. The candidate will understand how to evaluate and apply regulatory policies and restrictions for registered retirement plans.

**Learning Outcomes:**

(5i) The candidate will be able to describe and apply regulation pertaining to contributions and benefits.

**Sources:**

Section 3500 of the Canadian Institute of Actuaries' Standards of Practice

**Commentary on Question:**

*Commentary listed underneath question component.*

**Solution:**

(a) Calculate the commuted value interest rates under Section 3500 of the Canadian Institute of Actuaries' Standards of Practice as at the date of termination.

**Commentary on Question**:

*The majority of candidates were able to determine the non-indexed commuted value interest rates, but only a few properly determined the interest rates applicable for benefits indexed at CPI minus 1%. Candidates received the same points if the indexed rates were determined using the February 2022 CV standard.*

- Annualize published figures for December 2022 (one-month lag)

| Month | i7 | iL | rL |
|---|---|---|---|
| Dec-22 | 0.48% | 1.24% | -0.24% |

| Month | Mid-Term Provincial Bond Index | Long-Term Provincial Bond Index | Mid-Term Corporate Bond Index | Long-Term Corporate Bond Index | Mid-Term Federal Non-Agency Bond Index | Long-Term Federal Non-Agency Bond Index |
|---|---|---|---|---|---|---|
| Dec-22 | 1.11% | 2.02% | 1.85% | 2.90% | 0.61% | 1.13% |

- Calculate midterm real rate: $r_7 = i_7 \times r_L / i_L = 0.48\% \times -0.24 / 1.24 = -0.09\%$

- Calculate Spread components:
  - $PS_{1\text{-}10}$ = (Canada Mid-term provincial bond index yield, annualized) – (Canada Mid-term federal non-agency bond index yield, annualized) = 1.11% - 0.61% = 0.50%
  - $CS_{1\text{-}10}$ = (Canada Mid-term corporate bond index yield, annualized) – (Canada Mid-term federal non-agency bond index yield, annualized) = 1.85% - 0.61% = 1.24%

## 8. Continued

- $PS_{10+}$ = (Canada Long-term provincial bond index yield, annualized) – (Canada Long-term federal non-agency bond index yield, annualized) = 2.02% - 1.13% = 0.89%
- $CS_{10+}$ = (Canada Long-term corporate bond index yield, annualized) – (Canada Long-term federal non-agency bond index yield, annualized) = 2.90% - 1.13% = 1.77%

- Calculate the spreads:
  - $s_{1\text{-}10} = \text{Min}[1,5\%;(0.667 * PS_{1\text{-}10}) + (0.333 * CS_{1\text{-}10})] = \text{Min}[1,5\%;0.667*0.49\%+1.24\%*0.333] = 0.74\%$
  - $s_{10+} = \text{Min}[1,5\%;(0.667 * PS_{10+}) + (0.333 * CS_{10+})] = \text{Min}[1,5\%;0.667*0.89\%+1.77\%*0.333] = 1.19\%$

- Calculate the non-indexed rates:
  - $i_{1\text{-}10} = i_7 + s_{1\text{-}10} = 0.48\% + 0.74\% = 1.22\%$ (rounded to 1.20%)
  - $i_{10+} = i_L + 0.5 * (i_L – i_7 ) + s_{10+} = 1.24\% + 0.5*(1.24\%- 0.48\%) + 1.19\% = 2.81\%$ (2.80% rounded)

- Calculate the implied inflation:
  - $c_{1\text{-}10} = (1+i_7) / (1+r_7) – 1 = (1 + 0.48\%) / (1 + -0.24\%) = 0.57\%$ (0.60% rounded)
  - $c_{10+} = (1+i_L + 0.5 * (i_L – i_7)) /(1+r_L + 0.5 * (r_L – r_7)) – 1 =$ (1 + 1.24% + 0.5 * (1,24% - 0.48%)) / (1 + -0.24% + 0.5 (-0.24% - -0.09%)) - 1 = 1.95% (1.90% rounded)

- Calculate the indexed rates:
  - $i_{-1\%(1\text{-}10)} = (1+ i_{1\text{-}10})/(1+ \text{Max}[0;100\%*c_{1\text{-}10} - 1\%])-1 =$ (1 + 1.20%) / (1 + Max[0;100% * 0.57% - 1%]) - 1 = 1.20% (rounded)
  - $i_{-1\%(10+)} = (1+ i_{10+})/(1+ \text{Max}[0 ; 100\%*c_{10+} - 1\%])-1 =$ (1 + 2.80%) / (1 + Max[0;100% * 1.95% - 1%]) - 1 = 1.80% (rounded)

(b) Calculate the commuted value at the members' date of termination assuming the members terminated:

(i) Voluntarily; and

(ii) Involuntarily.

