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Research Paper

Development of New Prescribed Interest Rate Scenarios for CALM Valuations

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Development of New Prescribed Interest Rate Scenarios for CALM Valuations

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Memorandum

To: All Fellows, Affiliates, Associates, and Correspondents of the Canadian Institute of Actuaries

From: Bruce Langstroth, Chair
Practice Council
Alexis Gerbeau, Chair
Committee on Life Insurance Financial Reporting
Designated Group

Date: October 10, 2014

Subject: **Research Paper: Development of New Prescribed Interest Rate Scenarios for CALM Valuations**

The Committee on Life Insurance Financial Reporting (CLIFR) has drafted this paper to document the process that was followed in the development of the prescribed scenarios described in subsection 2330 of the Practice-Specific Standards of Practice on Insurance Contract Valuation: Life and Health (Accident and Sickness) Insurance published May 15, 2014.

CLIFR would like to acknowledge the contribution of its subcommittee that assisted in the development of the prescribed scenarios and thank the members for their efforts: Steve Sullivan (chair), Edward Gibson, Saul Gercowsky, Simran Bhullar, Wes Foerster, Shahab Mostafavi, Sunny Oh, Joan Strothard, Wally Bridel and Diana Pisanu.

In accordance with the Institute's Policy on Due Process for the Adoption of Guidance Material Other than Standards of Practice, this research paper has been prepared by CLIFR, and has received the approval for distribution from the Practice Council on September 2, 2014.

If you have any questions or comments regarding this research paper, please contact Alexis Gerbeau, Chair of CLIFR, at his CIA Online Directory address, alexis.gerbeau@standardlife.ca.

BL, AG

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1 PURPOSE

The Actuarial Standards Board (ASB) has revised the Practice-Specific Standards on Insurance Contract Valuation: Life and Health (Accident and Sickness) Insurance (section 2300) with respect to the economic reinvestment assumptions and investment strategies utilized for long-tail liability cash flows under the Canadian asset liability method (CALM).

As part of the revisions to section 2300 the ASB Designated Group (DG) directed that the Committee on Life Insurance Financial Reporting (CLIFR) assist it in the development of revisions to the base and prescribed scenarios (hereinafter referred to collectively as the prescribed scenarios) for subsection 2330 of the Standards of Practice. CLIFR formed a subcommittee to assist in recommending revisions to the prescribed scenarios.

The primary purpose of this research paper is to document the process that was followed in the development of revisions to the prescribed scenarios. These prescribed scenarios apply to investments dominated in Canadian dollars. This research paper would also provide guidance for developing risk-free interest rate scenarios for economies other than the Canadian economy.

2 DEFINITIONS

Former prescribed scenarios: the deterministic base and prescribed scenarios as described in subsection 2330 of the Practice-Specific Standards of Practice on Insurance Contract Valuation: Life and Health (Accident and Sickness) Insurance prior to the revisions published May 15, 2014 (document #214047).

Current prescribed scenarios: the deterministic base and prescribed scenarios as described in subsection 2330 of the Practice-Specific Standards of Practice on Insurance Contract Valuation: Life and Health (Accident and Sickness) Insurance after revisions published May 15, 2014 (document #214047).

Calibration criteria: the calibration criteria of stochastic risk-free interest rate models for use in CALM valuation, as promulgated from time to time by the ASB.

Deterministic CALM: Canadian asset liability method using deterministic risk-free prescribed interest rate scenarios.

Stochastic CALM: Canadian asset liability method using stochastic risk-free interest rate scenarios that satisfy the calibration criteria.

IRRs: Initial reinvestment risk-free interest rates.

URRs: the set of the ultimate reinvestment rates that will be promulgated in the Standards of Practice from time to time:

- Short-term ultimate risk-free reinvestment rate-high;
- Long-term ultimate risk-free reinvestment rate-high;
- Short-term ultimate risk-free reinvestment rate-median;
- Long-term ultimate risk-free reinvestment rate-median;
- Short-term ultimate risk-free reinvestment rate-low; and
- Long-term ultimate risk-free reinvestment rate-low.

