AMERICAN ACADEMY *of* ACTUARIES

Report of the American Academy of Actuaries'
Annuity Reserves Work Group

Presented to the National Association of Insurance Commissioners'
Life and Health Actuarial Task Force

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Executive Summary

- The pertinent section of the ARWG's portion of the Valuation Manual—a work in progress—is provided. Consistency with the work product of the Academy's Life Reserve Work Group (LRWG) is a goal, but the two documents are evolving simultaneously.
- The Scenario Reserve contains a unique but potentially useful definition in the ARWG section of the Valuation Manual that expands the concept of "Greatest Present Value of Accumulated Deficiency" (GPVAD), clarifying the distinction between the end (a self-financing Scenario Reserve) and the means of approximating the end (GPVAD or others).
- The scope of risks reflected in reserves is intended to reflect developments in other work groups, within the Academy's Consistency Work Group, and developments within our own work group. Discussions within the ARWG have been presented and debated in other venues.
- The ARWG has finalized its position and supports the approach of using a zero Working Reserve.
- Remaining issues and areas for development are enumerated.

Draft Valuation Manual

The ARWG has created a draft contribution to the Valuation Manual covering proposed reserve requirements for the business under scope. It is being provided to the Life and Health Actuarial Task Force (LHATF) for informational purposes and not for exposure purposes or other distributions beyond LHATF. This is because of the fact that it is a "work in progress" and several parts of the draft are either missing, since we've not had the time to develop them, or else are somewhat tentative. Nonetheless, the ARWG would appreciate receiving any feedback or guidance on this draft that LHATF is able to provide.

In creating this draft Valuation Manual contribution, we started with an early draft of the corresponding Valuation Manual contribution from the LRWG. Our efforts have been ongoing over the last six months. As a result, since the LRWG Valuation Manual contribution has changed and evolved, we have tried to compare the ARWG and LRWG drafts in an attempt to keep them consistent. However, we have been unable to identify and resolve all the differences between the ARWG and LRWG Valuation Manual drafts but intend to do as soon as possible and work with the LRWG and Consistency Work Group to ensure that the LRWG and ARWG versions are as consistent as possible.

Discussion of Key Aspects of Draft Valuation Manual

Definition of Scenario Reserve

As was reported to LHATF at the Summer 2007 NAIC Meeting, the ARWG does not believe that the Scenario Reserves, from which the CTE value is derived, should be defined using the Greatest Present Value of Accumulated Deficiencies (GPVAD) method, with present values computed using projected yields on the starting assets and their reinvestment (along with investment of positive cash flows). Rather, we feel that this method should be allowed as an acceptable approximation to the Scenario Reserve, at least under certain circumstances. This is primarily because using the GPVAD as the definition for the Scenario Reserve would make that definition be subject to the selection of Starting Assets – both in terms of magnitude and in composition. This is because the effectiveness of the GPVAD as definition of the Scenario Reserve would then depend on the assumption that the Company has additional assets which will produce investment yields equal to those projected to be earned on the original starting assets. For example, if Starting Assets yield 6% on a projected basis, and the future Accumulated Deficiencies are then discounted at 6%, then the resulting reserve will only be accurate to the extent the company has additional assets with a projected yield of 6%. To the extent the available assets yield less than 6%, the resulting reserve is understated and to the extent they yield more than 6%, the reserve is overstated. The ARWG believes, however, that the GPVAD can serve adequately as an approximation to the Scenario Reserve as long as certain conditions are satisfied.

The ARWG draft includes the following definition for the Scenario Reserve which avoids reliance on projected asset yields:

> "For each Scenario, the Scenario Reserve is defined as the book value (for general account reserves) or market or book value (for separate account reserves and depending on the accounting basis for the separate account) of a collection of assets comprised of the sum of the starting assets for each Valuation Segment, together with any additional assets needed to ensure that none of the Accumulated Deficiencies for the Scenario are positive."

This definition adds to the Starting Assets whatever additional assets are needed, *within that scenario*, to allow the total assets in the future to never become negative. This avoids using discount rates generated from the Starting Assets to predict the amount of additional assets which are needed and avoids the potential pitfalls of the GPVAD method as *definition* for the Scenario Reserve.