**Commentary on Question**:
*Overall, candidates struggled with the details of the calculation and failed to receive full marks due to one or more of the following:*

- *Failing to apply pre-retirement indexing*
- *Taking the final average rather than best average of Member B earnings*
- *Not calculating the CV at various ages*

## 8. Continued

| | Member A | Member B |
|---|---|---|
| BAE | = ($161,000 + $167,000 + $172,000)/3<br>= $166,667 | = ($70,500 + $71,500 + $71,500)/3<br>= $71,167 |
| Benefit | = 2.0% * BAE3 * Service<br>= 2.0$ * $166,667 * 4<br>= $13,333 | = 2.0% * BAE3 * Service<br>= 2.0$ * $71,167 * 10.5<br>= $14,945 |
| Grow-in | 55 points at termination so grow-in applies | 35 + 10.5 = 45.5 points < 55 points at termination so no grow-in |

Estimate AWI to determine the maximum pension at pension commencement:

- $AWI_{1-10}$ = CPI + 1% = 0.6% ($c_{1-10}$) + 1% = 1.60%
- $AWI_{1+0}$ = CPI + 1% = 1.90% ($c_{1-10}$) + 1% = 2.90%

| Member A | | | | | **Voluntary** | | **Involuntary** | |
|---|---|---|---|---|---|---|---|---|
| Age | Pre-ret index benefit | ITA pension at retirement | Pension | Factor | ERR | CV | ERR | CV |
| 55 | $14,152.77 | $14,809.99 | $14,152.77 | 23.2 | 60% | $ 196,668.30 | 79% | $258,946.59 |
| 56 | $14,322.60 | $15,046.95 | $14,322.60 | 22.3 | 64% | $204,407.13 | 82% | $261,896.64 |
| 57 | $14,494.47 | $15,287.70 | $14,494.47 | 21.5 | 68% | $211,454.25 | 85% | $264,317.81 |
| 58 | $14,668.40 | $15,532.30 | $14,668.40 | 20.6 | 72% | $217,803.51 | 88% | $266,204.29 |
| 59 | $14,844.42 | $15,780.82 | $14,844.42 | 19.8 | 76% | $223,444.56 | 91% | $267,545.46 |
| 60 | $15,022.56 | $16,033.31 | $15,022.56 | 19.0 | 80% | $228,361.45 | 94% | $268,324.70 |
| 61 | $15,292.96 | $16,498.28 | $15,292.96 | 18.0 | 84% | $231,666.60 | 97% | $267,519.77 |
| 62 | $15,568.24 | $16,976.73 | $15,568.24 | 17.1 | 88% | $234,254.71 | 100% | $266,198.53 |
| 63 | $15,848.46 | $17,469.05 | $15,848.46 | 16.2 | 92% | $236,123.66 | 100% | $256,656.16 |
| 64 | $16,133.74 | $17,975.65 | $16,133.74 | 15.3 | 96% | $237,282.98 | 100% | $247,169.77 |
| 65 | $16,424.14 | $18,496.95 | $16,424.14 | 14.5 | 100% | $237,743.34 | 100% | $237,743.34 |
| | | | | 50% * Best Age + 50% * EURA | | $237,743.34 | | $237,743.34 |

