## VM-21: Requirements for Principle-Based Reserves for Variable Annuities

**The following changes would need to be made in Section 4 of the document currently exposed for comment in order to retain consistency with the edits being proposed for the Hedge Modeling Section.**

A. Projection of Accumulated Deficiencies

4. Modeling of Hedges

a. For a company that does not have a CDHS:

i. the company shall not consider the cash flows from any future hedge purchases or any rebalancing of existing hedge assets in its modeling.

ii. Existing hedging instruments that are currently held by the company in support of the contracts falling under the scope of these requirements shall be included in the starting assets. The hedge assets may then be considered in one of two ways:

1. Include the asset cash flows from any contractual payments and maturity values in the projection model, or
2. No hedge positions – in which case the hedge positions held on the valuation date are replaced with cash and/or other general account assets in an amount equal to the aggregate market value of these hedge positions. The cash may then be invested following the company’s investment strategy.

A company may switch from method a) to b) at any time, but may only change from b) to a) with approval of the domiciliary commissioner.

b. For a compamy with a CDHS, the detailed requirements for the modeling of hedges are defined in Section 9. The following paragraphs are an overview summary and do not supersede the detailed requirements.

i. The appropriate costs and benefits of hedging instruments that are currently held by the company in support of the contracts falling under the scope of these requirements shall be included in the projections used in the determination of the stochastic reserve.

ii. The projections shall take into account the appropriate costs and benefits of hedge positions expected to be held in the future through the execution of that strategy. Because models do not always accurately portray the results of hedge programs, the company shall, through back-testing and other means, assess the accuracy of the hedge modeling. The company shall determine a stochastic reserve as the weighted average of two CTE values; first, a CTE70 (best efforts) representing a company’s projection of all of the hedge cash flows including future hedge purchases, and a second CTE70 (adjusted) which shall use only hedge assets held by the company on the valuation date and no future hedge purchases. These are described more fully in Section [9]. The stochastic reserve shall be the weighted average of the two CTE70 values, where the weights reflect the error factor (E) determined following the guidance of Section [9.x.xx.]

iii. The company is responsible for verifying compliance with clearly defined hedging strategy requirements and any other requirements in Section 10 for all hedge instruments included in the projections.

iv. The use of products not falling under the scope of these requirements (e.g., equity-indexed annuities) as a hedge shall not be recognized in the determination of accumulated deficiencies.

c. These requirements govern the determination of contract reserves and do not supersede any statutes, laws or regulations of any state or jurisdiction related to the use of derivative instruments for hedging purposes and should not be used in determining whether a company is permitted to use such instruments in any state or jurisdiction.

### Section 9: Modeling of Hedges under a CDHS

A. Initial Considerations

1. The appropriate costs and benefits of hedging instruments that are currently held by the company in support of the contracts falling under the scope of these requirements (excluding those that involve the offsetting of the risks associated with variable annuity guarantees with other products outside of the scope of these requirements, such as equity-indexed annuities) shall be included in the calculation of the Stochastic reserve, determined in accordance with Section 3.D and Section 4.DAt the option of the actuary, the full portfolio of these hedge instruments may be substituted by cash or other general account assets in an amount equal to their aggregate market value in the starting assets; however, the actuary may not conduct such substitution for individual hedge instruments.
2. If the company is following a clearly defined hedging strategy (“CDHS”), in accordance with an investment policy adopted by the board of directors, or a committee of board members, the company shall take into account the costs and benefits of hedge positions expected to be held by the company in the future along each scenario based on the execution of the hedging strategy and is eligible to reduce the amount of the Stochastic reserve using projections otherwise calculated. The investment policy must clearly articulate the company’s hedging objectives, including the metrics that drive rebalancing/trading. This specification could include maximum tolerable values for investment losses, earnings, volatility, exposure, etc. in either absolute or relative terms over one or more investment horizons vis-à-vis the chance of occurrence. Company management is responsible for developing, documenting, executing and evaluating the investment strategy, including the hedging strategy, used to implement the investment policy.
3. For this purpose, the investment assets refer to all the assets, including derivatives supporting covered products and guarantees. This also is referred to as the investment portfolio. The investment strategy is the set of all asset holdings at all points in time in all scenarios. The hedging portfolio, which also is referred to as the hedging assets, is a subset of the investment assets. The hedging strategy is the hedging asset holdings at all points in time in all scenarios. There is no attempt to distinguish what is the hedging portfolio and what is the investment portfolio in this section. Nor is the distinction between investment strategy and hedging strategy formally made here. Where necessary to give effect to the intent of this section, the requirements applicable to the hedging portfolio or the hedging strategy are to apply to the overall investment portfolio and investment strategy.
4. This particularly applies to restrictions on the reasonableness or acceptability of the models that make up the stochastic cash-flow model used to perform the projections, since these restrictions are inherently restrictions on the joint modeling of the hedging and non-hedging portfolio. To give effect to these requirements, they must apply to the overall investment strategy and investment portfolio.
5. Before either a new or revised hedging strategy can be used to reduce the amount of the Stochastic reserve otherwise calculated, the hedging strategy should be in place (i.e., effectively implemented by the company) for at least three months. The company may meet the time requirement by having evaluated the effective implementation of the hedging strategy for at least three months without actually having executed the trades indicated by the hedging strategy (e.g., mock testing or by having effectively implemented the strategy with similar annuity products for at least three months).
6. These requirements govern the calculation of contract reserves and do not supersede any statutes, laws or regulations of any state or jurisdiction related to the use of derivative instruments for hedging purposes and should not be used in determining whether a company is permitted to use such instruments in any state or jurisdiction.