Scope of Risks Reflected in Reserves

Throughout the development of the recommendations included in the ARWG portion of the Valuation Manual, we have relied heavily on the work of those groups that have pioneered the PBA effort on behalf of the Academy – the C-3 Phase II Work Group, the Variable Annuity Reserve Work Group (VARWG), and the LRWG. In addition, we have attempted to coordinate our efforts with the Academy's Annuity Capital Work Group (ACWG) and the Life Capital Work Group (LCWG). Nonetheless, we have taken a "clean sheet of paper" approach to our review of these previous efforts since non-variable annuity products present some very different issues from those for variable annuities and life insurance products.

This review has caused us to present several issues to the Consistency Work Group and sparked very healthy debate among actuaries working on the PBA initiatives. One of these issues forced a more in-depth analysis of the GPVAD technology discussed above. Another major area of discussion and debate has surrounded the questions of "What should be the purposes of reserves and Risk Based Capital within the current statutory framework?" and "What risks should be reflected in reserves and therefore modeled in the projections used to compute the Scenario Reserves and resulting Stochastic Reserve?" The Consistency Work Group has reported on its progress on these issues to LHATF in past and current reports, so there is no reason to elaborate on them here.

However, in summary, the ARWG portion of the Valuation Manual reflects the following important subset of the risks either included or excluded from the scope of risks to be modeled for reserve purposes:

- Risk of **Deterioration in Market Value of Assets** has only been reflected to the extent that assets must be liquidated in the future in order to provide funds for payment of contractholder benefits.

- The risk that the company may have **Insufficient Assets to Provide for Increases in Future Statutory Reserves** has not been reflected and is assumed to be borne by capital. This, together with the risks not assumed due to the previous bullet relating to market value of assets led the ARWG to reverse its previous position regarding the Working Reserve and conclude that having a Working Reserve of zero is appropriate for business under scope. As a result, this term was eliminated from previous drafts and the definition of Accumulated Deficiency is now stated strictly in terms of negative assets (if any).

- **Credit Risks, Mortgage Loan Redemption / Rollover Rates, Performance of Equities, Hedging Risks and Currency Risks** have all been assumed to be reflected in the modeling.

- **Persistency, Mortality, Premium Payment, Annuitization and Interest Guarantee Risks** have all been assumed to be reflected in reserve projections.

- **Disintermediation Risk** is assumed to be included in projections.

- **Liquidity Risk** has not been assumed to be reflected in projections.

- **Reinsurer Default or Impairment Risk** is to be included only if a reinsurer is already impaired or in default as of the valuation date.

- **Risk of Catastrophic Events** is assumed to not be reflected in projections.

- **Risks associated with Fluctuating Amounts of New Business** are assumed not to be reflected in reserve projections.

Working Reserve

As pointed out in the discussion on risks assumed to be modeled or not modeled in the projections supporting the calculation of the Stochastic Reserve, the ARWG has reversed its previous position and now supports the same position taken by the LRWG regarding the use of a zero Working Reserve.

Remaining Important Issues & Future Developments

The following list comprises the major items yet to complete for the ARWG to be able to furnish LHATF with a complete portion of the Valuation Manual relating to non-variable annuities:

- **Deterministic Reserve** – We are aware of the desirability for a Deterministic Reserve and plan to work towards the development of one. However, due to the wide-ranging risks present in the products within scope, we are not certain it will be possible to develop a meaningful formulaic reserve that will work across this wide spectrum of products.

- **Stochastic Modeling Exclusion / Simplified Requirements** – Again, we are aware of the desire for a simplified method of reserve calculation for "low risk" non-variable annuity products. Our concern is that the number of such low risk annuity products is very small inasmuch as products having cash surrender values have at least some disintermediation risk and almost all non-variable annuity products have at least some interest rate risk. This has led us to investigate an approach taken by the Canadian Institute of Actuaries (CIA) on which we may be able to build upon in the development of a principles-based approach to a Stochastic Modeling Exclusion.