## 8. Continued

| Member B | | | | | | **Involuntary/Voluntary** |
|---|---|---|---|---|---|---|
| Age | Pre-ret index benefit | ITA pension at retirement | Pension | Factor | ERR | CV |
| 55 | $20,126.99 | $56,015.24 | $20,126.99 | 16.4 | 60% | $198,492.99 |
| 56 | $20,489.28 | $57,639.69 | $20,489.28 | 15.7 | 64% | $205,388.44 |
| 57 | $20,858.08 | $59,311.24 | $20,858.08 | 14.9 | 68% | $211,567.64 |
| 58 | $21,233.53 | $61,031.26 | $21,233.53 | 14.2 | 72% | $217,041.12 |
| 59 | $21,615.73 | $62,801.17 | $21,615.73 | 13.5 | 76% | $221,815.42 |
| 60 | $22,004.81 | $64,622.40 | $22,004.81 | 12.8 | 80% | $225,892.74 |
| 61 | $22,400.90 | $66,496.45 | $22,400.90 | 12.2 | 84% | $229,270.93 |
| 62 | $22,804.12 | $68,424.85 | $22,804.12 | 11.6 | 88% | $231,948.02 |
| 63 | $23,214.59 | $70,409.17 | $23,214.59 | 11.0 | 92% | $233,922.71 |
| 64 | $23,632.45 | $72,451.04 | $23,632.45 | 10.4 | 96% | $235,203.87 |
| 65 | $24,057.84 | $74,552.12 | $24,057.84 | 9.8 | 100% | $235,801.37 |
| | | | | | 50% * Best Age + 50% * EURA | $235,801.37 |

(c) The members terminated their employment voluntarily and elected to receive lump-sum commuted values.

Calculate the pension adjustment reversals (PARs) for both members.

**Commentary on Question**:
*Most candidates successfully determined that the PARs are zero for both members, however many candidates missed reflecting the half year of service in the 2012 PA for Member B.*

PA = 9 * Service * Min[Max Pension, 2% * Salary] - $600
PAR = Max[0, Total PAs + PSPA - Settlement Payout]

Member A - Total PA = $112,650
2019 PA = 9 * 1 * Min($3,025.56, 2% * 158,000) - 600 = $26,630
2020 PA = 9 * 1 * Min($3,092.22, 2% * 161,000) - 600 = $27,230
2021 PA = 9 * 1 * Min($3,245.56 , 2% * 167,000) - 600 = $28,610
2022 PA = 9 * 1 * Min($3,420.00, 2% * 172,000) - 600 = $20,180
PAR = Max[0, $112,650 + 0 - $237,734] = 0

Member B - Total PA = $116,430
2012 PA = 9 * 0.5 * Min($2,646.67, 2% * $28,000) - 600 = $1,920
2013 PA = 9 * 1 * Min($2,696.67, 2% * $61,000) - 600 = $10,380
2014 PA = 9 * 1 * Min($2,770.00, 2% * $62,000) - 600 = $10,560
2015 PA = 9 * 1 * Min($2,818.89, 2% * $64,000) - 600 = $10,920
2016 PA = 9 * 1 * Min($2,890.00, 2% * $64,500) - 600 = $11,010
2017 PA = 9 * 1 * Min($2,914.44, 2% * $67,000) - 600 = $11,460

**8.** **Continued**

2018 PA = 9 * 1 * Min($2,944.44, 2% * $68,000) - 600 = $11,640
2019 PA = 9 * 1 * Min($3,025.56, 2% * $70,500) - 600 = $12,090
2020 PA = 9 * 1 * Min($3,092.22, 2% * $69,500) - 600 = $11,910
2021 PA = 9 * 1 * Min($3,245.56 , 2% * $71,500) - 600 = $12,270
2022 PA = 9 * 1 * Min($3,420.00, 2% * $71,500) - 600 = $12,270
PAR = Max[0, $116,430 + 0 - $235,801] = 0

## 9. Learning Objectives:

3. The candidate will understand how to apply/synthesize the methods used to value pension benefits for various purposes.

**Learning Outcomes:**

(3b) Perform periodic valuations of ongoing plans, calculating normal cost and actuarial liability, using a variety of cost methods.

**Sources:**

Anderson – Pension Mathematics for Actuaries book

**Commentary on Question:**

*This question was overall done poorly by candidates. Candidates generally answered part (a) of the question, but left other parts blank. Most candidates were not familiar with the cost method.*

**Solution:**

(a) Calculate the unfunded actuarial liability and total normal cost as at January 1, 2021.