B. Background

1. The analysis of the impact of the hedging strategy on cash flows is typically performed using either one of two methods as described below. Although a hedging strategy normally would be expected to reduce risk provisions, the nature of the hedging strategy and the costs to implement the strategy may result in an increase in the amount of the Stochastic reserve otherwise calculated.
2. The fundamental characteristic of the first method, referred to as the “explicit method.” is that hedging positionstheir resulting cash flows are included in the stochastic cash-flow model used to determine the scenario reserve, as discussed in Section 2.D, for each scenario.
3. The fundamental characteristic of the second approach, referred to as “implicit method” is that the effectiveness of the current hedging strategyon future cash flows is evaluated, in part or in whole, outside of the stochastic cash-flow model. There are multiple ways this type of modeling can be implemented. In this case, the reduction to the Stochastic reserve otherwise calculated should be commensurate with the degree of effectiveness of the hedging strategy in reducing accumulated deficiencies otherwise calculated.
4. Regardless of the methodology used by the company, the ultimate effect of the current hedging strategy (including currently held hedge positions) on the Stochastic reserve needs to recognize all risks, associated costs, imperfections in the hedges and hedging mismatch tolerances associated with the hedging strategy. The risks include, but are not limited to: basis, gap, price, parameter estimation and variation in assumptions (mortality, persistency, withdrawal, annuitization, etc.). Costs include, but are not limited to: transaction, margin (opportunity costs associated with margin requirements) and administration. In addition, the reduction to the Stochastic reserve attributable to the hedging strategy may need to be limited due to the uncertainty associated with the company’s ability to implement the hedging strategy in a timely and effective manner. The level of operational uncertainty varies indirectly with the amount of time that the new or revised strategy has been in effect or mock tested.
5. No hedging strategy is perfect. A given hedging strategy may eliminate or reduce some but not all risks, transform some risks into others, introduce new risks, or have other imperfections. For example, a delta-only hedging strategy does not adequately hedge the risks measured by the “Greeks” other than delta. Another example is that financial indices underlying typical hedging instruments typically do not perform exactly like the separate account funds, and hence the use of hedging instruments has the potential for introducing basis risk.

C. Calculation of Stochastic reserve (Reported)

1. The company should begin by calculating “CTE70 (best efforts)”—the results obtained when the CTE70 is based on incorporating the CDHS (including both currently held and future hedge positions) into the stochastic cash-flow model on a best efforts basis, including all of the factors and assumptions needed to execute the CDHS (e.g., stochastic implied volatility). The determination of CTE70 (best efforts) may utilize either explicit or implicit modeling techniques.

2. The company shall calculate a CTE70 (adjusted) by recalculating the CTE70 assuming the company has no dynamic hedging strategy, and shall reflect either:

a. Only hedge positions held by the company on the valuation date;; or

b2. No hedge positions – in which case the hedge positions held on the valuation date are replaced with cash and/or other general account assets in an amount equal to the aggregate market value of these hedge positions. The cash may then be invested following the company’s investment strategy.

The determination of CTE70 (adjusted) may utilize either explicit or implicit modeling techniques.

3. To compensate for potential overstatement of the impact of the hedging strategy, the value for the Stochastic reserve is given by:

Stochastic reserve = CTE70 (best efforts) + E

× max[0, CTE70 (adjusted) – CTE70 (best efforts)]

4. The company shall specify a value for *E* (the “error factor”) in the range from 5% to 100% to reflect the company’s view of the potential error resulting from the level of sophistication of the stochastic cash-flow model and its ability to properly reflect the parameters of the hedging strategy (i.e., the “Greeks” being covered by the strategy) as well as the associated costs, risks, and benefits. The greater the ability of the stochastic model to capture all risks and uncertainties, the lower the value of *E*. The value of *E* may be as low as 5% only if the model used to determine the CTE70 (best efforts) effectively reflects all of the parameters used in the hedging strategy. If certain economic risks are not hedged, yet the model does not generate scenarios that sufficiently capture those risks, *E* must be in the higher end of the range reflecting the greater likelihood of error. Likewise, simplistic hedge cash-flow models shall assume a higher likelihood of error.