  Note that the ARWG introduced a concept during 2006 called the Proprietary Scenario Sets and Weights that does not create a Stochastic Modeling Exclusion or set of Simplified Requirements, but does create an ability for companies to simplify the valuation process by running fewer scenarios at year-end and applying weights to the results in a manner similar to the calculations required under C-3 Phase I RBC. However, these scenarios and weights would have to be developed by each company, presumably in the "off season", and reviewed for adequacy on a periodic basis. We have not yet completed the requirements for this approach and would appreciate feedback regarding the desirability of this approach.

- **Review of Scope** – The ARWG has previously reported the assumed scope of the requirements we are developing for recommendation. The list of 23 product types identified as being within scope is included in the draft ARWG portion of the Valuation Manual as a footnote. We intend to review the requirements we have thus far developed in light of these 23 product types to ascertain the appropriateness of their application and will suggest modifications to the scope, if any, to LHATF in a future report.

- **Reconciliation of Margins in Aggregate vs. Individual Assumptions** (including Dynamic Assumptions) – This is the subject of analysis by the Consistency Work Group and the ARWG is participating in this discussion.

- **Provision for Model Understatement** – This is a concept that, for the ARWG, potentially addresses two separate needs. First, there may be, of necessity, inadequacies in the modeling or projections that may need to be addressed in an adjustment factor. Secondly, the ARWG feels that the implementation of these new requirements will be a significant burden on insurers. Additionally, "Rome wasn't built in a day" and the process of building and perfecting models will continue for many years following introduction of these new requirements. Many of the perfections that will likely be implemented a few years after introduction of the new requirements will come about because of increases in computer capabilities or in actuarial modeling software. As a result, the ARWG would like to develop and recommend to LHATF a procedure that actuaries may follow under which the very large modeling job may be broken into pieces on an approximate basis and thus result in a more manageable undertaking at the outset of these requirements' effectiveness.

  An example of this second type of model adjustment was the inclusion in Appendix VI of the Academy report that was adopted as part of the C-3 Phase II requirements for options for reflecting interest rate risk (integrated model, separate model for interest rate risk, or use of the C-3 Phase I factors). This allowed insurers to start off by using a more simplified approach to the reflection of interest rate risk (factors or separate model) and then move to the more complicated integrated model as computing power and software allowed.

- **Definition of Anticipated Experience Assumptions** – We have begun work on a definition of anticipated experience assumptions that would give regard to the mean rather than the median assumption. The ARWG believes the distinction might be important for risk factors where the distribution of actual risk factors may be skewed (rather than symmetrical).

- **Effect of IMR on Stochastic Reserve** – The LRWG has already started discussions of this topic and the ARWG intends to participate in these discussions at the Consistency Work Group level.

- **Tax Review** – The ARWG has tried to follow the lead of the VARWG and LRWG in recognizing the need for consistency with the tax code, but a formal review of our recommendations by tax experts has not yet been undertaken.

Analysis Subgroup Report

The ARWG's Analysis Subgroup (ARWG AS) was established to provide modeling support to the ARWG. In order to test the Principles-Based Reserve methodology created by the ARWG, the Analysis Subgroup has adopted an approach that utilizes five separate actuarial modeling systems. The systems currently in use are AXIS, MG-ALFA, MoSes, Prophet, and TAS.

The CTE calculations supplied by the ARWG AS do not reflect the resolution of many outstanding Principles-Based Approach concerns raised by the ARWG. As these concerns are resolved the models will be updated. All of these results are estimates intended to reflect the progress of the ARWG AS and not the final results of a PBA for non-variable annuities.

In order to establish a baseline result, each system team was required to program pre-generated assumptions, product features, and scenarios for an SPDA product with no unusual features, as well as a portfolio of assets backing the SPDA liabilities. The method required that each system team submit their results for direct comparison with the other systems. The purpose of this baseline comparison was to quantify the system differences (including default assumptions and methodologies) so the more complex products could be programmed by paired modeling system teams. The dual system approach would provide built-in peer review and validation of results. Additionally, the baseline SPDA product model comparison would provide a general direction and magnitude for known system differences.