3 EVALUATION AND OBJECTIVES

3.1 Concerns with the Former Prescribed Scenarios

The ASB, in its notice of intent (NOI) of December 21, 2012, identified a number of specific concerns with the former prescribed scenarios:

- Emerging differences between the guidance supporting stochastic and deterministic CALM.
- The widening difference between the conditional tail expectation (CTE)(0) results in stochastic testing and the base scenario result in deterministic testing.
- The breadth of ranges tested under the former prescribed scenarios compared to those resulting from the stochastic testing:
 - Does grading to risk-free fixed assets in some of the scenarios result in an unreasonably conservative basis?
 - Does assuming current rates forever in today's low-interest-rate environment result in an unreasonably conservative basis or drive inappropriate volatility?
- The extent of risk premiums which may be assumed for reinvestments beyond the horizon for which readily available liquid fixed income assets are available, considering the varying current investment strategies which may be employed.
 - Does assuming current risk premiums based on the current investment strategy forever, as defined in a number of the deterministic scenarios, result in an unreasonably large range of results?

Additional concerns were also identified with the former prescribed scenarios:

- The appropriateness of the URR is difficult to assess because the structure does not isolate the credit spread.
- The effective number of former prescribed scenarios is reduced from 10 scenarios (including the base scenario) to eight scenarios when the risk-free interest rates at the balance sheet date are outside of the former prescribed range. Under these conditions, former prescribed scenario 3 is identical to former prescribed scenario 4 and former prescribed scenario 5 is identical to former prescribed scenario 6.

3.2 Objectives for the Prescribed Scenarios

The ASB and CLIFR provided the following objectives in formulating a set of prescribed scenarios consistent with the NOI issued by the ASB on December 21, 2012:

- The prescribed scenarios would produce results under a deterministic CALM consistent with stochastic CALM.
- The prescribed scenarios would be defined in such a manner as to avoid inappropriate volatility from one accounting period to the next.
- The prescribed scenarios would be appropriate in a variety of economic conditions, including periods of high or low risk-free interest rates.

- The prescribed scenarios would be defined as risk-free interest rates, with credit spread best estimates and margins for adverse deviations (MfADs) separately defined.
- The prescribed scenarios would produce reasonable and appropriate results under a wide variety of asset-liability structures.

3.2.1 Consistency between Deterministic and Stochastic CALM

One of the objectives for the prescribed scenarios would be to generate results under deterministic CALM for most asset-liability portfolios that are consistent with CTE(60) to CTE(80) results under stochastic CALM. This would ensure a narrow range of practice in the calculation of insurance contract liabilities.

In the development of the prescribed scenarios, it was intended that the deterministic CALM would produce results at the higher-end of the range of CTE(60) to CTE(80), as it is a simplified approach relative to stochastic CALM. In addition, for stochastic CALM the Standards of Practice paragraph 2330.33 states that, in some circumstances, the actuary would adopt a scenario whose insurance contract liabilities are higher than the mid-point of the range of CTE(60) to CTE(80).

3.2.2 Avoiding Inappropriate Volatility

One of the objectives for prescribed scenarios is to avoid inappropriate volatility from one accounting period to the next.

This objective suggested that the current prescribed scenarios have the following characteristics:

- URRs should be based on long-term historical risk-free interest rates that would not vary to any material degree from one reporting period to the next. This would also provide a degree of consistency with stochastic CALM, as the calibration criteria for stochastic models are based on risk-free interest rates over the period 1936-2012. In order to provide ease of application and to ensure a narrow range of practice, it was decided that the URRs be promulgated by the ASB and be updated from time to time.
- That the grading of the IRRs to the URRs be done in such a manner as to avoid inappropriate volatility. Volatility increases by having risk-free interest rates that vary from period to period at long durations beyond the horizon where the insurer can match assets and liabilities if desired.

3.3 The Approach to Satisfy the Objectives

The following general approach to constructing the current prescribed scenarios was formulated with the goal of meeting the objectives set out in the previous section.

- The current prescribed scenarios would include eight or nine prescribed scenarios in addition to a base scenario. The former prescribed scenarios were considered as a reasonable starting point for the revisions. Those scenarios were designed to provide for extended periods of both low and high risk-free interest rates (former prescribed scenarios 1 and 2), as well as providing for periods of prolonged interest rate volatility (former prescribed scenarios 3 through 6) and to reflect immediate shocks to the current interest rate environment (former prescribed scenarios 7 and 8).
- The former prescribed scenario 9 would be eliminated.