Member A

$PVFB_{2021} = 1\% \times 70{,}000 \times 1.04^{(59-40)} \times (60-25) \times \ddot{a}_{60}^{(12)} \times v^{(60-40)} \times .25 +$
$1\% \times 70{,}000 \times 1.04^{(60-40)} \times (61-25) \times \ddot{a}_{61}^{(12)} \times v^{(61-40)} \times .3333 \times .75 +$
$1\% \times 70{,}000 \times 1.04^{(61-40)} \times (62-25) \times \ddot{a}_{62}^{(12)} \times v^{(62-40)} \times .5$
$= 700 \times 1.04^{(59-40)} \times 35 \times 14.8 \times v^{(60-40)} \times .25 +$
$700 \times 1.04^{(60-40)} \times 36 \times 14.5 \times v^{(61-40)} \times .25 +$
$700 \times 1.04^{(61-40)} \times 37 \times 14.3 \times v^{(62-40)} \times .50$
$= 288{,}085$

$ILP\ AL_{2021} = (AL_{2020} + NC_{2020}) \times 1.05$
$= (150{,}000 + 7{,}000) \times 1.05$
$= 164{,}850$

$PVFS_{2021} = .25 \times 70{,}000 \times \ddot{a}_{20\rceil}^{(j)} + .25 \times 70{,}000 \times \ddot{a}_{21\rceil}^{(j)} + .50 \times 70{,}000 \times \ddot{a}_{22\rceil}^{(j)}$
*where* $[\ \ddot{a}_{y-x\rceil}^{(j)} = (1-(1+j)^{-(y-x)})/(1-1/(1+j))\ \&\ j = (1.05/1.04)-1\ ]$
$= 1{,}352{,}271$

$ILP\ NC_{2021} = (PVFB_{2021} - AL_{2021}) / PVFS_{2021} \times S_{2021}$
$= (288{,}085 - 164{,}850) / 1{,}352{,}271 \times 70{,}000$
$= 6{,}379$

## 9. Continued

Member B

$PVFB_{2021} = 1\% \times 90{,}000 \times 1.04^{(59-50)} \times (60-30) \times \ddot{a}_{60}^{(12)} \times v^{(60-50)} \times .25 +$
$1\% \times 90{,}000 \times 1.04^{(60-50)} \times (61-30) \times \ddot{a}_{61}^{(12)} \times v^{(61-50)} \times .3333 \times .75 +$
$1\% \times 90{,}000 \times 1.04^{(61-50)} \times (62-30) \times \ddot{a}_{62}^{(12)} \times v^{(62-50)} \times .5$
$= 900 \times 1.04^{(59-50)} \times 30 \times 14.8 \times v^{(60-50)} \times .25 +$
$900 \times 1.04^{(60-50)} \times 31 \times 14.5 \times v^{(61-50)} \times .25 +$
$900 \times 1.04^{(61-50)} \times 32 \times 14.3 \times v^{(62-50)} \times .50$
$= 351{,}343$

$ILP\ AL_{2021} = (AL_{2020} + NC_{2020}) \times 1.05$
$= (240{,}000 + 10{,}000) \times 1.05$
$= 262{,}500$

$PVFS_{2021} = .25 \times 90{,}000 \times \ddot{a}_{10\urcorner}^{(j)} + .25 \times 90{,}000 \times \ddot{a}_{11\urcorner}^{(j)} + .50 \times 90{,}000 \times \ddot{a}_{12\urcorner}^{(j)}$
*where* $[\ \ddot{a}_{y-x\urcorner}^{(j)} = (1-(1+j)^{-(y-x)})/(1-1/(1+j))\ \&\ j = (1.05/1.04)-1\ ]$
$= 964{,}238$

$ILP\ NC_{2021} = (PVFB_{2021} - AL_{2021}) / PVFS_{2021} \times S_{2021}$
$= (351{,}343 - 262{,}500) / 964{,}238 \times 90{,}000$
$= 8{,}292$

Member C

$PVFB_{2021} = 1\% \times 100{,}000 \times 1.04^{(59-60)} \times (60-35) \times \ddot{a}_{60}^{(12)} \times v^{(60-60)} \times .25 +$
$1\% \times 100{,}000 \times 1.04^{(60-60)} \times (61-35) \times \ddot{a}_{61}^{(12)} \times v^{(61-60)} \times .3333 \times .75 +$
$1\% \times 100{,}000 \times 1.04^{(61-60)} \times (62-35) \times \ddot{a}_{62}^{(12)} \times v^{(62-60)} \times .5$
$= 1{,}000 \times 1.04^{(59-60)} \times 25 \times 14.8 \times v^{(60-40)} \times .25 +$
$1000 \times 1.04^{(60-60)} \times 26 \times 14.5 \times v^{(61-60)} \times .25 +$
$1000 \times 1.04^{(61-60)} \times 27 \times 14.3 \times v^{(62-60)} \times .50$
$= 360{,}810$