When the ARWG AS discovered that the system default settings were contributing what was, in the judgment of the ARWG as a whole, a difference worth further disclosure, we summarized the various causes as part of our documentation process. Below is a summary of the key system defaults that drive differences in the ARWG AS Principles-Based Reserve Models.

The differences in Principles-Based Reserves results for each system are due to differences in projected cash flows. The simplified SPDA product has a crediting rate strategy determined via a portfolio yield method less a spread. In the analysis of the Greatest Present Value of Accumulated Deficiencies, the ARWG AS determined that the main differences are caused by the determination of the yield rate for the portfolio. While differences at the beginning of the projection period were small, these differences compound over the 20 years of projection and result in a significant difference in the remaining policies in force.

Differences result from:

- Decrement Timing: Decrements occur at the beginning, in the middle and at the end of each monthly period. The timing of decrements is an actuarial assumption that is partially tied to the nature of the product features involved.

- Fractional Decrements: Modeling projections are performed monthly. The primary methods used by the modeling software to estimate fractional decrements are the exponential and uniform distribution methods. Differences created via monthly projections stem from these differences.

- Portfolio Yield Rates: Results differences also stem from differences in methods employed to determine portfolio yield rates. These differences can cause up to 200 bps differences in the crediting rates. Compound effects include the excess lapse formulae and resulting cash flows and asset purchases and sales.

- Discount Rates: The discount rate is equal to the portfolio yield including capital gains and losses. Differences in portfolio yields are compounded in discount rates. Substitution of a one-year Treasury yield plus two hundred basis points when assets fall below one percent of their initial levels assist in establishing reasonable results when assets fall below these levels or even turn negative.

These variances, separately and compounding on each other, can cause significant differences in the single scenario calculations. The main cause of this is the portfolio yields. In the case where there is an extreme mismatch between the durations of assets and liabilities, this can cause a single scenario Greatest Present Value of Accumulated Deficiency (GPVAD) to differ between systems as much as 3.60% of account value. In this same mismatched example, the meaningful

Scenario Reserves (above the 70th percentile) generate an average difference in reserves of over 1.0% of the initial account value.

These differences were important discoveries in the modeling analysis done by the ARWG. While they were not a goal of the process, they were a key step incorporating peer review. These discoveries make clear the importance of ownership, transparency, and consistency in modeling usage for financial reporting.

The full report of the Analysis Subgroup is attached.

Annuity Reserve Work Group Analysis Subgroup (ARWG AS) Appendices Accompanying Report to LHATF

Appendix 1 - Analysis Subgroup Modeling Assumptions & Preliminary SPDA Results

The models are intended to represent an in-force block of annuity policies, although the ARWG AS will create and test new business models as well. The models and assumptions are intended for development and analysis of principles-based reserves within the work of the ARWG, and are not appropriate or intended in any way to be used by companies in reserve modeling work or as a safe harbor. Nonetheless, the assumptions are the result of discussions within the subgroup, and are intended to represent a reasonable set of assumptions to illustrate principles-based reserves. The ARWG would appreciate receiving from LHATF any feedback on this approach, the assumptions, or direction.

A. Summary of Key Product Features and Assumptions for Asset-Liability SPDA Model

A.1 Product description

This product is a non-qualified SPDA sold through a career agency. The company is a mid-sized life insurance company with a mix of business where the largest block of business is the annuity block of business.

A.2 Projection assumptions

A.2.1 Scenarios Tested

The scenarios used to project all insurance cash flows and future asset values were the C-3 Phase I scenarios as of December 31, 2005.

A.2.2 Projection period

All models project results monthly. The results are projected 20 years into the future from the valuation date.

A.3 Asset assumptions

A.3.1 Existing asset portfolio

The models use a basic bond portfolio with A or BBB quality non-callable bonds at various durations (to be filled in with actual portfolio bonds when decided upon). The portfolio is a simple buy and hold portfolio. As we change to different products we will shift the weights of the portfolio to the different bonds to mimic a reasonable cover of risk.

