AMERICAN ACADEMY of ACTUARIES
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March 24, 2021

Mr. Mike Boerner
Chair, Life Actuarial (A) Task Force (LATF)
National Association of Insurance Commissioners (NAIC)

Dear Mr. Boerner,

The American Academy of Actuaries'[1] Economic Scenario Generator Work Group (the "ESGWG") appreciates the opportunity to offer comments on LATF's Economic Scenario Generator (ESG) exposures.

1. Proprietary ESGs
   As a general point, the ESGWG would like to reiterate the view previously communicated by Academy Life Practice Council work groups that the use of scenario sets generated by proprietary ESGs be permitted as an alternative option to scenario sets prescribed by the NAIC, subject to proper documentation on how the scenario sets were developed and why they are appropriate for statutory reserves and capital.

2. Full ESG Documentation
   Deliverable I of NAIC RFP #2053 is "Full documentation on the ESG specifications, calibration, and tools." The ESGWG would like to reiterate the importance of this deliverable because it is full documentation of the model that enables actuaries to adequately understand the dynamics of the model and objectively evaluate whether the scenario sets it produces are fit for purpose (adequate for determining reserves and capital, *irrespective of the starting yield curve*) as required of actuaries by Actuarial Standard of Practice (ASOP) No. 56, *Modeling*, and ASOP No. 41, *Actuarial Communications*.
   a. ASOP No. 56, *Modeling*, provides guidance to actuaries when performing actuarial services with respect to using, reviewing, or evaluating models. Section 3.1.2 of ASOP No. 56 states actuaries "evaluating the model … should confirm that, in the actuary's professional judgment, the model reasonably meets the intended purpose." Section 3.1.3 of ASOP No. 56 states that "[w]hen using the model, the actuary should make reasonable efforts to confirm that the model structure, data, assumptions, governance and controls, and model testing and output validation are consistent with the intended purpose."

[1] The American Academy of Actuaries is a 19,500-member professional association whose mission is to serve the public and the U.S. actuarial profession. For more than 50 years, the Academy has assisted public policymakers on all levels by providing leadership, objective expertise, and actuarial advice on risk and financial security issues. The Academy also sets qualification, practice, and professionalism standards for actuaries in the United States.

b. Section 3.2 of ASOP No. 41, *Actuarial Communications*, states "In the actuarial report, the actuary should state the actuarial findings, and identify the methods, procedures, assumptions, and data used by the actuary with sufficient clarity that another actuary qualified in the same practice area could make an objective appraisal of the reasonableness of the actuary's work as presented in the actuarial report."

Although several pieces of ESG documentation have been exposed by LATF, the ESGWG believes that many key elements of full ESG documentation are missing. Furthermore the ESGWG believes that achieving full documentation relies on the critical project path of adequately understanding how the ESG will perform under different conditions and assessing whether scenario sets produced by the ESG are fit for use in principle-based reserve and capital calculations. The ESGWG also believes that a lack of sufficient documentation could unintentionally impact the ESG quantity and quality of these important risk management tools available to the life insurance industry. Additional detail can be found in *Exhibit 2.1—ESG Documentation*,[2] but as a starting point, here are two specific pieces of documentation that, as yet, have not been publicly provided:

- The exact means by which the ESG model is adjusted to fit any discrepancies to the starting yield curve, and exactly how those discrepancies run off over the course of the projection (the entire yield curve, not just the three points corresponding to the model's three state variables).
- The correlations between the various equity and bond funds.

3. Significant Differences From Previously Prescribed ESG

The ESGWG does not believe the newly proposed ESG needs to be substantially similar to the Academy's Interest Rate Generator (AIRG). Indeed, the proposed ESG is not. But the ESGWG does believe it is important that regulators and interested parties appreciate just how different the two models are (in both underlying structure and calibration), generally agree that the differences are warranted, and understand the impact the differences will have on the scenario sets produced and the level and volatility of industry reserve and capital levels, including how model dynamics and interrelationships will change in the long term as the current economic environment changes. This will take time and additional documentation, but to start with, the ESGWG would like to highlight the following three significant differences:

a. **Lack of explicit MRP**—The old model has an explicit and intuitive mean-reversion parameter (MRP) that changes rather slowly according to a specified formula. The new model has no analogous MRP for regulators to explicitly set or control. Instead, NAIC's vendor, Conning, has agreed to target an MRP by tweaking various parameters during calibration, but as seen in the revised baseline scenario set, this can have unintended consequences given the various linkages in the model. And it remains to be seen how sensitive mean reversion is to the current economic environment—e.g., to the observed yield curve on the valuation date. The ESGWG believes it is important to understand this significant change in the mean-reversion process and resulting impact on the volatility of capital over time.