5. The company shall conduct via a formal back-test, based on an analysis of at least the most recent 12 months, to assess how well the model is able to replicate the hedging strategy in a way that supports determination of the value used for *E*.

6. Such a back-test shall involve one of the following analyses:

a1. For companies that model hedge cash flows directly (“explicit method”), replace the stochastic scenarios used in calculating the CTE70CTE Amount (best efforts) with a single scenario that represents the market path that actually manifested over the selected back-testing period and compare the projected hedge asset gains and losses against the actual hedge asset gains and losses – both realized and unrealized – observed over the same time period. For this calculation, the model assumptions may be replaced with parameters that reflect actual experience during the back-testing period. In order to isolate the comparison between the modeled hedge strategy and actual hedge results for this calculation, the projected liabilities should accurately reflect the actual liabilities throughout the back-testing period; therefore, adjustments that facilitate this accuracy (e.g. reflecting actual experience instead of model assumptions, including new business, etc.) are permissible.

To support the choice of a low value of E, the company should ascertain that the projected hedge asset gains and losses are within close range of 100 percent – e.g., 80 to 125 percent – of the actual hedge asset gains and losses. The company may also support the choice of a low value of E by achieving a high R-squared – e.g., 0.80 or higher – when using a regression analysis technique;

b. For companies that model hedge cash flows implicitly by quantifying the cost and benefit of hedging using the fair value of the hedged item, (“implicit method”, or “cost of reinsurance method”), calculate the delta, rho, and vega coverage ratios in each month over the selected back-testing period in the following manner:

i. Determine the hedge asset gains and losses – both realized and unrealized – incurred over the month attributable to equity, interest rate, and implied volatility movements;

ii. Determine the change in the fair value of the hedged item over the month attributable to equity, interest rate, and implied volatility movements. The hedged item should be defined in a manner that reflects the proportion of risks hedged – for example, if a company elects to hedge 50% of a contract’s market risks, it should quantify the fair value of the hedged item as 50% of the fair value of the contract;

iii. Calculate the delta coverage ratio as the ratio between (ia) and (iib) attributable to equity movements;

iv. Calculate the rho coverage ratio as the ratio between (iaa) and (iibb) attributable to interest rate movements;

v. Calculate the vega coverage ratio as the ratio between (iaa) and (iibb) attributable to implied volatility movements.

vi. To support the company’s choice of a low value of E, the actuary should be able to demonstrate that the delta and rho coverage ratios should are both be within close range of 100 percent – e.g., 80 to 125 percent – consistently across the back-testing period.

vii. In addition, the actuary should be able to demonstrate that the vega coverage ratio should be within close range of 100 percent in order to use the prevailing implied volatility levels as of the valuation date in quantifying the fair value of the hedged item for the purpose of calculating CTE70 (best efforts). Otherwise, the company shall quantify the fair value of the hedged item for the purpose of calculating CTE70 (best efforts) in a manner consistent with the realized volatility of the scenarios captured in the Conditional Tail Expectation. The company shall also disclose in the Required Memorandum both the implied volatility level used to quantify the fair value of the hedged item as well as the methodology undertaken to determine the appropriate level used.

c. Companies that do not model hedge cash flows explicitly, but that also do not use the implicit as outlined in Section 9.C.6.b. above, shall conduct the formal back-test in a manner that allows the company to validate the appropriateness of the selected method for reflecting the cost and benefit of hedging as well as the value used for E.

7. A company that does not have 12 months of experience to date shall set E to a value that reflects the amount of experience available, and the degree and nature of any change to the hedge program. For a material change in strategy, with no history, E should be at least 0.50, but may be lower reflecting the specific circumstances if some experience is available and/or if the change in strategy is more of a refinement than a substantial change in strategy.

**Guidance Note:** The following examples are provided as guidance for determining the E factor when there has been a change to the hedge program:

* The error factor should be temporarily large (e.g. 50%) for substantial changes in hedge methodology (e.g. moving from a fair-value based strategy to a stop-loss strategy) where the company has not been able to provide a meaningful simulation of hedge performance based on the new strategy.
* A temporary moderate increase (e.g. 15-30%) in error factor should be used for substantial modifications to hedge programs or CHDS modeling where meaningful simulation has not been created (e.g. adding second-order hedging such as gamma or rate convexity).
* ‘No increase’ in the error factor may be used for incremental modifications to the hedge strategy (e.g. adding death benefits to a program that previously covered only living benefits, or moving from swaps to Treasury futures).