One asset portfolio was developed with a small mismatch between the asset duration and the liability duration:

Bond	Par (000)	Num	Spread Over Risk Free	Coupon Rate (Yield)	Default Rates	Investment Expense
1-year	100	1	1.00%	4.70%	0.20%	0.10%
3-year	250	1	1.00%	5.16%	0.20%	0.10%
5-year	300	1	1.00%	5.49%	0.20%	0.10%
7-year	250	1	1.00%	5.64%	0.20%	0.10%
10-year	100	1	1.00%	5.83%	0.20%	0.10%
Total	1,000		1.00%	5.40%	0.20%	0.10%

Another asset portfolio was developed with a zero mismatch between the asset duration and the liability duration:

Bond	Par (000)	Num	Spread Over Risk Free	Coupon Rate (Yield)	Default Rates	Investment Expense
1-year	100	1	1.00%	4.70%	0.20%	0.10%
3-year	400	1	1.00%	5.16%	0.20%	0.10%
5-year	400	1	1.00%	5.49%	0.20%	0.10%
7-year	100	1	1.00%	5.64%	0.20%	0.10%
Total	1,000		1.00%	5.29%	0.20%	0.10%

A third asset portfolio with a significant mismatch between the asset duration and the liability duration was also tested.

The Coupon rates are stated as bond equivalent yield rates (BEY). The spread over risk free is a bond equivalent yield rate (BEY).

Determination of Current Bond Spreads:

Bond spreads for the yield rates are determined by calculating the current market value at the first month treasury rate and comparing that to the predetermined market rate (provided in the portfolio data to be modeled). The adjustment necessary to the current rate, to make the market values equal is the spread to be held constant over the life of the bond. Note the reinvestment bond has a constant spread predetermined. We have calculated these initial implied spreads for a flat rate scenario (Scenario 11, C-3 P I, 12/31/2005 scenario).

Cusip	Maturity Date	Coupon Mode	Book Value	Par Value	Market Value	Coupon	Statutory Yield	Accrued Interest 12/31/2005	Market Value with Accrued Interest 12/31/2005
1 year	12/31/2006	Semi-Annual	100,000.00	100,000.00	98,139.08	4.70%	4.70%	-	98,139.08
3 year	11/30/2008	Semi-Annual	250,000.00	250,000.00	248,563.02	5.16%	5.16%	1,068.82	249,631.84
5 year	10/31/2010	Semi-Annual	300,000.00	300,000.00	301,149.97	5.49%	5.49%	2,755.52	303,905.49
7 year	9/30/2012	Semi-Annual	250,000.00	250,000.00	251,916.29	5.64%	5.64%	3,552.02	255,468.31
10 year	8/31/2015	Semi-Annual	100,000.00	100,000.00	101,203.92	5.83%	5.83%	1,966.73	103,170.65
20 year	7/31/2025	Semi-Annual	-	-	-	6.32%	6.32%	-	-
Total			1,000,000.00	1,000,000.00	1,000,972.28	5.40%	5.40%		

Calculated Discount Spreads over Treasury Spot Rates

Cash Flows	Market Value	1 year	3 year	5 year	7 year	10 year	20 year
Pre Default	Without Accrued Interest	237	117	126	138	151	174
Pre Default	With Accrued Interest	237	101	103	112	124	150
Post Default	Without Accrued Interest	215	96	105	117	130	153
Post Default	With Accrued Interest	215	80	82	91	102	128

A.3.2 Reinvestment and disinvestment

Any asset cash flow will be reinvested in a BBB, 5-year non-callable bond, with an 80 bp credit spread and 20 bp default rates.

Any deficiency in cash flow will be covered by selling off a % of existing assets. This % will be determined by the amount necessary to cover benefits and expense. Assets will be sold proportionally.

Loans are ignored. They may appear in later portfolios but in keeping with the basic set up required, the initial portfolios will not have the option to borrow.

The asset balance is allowed to reduce to 0. When this occurs, the model will borrow the amount of any negative cash flows at an interest rate equal to the 1-year Treasury rate + 200 bps. The cost of this will be reflected in Net Investment Income.

A.3.3 Default rates

Defaults will occur at the end of each month. The default rate is an annual decrement and is modified to a monthly rate in the same manner that liability decrements are converted. The annual default rate is 20 bp.