b. **Connection Between Interest Rates and Equity Returns**—The old model has no such connection. The simple formulaic connection in the new model (equity risk premium over short Treasury rate) is largely based on actuarial judgment and the goal that the model produces risk-neutral scenarios. Empirical evidence suggests the equity risk premium depends on non-modeled macroeconomic factors (historical correlations have been both highly negative and highly

[2] This exhibit and subsequent exhibits cited are included in the enclosure to this comment letter.

positive). This has the potential to magnify the tails because calibration points in the new model depend on the starting yield curve in a way that they did not in the past. It also has the potential to make long-duration insurance liabilities dependent on overnight Treasury rates, which seems artificial and counterintuitive. The ESWG believes it is important to understand this connection that was not in the old model, and to consider the impact the connection has on reserve and capital levels and whether calibration standards may need adjustment in level and/or form as a result.

c. **Stochastic Modeling of Credit Spreads and Defaults for Bond Fund Returns**—The new ESG simulates bond fund returns by first using a credit model to simulate each of the individual bonds contained in the bond fund; e.g., using stochastic credit spreads, transitions, and defaults. The old ESG uses a simpler approach that does not involve a credit model. To date, the ESGWG simply does not have enough documentation on the new credit model to comment further on the impact this significant change may have and whether it is desirable or not. Until we have complete documentation of the credit model, the ESGWG suggests revisiting whether a simpler approach to simulating bond fund returns (not requiring a credit model) would be more appropriate. Regulators may also wish to consider the degree to which the approach for simulating bond fund returns is consistent with the regulatory framework for modeling insurer general account assets, which requires using deterministic prescribed credit spreads and defaults and could easily lead to calibration inconsistencies.

4. Implementation Timeline

The ESGWG believes the implementation timeline does not leave enough time for regulators and interested parties to:

a. Review the totality of exposed documentation and adequately understand the newly proposed ESG model and the scenarios it would produce under various initial conditions.
b. Discuss the properties that scenario sets used for reserves/capital *should have* and evaluate the new ESG and its scenario sets on that basis.
c. Iterate to desirable field-testing options based on (a) and (b).
d. Conduct a field test, allowing time for additional/iterative testing (given the likelihood there will be adjustments based on what is learned from prior iterations of testing).

The ESGWG also believes that approval in November/December could present companies and vendors with an insufficient short timeframe to implement the final ESG in their systems.

5. Scenario Sets – Rates

Although the ESGWG may have additional comments as additional missing documentation is exposed, the ESGWG's initial comments on the **baseline scenario set** (exposed 12/18/20) can be found in *Exhibit 5.1: Scenario Sets—Rates*. Key issues include the following:

a. The exposed scenario set, which is as of 12/31/19, has interest rates as low as -4.8%, which seems quite extreme. The likelihood and magnitude of negative interest rates produced by the model may be even more extreme when calibrated to more recent market conditions.
b. A comparison of risk-neutral and real-world calibrations implies a negative market price of risk for long-term interest rates.
c. Equity indices lose all value in some scenarios while increasing hundreds of times in others.
d. Unreasonable short-end inversions. In nearly all scenarios, the yield curve is inverted between 1-month and 2-year rates (fixed in the revised baseline scenario set).

The ESGWG also reviewed the **revised baseline scenario set** (exposed 2/24/21). Although the addition of a long-term overnight yield target appeared to fix (d) above, *the other issues found in the*

baseline scenario set are still present, even exacerbated for example, for (a) negative rates are even more extreme, and for (c) equity indices have even more extreme tails. This highlights how calibrating ESG models can be complicated; i.e., recalibrating to fix a particular issue can easily have unforeseen consequences, often exposing new issues or exacerbating existing issues. The ESGWG suggests discussing the properties that scenario sets used for reserves/capital *should have*, and understanding the degree to which desired scenario set properties can be achieved via recalibration of real-world (RW) and/or risk-neutral (RN) parameters. It may be that certain desired scenario set properties are out of reach given constraints on calibration and/or model structure.