- This scenario has contributed to inappropriate volatility from one accounting period to the next.
- When risk-free interest rates are at or near historical lows, the former prescribed scenario 9 assumption that risk-free interest rates remained indefinitely at current levels produces results that are inconsistent with results under stochastic CALM.
- URRs will be defined with reference to historical risk-free interest rates that are consistent with the calibration criteria for stochastic risk-free interest rate models.
- The grading of IRRs to URRs would be defined in such a manner as to ensure consistency with results from stochastic CALM.
- The guidance in respect of the construction of the current prescribed scenarios would be limited to risk-free interest rates, with the guidance for consideration of credit spreads defined separately.

The current prescribed scenarios will retain a number of scenarios designed to reflect interest rate volatility applicable to short- to medium-term asset-liability profiles.

4 PROJECT METHODOLOGY

4.1 Determine a General Framework for the Current Prescribed Scenarios

A preliminary framework for defining a new set of prescribed scenarios was formulated giving consideration to the objectives defined in the previous section.

- The ASB would promulgate the URRs to be used to construct the current prescribed scenarios.
- The current base scenario will be similar to the former base scenario, except that the URRs will be reached at duration 60 (instead of at duration 40) and the ultimate rates will be based on the URR median rates.
- Current prescribed scenarios 1 and 2 will be similar to the former prescribed scenarios 1 and 2 except that the URRs will be based respectively on the URR low and URR high rates, and will be reached later than duration 20.
- Current prescribed scenarios 3 through 6 will continue to feature risk-free interest rates fluctuating between high and low bounds in varying patterns. The high and low bounds will be defined by the URR low and URR high rates. A review of patterns of interest rate movements under stochastically generated interest rates suggested that the current oscillation period of 14 years is too short, and should be replaced with a longer oscillation period, perhaps 20 years.
- Current prescribed scenarios 7 and 8 will be modified from former prescribed scenarios 7 and 8. The 10% shocks may be increased to as high as 20%. In addition, the grading from the IRRs to the URRs may be modified.
- Former prescribed scenario 9 will be eliminated.
- The base scenario risk-free interest rates for the first 20 years after the balance sheet date will continue to be based on the equilibrium curve at the balance sheet date, in order to prevent the situation where the base scenario liability is decreased by creating a mismatch deliberately. This requirement is irrespective of the objective to have greater

consistence between the base scenario result and the CTE (0) results in stochastic valuation. Changes to the base scenario URR as well as changes to the guidance for constructing the equilibrium curve will likely bring the base scenario results closer to stochastic CTE(0) results.

4.2 Generate a Set of Preliminary Prescribed Scenarios

A set of preliminary prescribed scenarios that met the objectives of the general framework were generated. This process is more fully described in the appendix to the report.

4.3 Generate Stochastic Scenarios

Using a stochastic interest rate model that met the calibration criteria, a suitable number of stochastic interest rate scenarios were developed. For this purpose, 10,000 scenarios were considered to be adequate. The scenarios were based on the risk-free Canadian yield curve in effect at December 31, 2012.

4.4 Build a Simplified Asset-Liability Model

The CLIFR subcommittee built a simplified asset-liability model which was used to test a wide range of asset-liability profiles. In summary, the profiles included:

- A number of portfolios were constructed around guaranteed investment contracts (GICs) of varying maturities. Maturities of five years, 10, 20 and 50 years were tested. In some cases the assets supporting the liabilities were shorter than the liabilities, presenting reinvestment risk. In other situations the assets supporting the liabilities were longer than the liabilities, presenting disinvestment risk.
- Three portfolios were constructed that were typical of blocks of payout annuities with the assets supporting the liabilities shorter than the liabilities, presenting longer-term reinvestment risk. One portfolio consisted of annuity cash flows payable more than 30 years from the valuation date and was designed to represent a situation where cash flows were well matched for the first 30 years with the longer tail presenting reinvestment risk.
- Two portfolios were constructed that were typical of longer-term life insurance portfolios that included a moderate amount of reinvestment risk. Early-year net positive cash flows were considered to be hedged and did not generate reinvestment risk. In one portfolio the reinvestment strategy involved a duration matching approach and in the other portfolio it involved a cash flow matching approach.