A.3.4 Investment expenses

The investment expense is 10 bp of the book value of assets.

A.4 Product features

A.4.1Liability Portfolio

Issue Age	Sex	Issue Year	Issue Month	Number In Force	Account Value	Cash Value
53	Female	2004	12	10	209,000	193,012
35	Male	2001	12	10	383,756	364,184
65	Female	1998	12	2	203,622	198,430
65	Male	1998	12	2	203,622	198,430
			Totals:	24	1,000,000	954,055

A.4.2 Initial, renewal and guaranteed credited rates (including guarantee periods)

The initial credited rate is 4.5% guaranteed for 1 year. The renewal credited rate is guaranteed for 1 year and is guaranteed to be no lower than 2%.

A.4.3 Allowable free partial withdrawals

10% of account value can be taken as a partial withdrawal each year free of charge.

A.4.4 Surrender charge schedule

The surrender charge schedule is summarized in the following table.

Duration	Surrender Charge	Duration	Surrender Charge
1	7.00%	5	3.00%
2	6.00%	6	2.00%
3	5.00%	7	1.00%
4	4.00%	8+	0.00%

A.4.5 Policy administration fee

The fee is a $30 annual charge which is prorated for full surrenders. The fee is being subtracted as 1/12 per month in the projections.

A.5 Liability assumptions

A.5.1 Taxes

US Federal Income Taxes are not included in the projection, which is consistent with the other principles-based reserve approaches being developed with reserves being calculated on a pre-tax basis.

A.5.2 Expenses

Expenses are subtracted on a monthly basis. The timing with respect to where within each month varies by software platform. The maintenance expense is a $30 annual expense, modeled as 1/12th per month, starting at the valuation date. The overhead expense is an additional $20 annual expense, modeled as 1/12th per month, starting at the valuation date. 2% annual inflation is assumed.

A.5.3 Mortality

The mortality assumption is 100% of the Annuity 2000 Mortality Table (basic). Fractional decrements follow either exponential or uniform distributions depending upon software platform, and occur either at the beginning or at the end of each monthly period, depending upon the software platform. There is no improvement in mortality for the SPDA models, which we believe is conservative because of minimum guarantees and other product features.

A.5.4 Surrenders

Full surrenders: Rates of full surrenders vary by policy duration. Full surrenders are indicative of risk associated with policyholder behavior not tied to market or interest rate performance. Risk associated with policyholder behavior that is tied to market or interest rate performance is detailed in the dynamic surrenders section below. At the end of the surrender charge period, there is an additional shock lapse of 25% in the following policy year. The additional shock lapses are skewed non-uniformly with the majority in the beginning of the year. The shock lapse rate is not subject to the maximum lapses.

Dynamic surrenders: A dynamic surrender assumption is included to reflect policyholder behavior that is motivated by having credited interest rates that may be different than what competitors are offering.

The **Competitor Rate** is assumed to be the 5-year Treasury rate + 50 bps. This is modeling the net competitor crediting rate that is credited to their policyholders, net of all pricing and asset related deductions. This was driven primarily by historical analysis of crediting rates with 3, 5, and 7 year Treasuries, considering the duration of the surrender charge (SC) for the base SPDA product.

The excess lapse formula offered here is an additive formula designed to allow for changes in policyholder lapse behavior when the relationship between the company's SPDA crediting rate and a competitor's SPDA rate changes. The value of Excess Lapse Rate will be added to the base lapse assumption (the Full Surrender Rates). The risk factors associated with excess lapses are market rate or interest rate changes. This dynamic relationship is modeled for three stages of relationships between competing companies.

Stage 1: The company's crediting rates are greater than competition's crediting rates.

Stage 2: The company's crediting rates are less than the competitor's rate, but are also within a tolerance threshold that does not produce any additional strain on the policyholder lapse behavior.

Stage 3: The company's crediting rates are less than the competitor's crediting rate, and this difference is greater than the tolerance threshold. This difference drives excess policyholder lapse behavior in Stage 3.