6. Scenario Sets—Accompanying Report
   To facilitate reviewing newly published scenario set files, the ESGWG suggests adding: (A) a new section on Model Input, and (B) additional statistics and charts for the existing section on Model Output. Additional detail can be found in *Exhibit 6.1: Scenario Sets—Accompanying Report.*

7. Scenario Sets—File Format
   For use in companies' existing models, the ESGWG suggests publishing scenario sets in two alternative .CSV file formats: (A) GEMS .CSV file format, which is currently exposed, and (B) the Academy Interest Rate Generator (AIRG) multiple .CSV file format. Additional detail can be found in *Exhibit 7.1: Scenario Sets—File Format*.

We look forward to further documentation and discussion on the NAIC's ESG project.

Sincerely,

Jason Kehrberg, MAAA, FSA
Chairperson, Economic Scenarios Work Group
American Academy of Actuaries

Enclosures: Exhibits 2.1, 5.1, 6.1 and 7.1

Exhibit 2.1 – ESG Documentation

There is widespread expectation that the NAIC will be providing sufficient details on the new models so that interested practitioners can attain a complete operational understanding of all aspects of the simulation of model output, calibration of the models, and application of related tools. This expectation was set by the requirement in item I in the Deliverables section of the RFP which states: "[f]ull documentation on the ESG specifications, calibration, and tools." The requirement of full documentation was reiterated on slide 11 of the October 27, 2020 NAIC presentation of Pat Allison "ESG Implementation Project: Background and Deliverables" which states: "Conning will provide full documentation on specifications, calibration, and tools. This will include: Full documentation of the necessary components used to develop the Basic Data Set." This is an important commitment since it is the Basic Data Set which is to be prescribed by the NAIC for statutory reporting.

As summarized on slide 7 of the aforementioned October 27, 2020 NAIC presentation, the components of the Basic Data Set are:

- Treasury Yields - 1M, 3M, 6M, 1Y - 30Y by year; Spot and Coupon Yields.
- Bond Returns - Money Market; Short, Intermediate and Long Governments; Short, Intermediate and Long Investment Grade Corporates; High Yield Corporates.
- Equity Returns - S&P 500, Russell Midcap, Russell 2000, NASDAQ, MSCI EAFE and MSCI Emerging Market.

As of the end of February 2021, the NAIC has provided three documents that relate to the models underlying the Basic Data Set:

- NAIC Scenario Set Technical Documentation - Interest Rates Model
- NAIC Scenario Set Technical Documentation - Equity and Dividend Model
- NAIC Scenario Set Technical Documentation - Corporate Yield Model

No specific documentation has been provided on how the bond returns are computed. The NAIC Scenario Set Technical Documentation - Interest Rates Model contains significant information on the treasury interest rate model but does not constitute full documentation. The NAIC Scenario Set Technical Documentation - Equity and Dividend Model provides a sense of how the equity model works but is missing fundamental information. The NAIC Scenario Set Technical Documentation - Corporate Yield Model provides no meaningful details on how the corporate yield model works.

Full documentation must achieve the following outcomes for each of the models used to develop the Basic Data Set.

1. Full specification of model dynamics.
2. Operational description of the calibration process.
3. Mapping of the calibration parameters into the model dynamics.

Full documentation of calibration requires the details of how the parameters for each model are determined and what data is used in the calibration procedure. It is reasonable to expect that someone who has understood the model specification and calibration documents would be able to arrive at similar model parameters. Indeed, the ability to independently reproduce calibration results is an important check and robustness and stability of a model.

Full specification of Treasury model dynamics requires the following:

1. Bond pricing formulas
2. State variable simulation procedure
3. State variable initialization procedure

4. Initial yield curve fitting procedure
5. Explicit mapping between real world and risk neutral model parameters
6. Documentation should use the original standard notation of Cox, Ingersoll, and Ross

Full specification of Equity model dynamics requires the following:

1. Dynamic specification for equity price return
2. Details of jump process for equity index
3. Correlation specifications for diffusion and jump terms across equity indices
4. Dynamic specification for dividend yield process
5. Any adjustments that need to be made to dividend process when very large jumps occur in the equity process
6. Specific linkages between equity returns and interest rates

Full specification of Bond Fund Return model dynamics:

The bond fund returns models appear to be based on a corporate bond pricing model called the corporate yield model. Therefore, to understand the bond fund returns the details of the corporate yield model are needed, including details on credit spreads, credit migration, loss given default and the relationships between rates/spreads and equity/credit. Similar information detail to what is needed for the treasury model is required. NAIC documents and presentations have indicated that the bond fund returns are based on an index of individual bonds. Therefore, the methodology/rules of the index construction are required.