$ILP\ AL_{2021} = (AL_{2020} + NC_{2020}) \times 1.05$
$= (330{,}000 + 8{,}000) \times 1.05$
$= 354{,}900$

$PVFS_{2021} = 0 + .25 \times 100{,}000 \times \ddot{a}_{1\urcorner}^{(j)} + .50 \times 100{,}000 \times \ddot{a}_{2\urcorner}^{(j)}$
*where* $[\ \ddot{a}_{y-x\urcorner}^{(j)} = (1-(1+j)^{-(y-x)})/(1-1/(1+j))\ \&\ j = (1.05/1.04)-1\ ]$
$= 124{,}525$

$ILP\ NC_{2021} = (PVFB_{2021} - AL_{2021}) / PVFS_{2021} \times S_{2021}$
$= (360{,}810 - 354{,}900) / 124{,}525 \times 100{,}000$
$= 4{,}746$

$Tot\ NC_{2021} = 6{,}379 + 8{,}292 + 4{,}746$
$= 19{,}418$

*(pts for UAL)*

$UAL_{2021} = AL_{2021} - F_{2021}$
$= 164{,}850 + 262{,}500 + 354{,}900 - 750{,}000$
$= 32{,}250$

## 9. Continued

(b) Calculate the unfunded actuarial liability and total normal cost as at January 1, 2022.

Member A

$PVFB_{2022}$ $= 1\% \times 77{,}000 \times 1.04^{(59-41)} \times (60-25) \times \ddot{a}_{60}^{(12)} \times v^{(60-41)} \times .25 +$
$1\% \times 77{,}000 \times 1.04^{(60-41)} \times (61-25) \times \ddot{a}_{61}^{(12)} \times v^{(61-41)} \times .3333 \times .75 +$
$1\% \times 77{,}000 \times 1.04^{(61-41)} \times (62-25) \times \ddot{a}_{62}^{(12)} \times v^{(62-41)} \times .5$
$= 770 \times 1.04^{(59-41)} \times 35 \times 14.8 \times v^{(60-41)} \times .25 +$
$770 \times 1.04^{(60-41)} \times 36 \times 14.5 \times v^{(61-41)} \times .25 +$
$770 \times 1.04^{(61-41)} \times 37 \times 14.3 \times v^{(62-41)} \times .50$
$= 319{,}940$

ILP $AL_{2022}$ $= (AL_{2021} + NC_{2021}) \times 1.05$
$= (164{,}850 + 6{,}379) \times 1.05$
$= 179{,}791$

$PVFS_{2022}$ $= .25 \times 77{,}000 \times \ddot{a}_{19\rceil}^{(j)} + .25 \times 77{,}000 \times \ddot{a}_{20\rceil}^{(j)} + .50 \times 77{,}000 \times \ddot{a}_{21\rceil}^{(j)}$
*where* $[\ddot{a}_{y-x\rceil}^{(j)} = (1-(1+j)^{-(y-x)})/(1-1/(1+j))$ *&* $j = (1.05/1.04)-1\ ]$
$= 1{,}424{,}059$

ILP $NC_{2022}$ $= (PVFB_{2022} - AL_{2022}) / PVFS_{2022} \times S_{2022}$
$= (319{,}940 - 179{,}791) / 1{,}424{,}059 \times 77{,}000$
$= 7{,}578$

Member B

$PVFB_{2022}$ $= 1\% \times 93{,}600 \times 1.04^{(59-51)} \times (60-30) \times \ddot{a}_{60}^{(12)} \times v^{(60-51)} \times .25 +$
$1\% \times 93{,}600 \times 1.04^{(60-51)} \times (61-30) \times \ddot{a}_{61}^{(12)} \times v^{(61-51)} \times .3333 \times .75 +$
$1\% \times 93{,}600 \times 1.04^{(61-50)} \times (62-30) \times \ddot{a}_{62}^{(12)} \times v^{(62-51)} \times .5$
$= 368{,}910$