Proposed Formula:

CompetitorRate = Competition's Crediting Rate [new money rate]
CreditedRate = Company's Crediting Rate
Threshold = Threshold for which policyholders are unaffected by differential in crediting rates.
Multiplier% = The multiplier is an indication of the % of competition's crediting rates impact on the company's excess lapses. We are using 10%.
SCMultiple = 10, to convert surrender charge to a % of protection for excess lapses.
SCRatio = This is the level of net SC protection. This is equal to 1 – *Cash Value / Account Value.*
Exponent = 1.5

Stage 1 and 2 Formula:

$$ExcessLapses = -Multiplier\% \times CompetitorRate \times (CreditingRate - 0 - CompetitorRate)^{Exponent} \times (1 - 0 \times SCRatio)/100$$

Stage 3Formula:

$$ExcessLapses = Multiplier\% \times CompetitorRate \times (CompetitorRate - CreditingRate - Threshold)^{Exponent} \times (1 - SCMultiple \times SCRatio)/100$$

Minimum Aggregate Lapse Rates: During the surrender charge period, minimum aggregate lapse rates are 2%. After the surrender charge period, minimum aggregate lapse rates are 4%. The minimum aggregate lapse rate will be validated (or tested) at the monthly level. The monthly value of this floor will be determined consistent with the fractional decrement methodology. Both the base and the excess lapses are subject to this minimum.

Maximum Aggregate Lapse Rates: During the surrender charge period, the maximum aggregate lapse rate is 30%. After the surrender charge period, the maximum aggregate lapse rate is 50%. Both of these caps will be validated at the monthly level. The fractional value will be determined consistent with the fractional decrement assumption.
Note that in the Excess Lapses formula for Stage 1 there is a zero value where the Threshold should be and where the SC Multiple should be in Stages 2 or 3. The reason for this is to reflect that the Threshold is actually only impacting the dynamic relationship when the competition's rate is in excess of the company's SPDA crediting rate. Additionally, the SC Multiple of zero removes the dampening of excessive lapses. In both of these instances, the higher crediting rate should afford the issuing company the appropriate protection, and no additional protection is afforded by surrender charges or thresholds. Shock lapse rates after the surrender charge period are excluded from the lapse cap.

A.5.5 Annuitizations

Annuitizations are currently being considered as part of full surrenders. This was done intentionally to keep the initial basic SPDA model simple. We recognize that this may not be an appropriate assumption for other products.

A.5.6 Withdrawals

Partial withdrawals are a monthly decrement based on attained age, as a percent of available free amount at the beginning of the policy year. The partial withdrawal rate is a percentage of account value: 1.5% (66-70), 2.5% (71-75), 4% (76+).

A.5.5 Fractional decrement rates and timing

As discussed for mortality and lapses, fractional decrements follow either exponential or uniform distributions and vary by software platform.

Method	MG-ALFA	AXIS	MoSes	Prophet	TAS
Uniform	X	X			
Exponential			X	X	X

The uniform distribution method requires that the amount withdrawn be taken continuously from a single value at the BOM in order to have the full effective rate act upon the cell. A constant force of interest does not require this same adjustment. The result of this is that the uniform method amount is near (and above) the decrement value while the constant force is much closer.

Decrements may occur at different timing during a projection period. Below is a list of systems and the timing of decrements during the projection period where D = deaths and the L = lapses.

Timing	MG-ALFA	AXIS	MoSes	Prophet	TAS
Beginning					
Middle	D	D	D	D	D
End	L	L	L	L	L

A.5.6 Interest crediting

Credited rate is 150 bp less than the asset earned rate, subject to guaranteed minimums. This rate changes annually. Additionally, this value will never fall below the product minimum guaranteed rate. The credited rate when admitted assets are less than or equal to zero is the minimum guaranteed rate.

A.5.7 Policy loans

These models ignore loans. Loans may appear in later models.

A.5.9 Working reserve

The beginning working reserves for the SPDA product will be equal to the cash surrender value.

B. Numerical results for SPDA model – 1 year mismatch and no mismatch between duration of assets and liabilities

B.1 Introduction to results

Deficiency Calculation: Working Reserve less the Admitted Assets.