These portfolios only considered investment in risk-free assets.

4.5 Run and Compare CALM Results – Prescribed vs. Stochastic

A preliminary set of prescribed scenarios was determined using the general framework described above; for more detail on this process refer to the appendix. CALM results were determined for each of the asset-liability portfolios under (1) the preliminary prescribed scenarios and (2) the 10,000 stochastic scenarios. The deterministic CALM result was equated to the corresponding CTE level from the stochastic CALM using 10,000 scenarios.

It was observed that for the asset-liability profiles that were sensitive to reinvestments at low interest rates, the deterministic CALM result under prescribed scenario 9 was generally well in

excess of the CTE(80) result under stochastic CALM. These results support the decision to eliminate scenario 9 for the current prescribed scenarios.

4.6 Modify the Preliminary Prescribed Scenarios

The preliminary prescribed scenarios were modified to improve the consistency of the results between the deterministic and stochastic CALM. Modifications were made considering feedback and direction provided by the ASB. Modifications included the following:

- Revisions to URRs;
- Revisions to the grading of risk-free interest rates between the IRRs and URRs for current prescribed scenarios 1 and 2;
- Various revisions to current prescribed scenarios 3 through 6, especially with respect to the movement of risk-free interest rates over the first five years (one-quarter oscillation period), the period when rates move from the IRR to the point where the normal interest oscillation patterns begin; and
- Revisions to the shocks for current prescribed scenarios 7 and 8. In addition, changes were made to the manner in which risk-free interest rates were constructed between the balance sheet date and the date the URRs were reached.

After making changes to the prescribed scenarios, the comparison of results with the stochastic scenarios was updated.

4.7 Reflect the ASB Quantitative Impact Studies

The ASB conducted a quantitative impact study (QIS) where industry participants were requested to provide CALM valuation results as at December 31, 2012, using proposed draft changes to subsection 2330 of the Standards of Practice. Those changes incorporated the proposed revisions to the prescribed scenarios and changes to guidance regarding credit spreads and on the use of non-fixed income assets. Based on results of the initial QIS, the ASB provided feedback on the preliminary prescribed scenarios and proposed refinements. Those refinements were incorporated into the preliminary prescribed scenarios and the subsequent deterministic versus stochastic comparisons. The ASB conducted two additional QIS's that resulted in further changes that were incorporated into the current prescribed scenarios.

4.8 Conduct Sensitivity Testing

The sensitivity of results to variations in the starting yield curve was tested using the current prescribed scenarios. The testing compared the results between deterministic and stochastic CALM and determined whether they would remain similar under higher and lower starting risk-free interest rate environments. In this regard testing was performed using the following balance sheet date yield curves:

- The December 31, 2012, yield curve shifted upwards by 1.0%.
- The December 31, 2012, yield curve shifted downwards by 0.5%.

The testing confirmed that the differences between stochastic and deterministic CALM were not materially affected by the starting yield curve.

APPENDIX A DETAILED DISCUSSION ON CONSTRUCTION OF CURRENT PRESCRIBED SCENARIOS

1. Define Scenarios Consistent with the General Framework

Section 4.1 describes the general framework adopted for constructing the current prescribed scenarios. Detailed work needed to be completed to construct a set of preliminary prescribed scenarios. This work involved:

- The selection of the six URRs;
- Development of methodology to grade between the IRRs and the URRs;
- Development of shock factors to utilize for prescribed scenarios 7 and 8; and
- Formulating detailed specifications for prescribed scenarios 3 through 6.

1.1 Detailed Discussion – Construction of Prescribed Scenarios 1 and 2

The initial methodology that was utilized in setting the URRs (low and high) and the grading of the IRRs to the URRs high had the following characteristics.