Exhibit 5.1: Scenario Sets – Rates

Selected ESWG findings on rates baseline scenario set (exposed on 12/18/20):

A. Interest Rate Model
   1. Conning's interest rate model structure and calibration (i.e., 1M to 2Y) are inverted in most scenarios nearly immediately and in nearly all scenarios after projection year 5.
   2. The **frequency and severity of negative interest rates** in the exposed scenario set are high
      a. Rates for short-term maturities approach -5%.
      b. Roughly 20% of the 1Y and 2Y yields are negative between projection years 5 and 15, and those rates are negative in more than 15% scenarios over the longer term.
   3. **Insufficiently broad range of rates** or other anomalies / inconsistencies
      a. 20Y yields were above 8% for much of the period between 1974 and 1990, but exposed 20Y yields are above 8% less than 1% of the time.
      b. While there are more low-rate scenarios than the AIRG, 20Y rates seldom average below 1% over the 30-year projection (and never average below 70-80 bps).
      c. In the exposed scenarios, annualized realized volatility for 20Y yields is nearly double the annualized realized volatility for 1Y yields. This is inconsistent with both Conning's 1995+ historical period (where 1Y volatility was lower than 20Y) and LATF's 1953+ historical period (where 1Y volatility was higher than 20Y by ~50%, not double). The relationship between the volatilities for longer and shorter maturities may be contributing to shorter term bond funds having higher volatility and lower returns over the long term.

B. Equity Model
   1. Index returns **explode** in both tails. In some scenarios equity *indices* essentially become worthless while other scenarios have indices hundreds of times starting levels by year 30.
   2. Other characteristics of the equity distribution also seem to diverge from historical data
      a. Monthly S&P 500 returns in LATF's exposure have substantially more negative skew and higher kurtosis than history.
      b. The S&P 500 (price index) has negative returns over 30 years in more than 5% scenarios (even though that has never been observed in history).
      c. The exposed scenarios set international dividend yields to zero even though EAFE dividends have historically been non-zero.
      d. SPX / EAFE correlations seem higher than long-term historical data.

C. Corporate Model:
   1. **Credit spreads** inferred by taking the difference between annualized corporate and government bond fund income returns suggest that
      a. LATF's / Conning's proposed long-term credit spread for bonds in the separate account are lower than the prescribed NAIC general account bond fund spreads.
      b. Extreme credit events in the scenarios appear to be materially higher than historical stresses.
   2. Month 1 income returns for government bonds do not seem to align with time 0 government bond yields. (Month 1 Short Gov income return ~ 1Y UST yield. Expected to align with the 50% 1Y / 50% 5Y given the short-term fund definition.)

Exhibit 6.1: Scenario Sets – Accompanying Report

To facilitate reviewing newly published scenario set files, the ESWG suggests adding the following to the report accompanying scenario sets.

A. A new section on Model Input
   1. Values of the model parameters used to generate the associated scenario set
   2. Starting state variables used to generate the associated scenario set

B. Additional statistics and charts for the existing section on Model Output
   - Unless otherwise specified
     - Selected key rate tenors: 1M, 3M, 6M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y, 20Y, 30Y
     - Selected funds: all equity and bond funds included in the published scenarios
     - Selected time points: 0.25, 0.5, 1, 2, 3, 4, 5, 10, 20, 30, 40 and 50 years
     - Selected percentiles: 1, 2.5, 5, 10, 25, 50, 75, 90, 95, 97.5 and 99
     - Selected key rate pairs: 1m2s (2Y rate less 1M rate), 3m10s, 2s10s, 10s30s, 1s20s
     - Selected corp bonds: 1Y A, 5Y A, 10Y A, 30Y A, 1Y BBB, 5Y BBB, 10Y BBB and 30Y BBB
     - Selected yield curve shapes: Normal, Flat, Steep, Inverted, Humped (criteria TBD)
   1. Not scenario path dependent
      a. Distribution of Key Rate Pair Term Spreads
         - Key rate term spread (y-axis) by selected time points (x-axis)
         - One chart for each selected key rate pair
         - Legend: mean, min, max, selected percentiles
      b. Table on Key Rate Pair Inversions (no chart)

End of proj. mo.	Key Rate Pairs Term Spreads – Percent of Scenarios Where Negative				
	1m2s	3m10s	2s10s	10s30s	1s20s
0	%	%	%	%	%
1	%	%	%	%	%
2	%	%	%	%	%
⋮	⋮	⋮	⋮	⋮	⋮
360	%	%	%	%	%

      c. Median Key Rate Yield Curves
         - Key rate (y-axis) by key rate tenor (x-axis)
         - One chart showing median key rate yield curves
         - Legend: selected time points
      d. Table on Negative Key Rates (no chart)