8. A safe harbor approach is permitted for CDHS reflection for those companies whose modeled hedge assets comprise only linear instruments not sensitive to implied volatility. For companies with option-based hedge strategies, electing this approach would require representing the option-based portion of the strategy as a delta-rho two-Greek hedge program. The normally-modeled option portfolio would be replaced with a set of linear instruments that have the same first-order Greeks as the original option portfolio.

D. Additional Considerations for CTE70 (best efforts)

If the company is following a CDHS, fair value of the portfolio of contracts falling within the scope of these requirements shall be computed, and compared to the CTE (best efforts) and to the CTE (adjusted) values. If the CTE (best efforts) is below both the fair value and the CTE (adjusted) value, the company should be prepared to explain why that result is reasonable.

For the purposes of this analysis, the stochastic reserves and fair value calculations shall be done without requiring the scenario reserve for any given scenario to be equal to or in excess of the cash surrender value in aggregate on scope of the valuation date for the group of contracts modeled in the projection.

E. Specific Considerations and Requirements

* 1. As part of the process of choosing a methodology and assumptions for estimating the future effectiveness of the current hedging strategy (including currently held hedge positions) for purposes of reducing the Stochastic reserve, the company should review actual historical hedging effectiveness. The company shall evaluate the appropriateness of the assumptions on future trading, transaction costs, other elements of the model, the strategy, the mix of business and other items that are likely to result in materially adverse results. This includes an analysis of model assumptions that, when combined with the reliance on the hedging strategy, are likely to result in adverse results relative to those modeled. The parameters and assumptions shall be adjusted (based on testing contingent on the strategy used and other assumptions) to levels that fully reflect the risk based on historical ranges and foreseeable future ranges of the assumptions and parameters. If this is not possible by parameter adjustment, the model shall be modified to reflect them at either anticipated experience or adverse estimates of the parameters.
  2. A discontinuous hedging strategy is a hedging strategy where the relationships between the sensitivities to equity markets and interest rates (commonly referred to as the Greeks) associated with the guaranteed contract-holder options embedded in the variable annuities and other in-scope products and these same sensitivities associated with the hedging assets are subject to material discontinuities. This includes, but is not limited to, a hedging strategy where material hedging assets will be obtained when the variable annuity account balances reach a predetermined level in relationship to the guarantees. Any hedging strategy, including a delta hedging strategy, can be a discontinuous hedging strategy if implementation of the strategy permits material discontinuities between the sensitivities to equity markets and interest rates associated with the guaranteed contract-holder options embedded in the variable annuities and other in-scope products and these same sensitivities associated with the hedging assets. There may be scenarios that are particularly costly to discontinuous hedging strategies, especially where those result in large discontinuous changes in sensitivities (Greeks) associated with the hedging assets. Where discontinuous hedging strategies contribute materially to a reduction in the Stochastic reserve, the company must evaluate the interaction of future trigger definitions and the discontinuous hedging strategy, in addition to the items mentioned in the previous paragraph. This includes an analysis of model assumptions that, when combined with the reliance on the discontinuous hedging strategy, may result in adverse results relative to those modeled.
  3. A strategy that has a strong dependence on acquiring hedging assets at specific times that depend on specific values of an index or other market indicators may not be implemented as precisely as planned.
  4. The combination of elements of the stochastic cash-flow model—including the initial actual market asset prices, prices for trading at future dates, transaction costs and other assumptions—should be analyzed by the company as to whether the stochastic cash-flow model permits hedging strategies that make money in some scenarios without losing a reasonable amount in some other scenarios. This includes, but is not limited to:
     1. Hedging strategies with no initial investment that never lose money in any scenario and in some scenarios make money.
     2. Hedging strategies that, with a given amount of initial money, never make less than accumulation at the one-period risk free rates in any scenario but make more than this in one or more scenarios.
  5. If the stochastic cash-flow model allows for such situations, the company should be satisfied that the results do not materially rely directly or indirectly on the use of such strategies. In addition, the company should disclose the situations and provide supporting documentation as to why the company believes the situations are not material for determining the Stochastic reserve. If the results do materially rely directly or indirectly on the use of such strategies, the strategies may not be used to reduce the Stochastic reserve otherwise calculated.
  6. In addition to the above, the method used to determine prices of financial instruments for trading in scenarios should be compared to actual initial market prices. If there are substantial discrepancies, the company should disclose the substantial discrepancies and provide supporting documentation as to why the model-based prices are appropriate for determining the Stochastic reserve. In addition to comparisons to initial market prices, there should be testing of the pricing models that are used to determine subsequent prices when scenarios involve trading financial instruments. This testing should consider historical relationships. For example, if a method is used where recent volatility in the scenario is one of the determinants of prices for trading in that scenario, then that model should approximate actual historic prices in similar circumstances in history.