- The URR high was to be set equal to the average of the highest X% of observed rates using historical data. Similarly, the URR low was to be set equal to the average of the lowest X% of observed rates using the same historical data.
- Initially the subcommittee considered values of 20%, 30% and 40% for X%. The URR would be reached no later than duration 60.
- The subcommittee selected a value of X=30% for preliminary testing rather than 20% or 40%. The goal was to produce a liability in the CTE(70) to CTE(80) range.
- The preliminary testing was primarily based on the setting of the long-term URR low. The results of the setting of the URR low were to be extended to the setting of short-term URR low. The short-term and long-term URR highs were to be determined using a mirroring approach.
- The preliminary approach was to set anchor points at durations 5, 20, and 40; formulae (utilizing weightings of the IRRs and URRs) to determine the anchor points were designed to reproduce the average of the lowest and highest 30% of risk-free interest rates at those durations. The anchor point at duration 5 was specifically chosen to produce a bulge at that duration, as such bulge was observed when graphing either CTE or percentile levels of stochastically generated interest rate scenarios. Risk-free interest rates between the anchor points would be determined via linear interpolation.

The initial URRs low and high and the preliminary formulae used to set the anchor points are shown in the following table. Anchor points are derived using factors, W and M, governing the weight applied to the URR and IRR at the anchor durations.

Preliminary Definitions for Reinvestment Rates – Scenarios 1 and 2

Scenario	URR – Short	URR – Long	Anchor Point W and M Factors		
			Dur'n 5	Dur'n 20	Dur'n 40
Scenario 1	1.40	3.20	20%, 75%	80%, 90%	95%, 95%
Scenario 2	8.40	10.20	20%, 125%	80%, 110%	95%, 105%

Anchor Points Rates: $Int(t) = (URR \times W(t) + IRR \times (1 - W(t))) \times M(t)$

t is the period of time, in years, from the balance sheet date

Testing indicated that the construction of scenarios 1 and 2 using the above described methodology and parameters typically produced results above the CTE(80) level. The following changes were made to current prescribed scenarios 1 and 2 so as to produce results at a lower CTE level:

- The anchor point at duration 5 was removed and replaced by an anchor point at duration 1. The definition of the duration 1 rates results in a 10% shock to risk-free interest rates at that duration. That is, under current prescribed scenario 1 (current prescribed scenario 2) risk-free interest rates at duration 1 are 90% (110%) of the rates in effect at the balance sheet date.
- Factors W and M were modified to provide for an accelerated rate of grading from the IRR to the URR. This was accomplished by having (1) higher W factors at durations 20 and 40, and (2) setting the M factors at durations 20 and 40 to 100%.

The final adopted factors for the construction of scenarios 1 and 2 are shown in the following tables.

Final Definitions for Reinvestment Rates – Scenarios 1 and 2

Scenario	URR – Short	URR – Long	Anchor Point W and M Factors		
			Duration 1	Duration 20	Duration 40
Scenario 1	1.40	3.30	0%, 90%	90%, 100%	100%, 100%
Scenario 2	10.0	10.40	0%, 110%	90%, 100%	100%, 100%

Anchor Points Rates: $Int(t) = (URR \times W(t) + IRR \times (1 - W(t))) \times M(t)$

t is the period of time, in years, from the balance sheet date

Note that the setting of the W factor to 100% at duration 40 means that the URR is reached at duration 40 rather than at duration 60, as was the preliminary proposal.

1.2 Detailed Discussion – Construction of Prescribed Scenarios 3 through 6

The general objective in constructing these four scenarios was to build interest rate scenarios that tested the sensitivity of asset-liability blocks to relatively volatile and quick movements of risk-free interest rates up and down. Additionally these scenarios would feature relatively severe changes over time in the slope of the yield curve, including situations where inverted yield curves develop. Thus the objective was to replace the former prescribed scenarios 3 through 6

with scenarios that had the same purpose and would ensure consistency with the calibration criteria.

Results of testing showed the oscillation period (OP) of 14 years for former prescribed scenarios 3 through 6 to be too short, and inconsistent with the mean reversion period not less than 14.5 years under the calibration criteria. Such criteria could be construed as suggesting an oscillation period of 28 years. However, due to the limited number of prescribed scenarios that are constructed to test oscillating risk-free interest rates, 20 years was tested.

The preliminary definition of the proposed prescribed scenarios is described below.