ILP $AL_{2022}$ $= (AL_{2021} + NC_{2021}) \times 1.05$
$= (262{,}500 + 8{,}292) \times 1.05$
$= 284{,}332$

$PVFS_{2022}$ $= .25 \times 93{,}600 \times \ddot{a}_{9\rceil}^{(j)} + .25 \times 93{,}600 \times \ddot{a}_{10\rceil}^{(j)} + .50 \times 93{,}600 \times \ddot{a}_{11\rceil}^{(j)}$
*where* $[\ddot{a}_{y-x\rceil}^{(j)} = (1-(1+j)^{-(y-x)})/(1-1/(1+j))$ *&* $j = (1.05/1.04)-1\ ]$
$= 917{,}949$

ILP $NC_{2022}$ $= (PVFB_{2022} - AL_{2022}) / PVFS_{2022} \times S_{2022}$
$= (368{,}910 - 284{,}332) / 917{,}949 \times 93{,}600$
$= 8{,}624$

Member C

$PVFB_{2022}$ $= 1\% \times 104{,}000 \times 1.04^{(60-61)} \times (61-35) \times \ddot{a}_{61}^{(12)} \times v^{(61-61)} \times .3333 +$
$1\% \times 104{,}000 \times 1.04^{(61-61)} \times (62-35) \times \ddot{a}_{62}^{(12)} \times v^{(62-61)} \times .6667$
$= 1{,}040 \times 1.04^{(60-61)} \times 26 \times 14.5 \times v^{(61-61)} \times .3333 +$
$1{,}040 \times 1.04^{(61-61)} \times 27 \times 14.3 \times v^{(62-61)} \times .6667$
$= 380{,}616$

## 9. Continued

ILP $AL_{2022}$ = $(AL_{2021} + NC_{2021}) \times 1.05$
= $(354{,}900 + 4{,}746) \times 1.05$
= 377,628
$PVFS_{2022}$ = $0 + .6667 \times 104{,}000 \times \ddot{a}_{1\overline{7}|}^{j}$
*where* $[\ddot{a}_{y-x\overline{}|}^{j} = (1-(1+j)^{-(y-x)})/(1-1/(1+j))$ *&* $j = (1.05/1.04)-1\ ]$
= 69,333
ILP $NC_{2022}$ = $(PVFB_{2022} - AL_{2022})/ PVFS_{2022} \times S_{2022}$
= $(380{,}616 - 377{,}628) / 69{,}333 \times 104{,}000$
= 4,481

Tot $NC_{2022}$ = 7,578 + 8,624 + 4,481
= 20,684
$F_{2022}$ = $750{,}000 \times 1.10 + 50{,}000$
= 875,000
$UAL_{2022}$ = $AL_{2022} - F_{2022}$
= 179,791 + 284,332 + 377,628 – 875,000
= -33,249

(c) Calculate the impact of demographic experience, by source, between January 1, 2021 and January 1, 2022, on the normal cost.

**Commentary on Question**:
*Most candidates did not attempt to answer this question. Some candidates did not calculate the impact of the demographic experience by source and others calculated the impact on the actuarial liability, rather than the normal cost.*

Increase in NC due to salary increases (Member A):
Act'l PV $FB_{2022}$ = 319,940
Exp'd $PVFB_{2022}$ = 319,940 x 1.04/1.1
= 302,489
Act'l $PVFS_{2022}$ = 1,424,059
Exp'd $PVFS_{2022}$ = 1,424,059 x 1.04/1.1
= 1,346,383
Exp'd $NC_{2022}$ = $(302{,}489 - 179{,}791) / 1{,}346{,}383 \times 77{,}000$ x 1.04/1.10
= 6,634 (or 6,379 x 1.04)
Increase = 7,578 – 6,634
= 944

Increase in NC due to retirement experience (25% of Member C not retiring):
Act'l $PVFB_{2022}$ = 380,616
Exp'd $PVFB_{2022}$ = 360,810 x 1.05
= 378,851
Act'l $PVFS_{2022}$ = 69,333

**9. Continued**

| | |
|---|---|
| Exp'd $PVFS_{2022}$ | = 69,333 x .5 / .6667 |
| | = 51,997 |
| Exp'd $NC_{2022}$ | = (378,851 – 377,628) / 51,997 × 104,000 |
| | = 2,446 |
| Increase | = 4,481 – 2,446 |
| | = 2,035 |

## 10. Learning Objectives:

2. The candidate will understand how to analyze/synthesize the factors that go into selection of actuarial assumptions for funding purposes.