End of proj. mo.	Key Rates – Percent of Scenarios Where Negative										
	1M	3M	6M	1Y	2Y	3Y	5Y	7Y	10Y	20Y	30Y
0	%	%	%	%	%	%	%	%	%	%	%
1	%	%	%	%	%	%	%	%	%	%	%
2	%	%	%	%	%	%	%	%	%	%	%
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
360	%	%	%	%	%	%	%	%	%	%	%

e. Distribution of Credit Spreads
    - Credit spread (y-axis) by selected time points (x-axis)
    - Charts: one for each selected corporate bond maturity and credit quality
    - Legend: mean, min, max, percentiles
f. Distribution of Default Losses (net of recoveries)
    - Default loss (y-axis) by selected time points (x-axis)
    - Charts: one for each selected corporate bond maturity and credit quality
    - Legend: mean, min, max, percentiles
g. Correlation Tables: (for each selected time point)
    - Table of correlations between selected tenors (change in key rates), selected funds (total returns), selected corp bonds (credit spreads), selected corporate bonds (default losses),
    - Table of correlations between a modeled key rate or total fund return and its volatility
    - Table of correlations between 10Y key rate and 2s10s term spreads
    - Table of correlations between 10Y key rate and 10s30s term spreads
h. Tables on Frequency of Yield Curve Shapes (TBD) and Transitions Between Shapes
    - Frequencies: At selected time points, over successive 10-year periods, and in total
i. Table on speed of reversion to equilibrium/ultimate state
    - Specific metric TBD
j. Table on low interest rate persistency ("low for long")
    - Specific metric TBD

2. Scenario path dependent
    a. Distribution of Cumulative Arithmetic Averages of Key Rates and Total Fund Returns
        - Cumulative arithmetic average (y-axis) by selected time points (x-axis)
        - One chart for each key rate tenor and fund
        - Legend: mean, min, max, selected percentiles
    b. Distribution of Cumulative Geometric Averages of Key Rates and Total Fund Returns
        - Cumulative geometric average (y-axis) by selected time points (x-axis)
        - One chart for each key rate tenor and fund
        - Legend: mean, min, max, selected percentiles
    c. Distribution of Volatilities of Key Rates and Total Fund Returns
        - Volatility *along each scenario path* from time 0 to time t (y-axis) by time points (x-axis)
        - One chart for each key rate tenor and fund
        - Legend: mean, min, max, selected percentiles
    d. Distribution of Cumulative Accumulation Factors of Key Rates and Fund Returns
        - Cumulative accumulation factor (y-axis) by selected time points (x-axis)
        - One chart for each key rate tenor
        - Four charts for each fund
            i. Total return
            ii. Price return
            iii. Dividend return
            iv. Excess return
                - Equity funds: Relative to the short Treasury rate
                - Bond funds: Relative to the Treasuries used to model the underlying bonds
        - Legend: mean, min, max, selected percentiles

e. Cumulative Risk/Return Profiles
   - Mean cum volatility (y-axis) by mean cum geometric average total return (x-axis)
   - Charts: one for each selected time point
   - Legend: selected funds

Exhibit 7.1: Scenario Sets – File Format

For use in companies' existing models, the ESWG suggests publishing scenario sets in two alternative .CSV file formats:

A. GEMS .CSV file format, which is currently exposed, but with the following additional fields:
   1. Interest Rates – The values of the three state variables and their associated random numbers
   2. Equity and Bond Fund Returns – The random deviates for the Wiener process and jumps.

B. AIRG multiple .CSV file format:
   1. Interest Rates – One file with spot (annual effective) rates, one file with coupon (BEY) rates, each with the following 12 columns: Scenario, Time, 0.25y, 0.5y, 1y, 2y, 3y, 5y, 7y, 10y, 20y, 30y. The ESWG feels that these 10 points on the yield curve, appropriately interpolated, are adequate when doing projections for principle-based reserve and capital calculations.
   2. Equity and Bond Fund Returns – One file for each fund modeled by the ESG, with Time across the columns, Scenarios down the rows, and data showing total return only (not split by price and income).

"The ESWG also notes the current AIRG can produce scenario sets with projection lengths up to 100 years to support insurance products with very long durations, e.g., SPIAs and some life insurance products. Therefore, for the files specified in both A and B above, actuaries will need similarly long projection lengths out of the new ESG."