- Scenario 3: long-term rates move to URR high over the first five years (one-quarter OP), and then oscillate every 20 years between URR high and URR low. Short-term rates move over three years to be 60% of the long-term rates and remain at that percentage of the projected long term rates.
- Scenario 4: long-term rates move to URR low over the first five years (one-quarter OP), and then oscillate every 20 years between URR low and URR high. Short-term rates move over three years to be 60% of the long-term rates and remain at that percentage of the projected long-term rates.
- Scenario 5: long-term rates move as in scenario 3. Short-term rates move in 20% steps between 40% and 120% of long-term rates.
- Scenario 6: long-term rates move as in scenario 4. Short-term rates move in 20% steps between 40% and 120% of long-term rates, similar percentages to scenario 5, except initially in the opposite direction.

Preliminary testing indicated that there were certain shortcomings with these scenarios, as follows:

- Testing indicated that for asset-liability portfolios sensitive to increasing risk-free interest rates over the short-to-medium term, scenarios 3 and 5 produced results well in excess of CTE(80). This is because of the extremely rapid rise in risk-free interest rates moving from current rates to URR high over five years from the balance sheet date.
- These scenarios did not make adequate provision for declining risk-free interest rates over the short to medium terms. This is due to the fact that when current risk-free interest rates are low, the grading to URR low over the first quarter OP (five years) may make little or no provision for interest rate declines over that period.

The following changes were made to the current prescribed scenarios 3 through 6 to address these shortcomings.

- Scenario 3: over the first five years long-term risk-free interest rates move to a rate equal to 75% of (80% of the IRR plus 20% of the URR low). Over the following five years rates move to the URR low before beginning the regular oscillation every 20 years between the URR low and the URR high. Short-term rates move in a similar manner over the first five years (except that the factor of 75% is replaced by 50%) before grading to 60% of long-term rates by duration 10.
- Scenario 4: similar to scenario 3, over the first five years long-term risk-free interest rates move to a rate equal to 125% of (80% of the IRR plus 20% of the URR high).

Over the following five years rates move to the URR high before beginning the regular oscillation every 20 years between the URR high and the URR low. Short-term rates move in a similar manner over the first five years (except that the factor of 125% is replaced by 150%) before grading to 60% of long-term rates by duration 10.

- The same changes to scenario 5 were made as to scenario 3 for long-term rates. Short-term rates move over the first five years to 40% of long-term rates and then oscillate in 20% steps between 40% and 120% of long-term rates.
- The same changes to scenario 6 were made as to scenario 4 for long-term rates. Similar to scenario 5, short-term rates move over the first five years to 120% of long-term rates and then oscillate in 20% steps between 120% and 40% of long-term rates.

The changes made moderated the movement from the current risk-free interest rates to either of the URR high or URR low, as the case may be, as now that movement takes 10 years as compared to five years in the initial proposal. These scenarios also make provision for risk-free interest rates declining over the five years from the balance sheet date (particularly in a low interest rate environment), as that interest rate movement is no longer tested as part of scenario 1, as was initially contemplated. Similarly these scenarios also make provision for risk-free interest rates increasing over the five years from the balance sheet date (particularly in a high interest rate environment), as that interest rate movement is no longer tested as part of scenario 2, as was initially contemplated.

1.3 Detailed Discussion – Construction of Prescribed Scenarios 7 and 8

Former prescribed scenarios 7 and 8 used risk-free interest rates equal to 90%/110% of the former base scenario risk-free interest rates. Initially, the intent was to retain former prescribed scenarios 7 and 8 with perhaps one change. That change was to consider changing the factors of $\pm 10\%$ to perhaps as high as $\pm 20\%$.

Testing indicated that interest shocks of $\pm 10\%$ provided little margin, especially when base scenario ultimate risk-free interest rates are at the URR median level. Therefore it was decided to test interest shocks of $\pm 20\%$. In conjunction with the higher shocks, it was decided to de-link risk-free interest rates between the balance sheet date and duration 60 from the base scenario rates, which are largely based on implied forward risk-free interest rates. Those rates are now based on an interpolation between 80%/120% of IRRs at duration one to 80%/120% of URR medians at durations 60+, with pivot points at durations 20 and 40.

1.4 Detailed Discussion – Elimination of Prescribed Scenarios 9

It was observed that for the asset-liability profiles that were sensitive to reinvestments at low interest rates, the deterministic CALM result under prescribed scenario 9 was generally well in excess of CTE(80) result under stochastic CALM. These results support the decision to eliminate scenario 9 for the current prescribed scenarios.