**Learning Outcomes:**

(2c) Evaluate actual experience, including comparisons to assumptions.

**Sources:**

FR-151-21 CAPSA Guidance Solvency or hypothetical wind-up liabilities based on actual life insurance company annuity quotation

FR-121-21 Assumptions for Hypothetical Wind-Up and Solvency Valuations with Effective Dates between December 31, 2019, and December 30, 2020

FR-143 -21 Educational Note Supplement: Guidance for Assumptions for Hypothetical Wind-Up andSolvency Valuations Update – Effective March 31, 2020, and Applicable to Valuations with Effective Dates Between March 31, 2020, and December 30, 2020

ASOP 35

CIA Educational note for selection of mortality assumptions for pension plan actuarial valuations

**Commentary on Question:**

*This question is to test candidate's understanding regarding selection of actuarial assumptions for funding purposes based on actual experience (i.e., an annuity quote was provided for the plan).*

**Solution:**

(a) Describe the considerations for setting the assumptions that will be used to measure the hypothetical wind-up liabilities given the annuity quotation received.

**Commentary on Question**:

*Candidates are not required to list all bullets below to get full points. Many candidates did not attempt this question. For those who did, they listed considerations for setting assumptions in general, without considering the fact that annuity quotation was received for this plan.*

[Source: CAPSA Guidance]

- The assumptions used for actual and hypothetical wind-up valuations should reflect single premium annuity rates in respect of benefit entitlements that are assumed to be settled by purchase of annuities, unless the establishment of a replicating portfolio is assumed.
- Although not required to do so, a life insurance company may provide a quotation for all or a portion of the pension benefits that are assumed to be settled through the purchase of an annuity.
- Note that the CAPSA guidance is applicable to solvency or hypothetical wind-up valuations and may not be appropriate for actual wind-up valuations.

- It is expected that the actuary would consider the quotation in determining the pension plan's liabilities, irrespective of whether the premium amount in the quotation is lower or higher than the solvency or hypothetical wind-up liabilities produced by CIA guidance.
- The approach taken to establish the solvency or hypothetical wind-up liabilities should be applied in a consistent manner.
- The date of quotation should coincide with the valuation date.

## 10. Continued

- If the quotation date is not the same as the valuation date, the quotation would be considered valid if the quotation date is within six (6) months before or after the valuation date. If this is the case, the solvency or hypothetical wind-up liabilities should be adjusted using the methodology described under "Adjustment to quotation" in the CAPSA guidance note. (e.g. reflect the change in the CIA annuity proxy liability from the date of quotation to the date of the valuation).
- The use of an annuity quotation may not be acceptable if circumstances have changed significantly between the valuation date and the quotation date such that the quote is not representative of financial or market conditions existing at the valuation date.

(b) Describe the considerations for using the annuity quote from September 30, 2021 for setting the assumptions for the hypothetical wind-up valuation.

**Commentary on Question**:
*See above*

- Must consider the date of quotation. Specifically:
  - The date should coincide with the valuation date, which it does not.
  - If the date does not coincide, it should be within six (6) months before or after the valuation date. The previous annuity quote as at September 30, 2020 is no longer valid, given it is over 6 months old.
- Must consider if circumstances have changed significantly between the valuation date and the quotation date.

(c) Recommend a course of action for setting assumptions that better reflect the reduction in the liability suggested by the annuity quotation.

**Commentary on Question**:
*See above*

- Annuity Proxy recommends using the CPM2014 base mortality table.
  For the annuity proxy assumption setting, the actuary could consider changing the base mortality table assumption from CPM2014 to a table that reflects the experience of the plan and judgment.
- The actuary may consider certain factors when determining adjustments to the standard mortality table assumption. Specifically:
  - the credibility of experience,
  - the experience of similar plans,
  - published mortality studies, and
  - possible adjustments based on characteristics such as collar type, industry, and pension size.