Admitted Assets: Admitted Assets are the book value of the portfolio plus accrued interest less loan balances taken when admitted assets are less than zero.

Working Reserve: The Working Reserve is the Cash Surrender Value. **Note:** The Working Reserve current definition is 0 but the results for the ARWG Analysis Subgroup does not yet reflect this recent change in the definition.

Discount Rate: The discount rate is equal to the portfolio yield including capital gains and losses. We will allow negative yield rates to be included in the calculations. When the book value of admitted assets is less than 1% of the initial book value of assets, the loan rate is used to discount the accumulated deficiency (1-year Treasury + 200 bps). The accumulated deficiencies are discounted by a different rate each month.

Greatest Present Value Of Accumulated Deficiency	The accumulated deficiency is the Deficiency Calculation at each point in time. Each projected Deficiency Calculation is discounted back to the valuation date using the Discount rate.
Scenario Reserve:	This is the greatest present value of the accumulated deficiency for a specific scenario plus the admitted assets at the start of the projection.
Caveats:	The CTE calculations supplied by the ARWG AS do not include the resolution of many outstanding Principles-Based Approach concerns raised by the ARWG. As these concerns are resolved the models will be updated. All of these results are estimates intended to reflect the progress of the ARWG AS and not the final results of a PBA for non-variable annuities.

B.2 Stochastic summary for mismatch and 0 mismatch portfolios – CTEs and percentiles

The following results include CTE and percentiles for two separate portfolios. One portfolio has a slight duration mismatch with the liabilities. This mismatch is approximately 1 year. The second portfolio has approximately a 0 duration mismatch with the liabilities. At the time of preparation, only three systems had submitted the results for both portfolios. While 5 systems are in use, only three are shown here for consistency

1-year Duration Mismatch between Assets and Liabilities

		System 1			System 2			System 3		
%tile	CSV	Scenario	Scenario Reserve	Excess over CSV	Scenario	Scenario Reserve	Excess over CSV	Scenario	Scenario Reserve	Excess over CSV
10%	954,661	795	962,778	8,117	188	962,582	7,921	230	962,483	7,821
20%	954,661	413	962,795	8,134	685	962,595	7,934	730	962,500	7,838
30%	954,661	580	962,806	8,145	362	962,603	7,942	673	962,511	7,850
40%	954,661	960	962,820	8,159	689	962,612	7,950	444	962,522	7,861
50%	954,661	530	962,834	8,173	607	962,622	7,961	684	962,535	7,873
60%	954,661	295	962,851	8,190	521	962,632	7,971	438	962,547	7,886
70%	954,661	76	962,889	8,228	941	962,646	7,985	441	962,562	7,900
80%	954,661	718	966,146	11,484	178	963,699	9,038	374	962,585	7,924
90%	954,661	67	973,391	18,730	616	970,482	15,821	55	966,578	11,916
100%	954,661	872	1,013,178	58,516	175	1,009,482	54,821	175	1,006,249	51,588

Statistics on Scenario Reserves with 1-year Duration Mismatch

Measure	Sys 1	Sys 2	Sys 3
mean:	965,611	964,679	963,879
median:	962,833	962,622	962,535
st devn:	6,780	5,700	4,587
cte(50):	968,425	966,761	965,258
cte(70):	972,139	969,513	967,065
cte(90):	983,017	979,201	975,043

0 Duration Mismatch between Assets and Liabilities

		System 1			System 2			System 3		
%tile	CSV	Scenario	Scenario Reserve	Excess over CSV	Scenario	Scenario Reserve	Excess over CSV	Scenario	Scenario Reserve	Excess over CSV
10%	954,661	733	962,840	8,179	661	962,581	7,920	267	962,511	7,850
20%	954,661	174	962,856	8,194	730	962,592	7,931	236	962,531	7,869
30%	954,661	375	962,865	8,204	75	962,599	7,938	208	962,542	7,881
40%	954,661	212	962,876	8,214	711	962,606	7,945	62	962,553	7,891
50%	954,661	30	962,888	8,227	861	962,616	7,954	539	962,566	7,905
60%	954,661	489	962,899	8,238	972	962,623	7,962	251	962,579	7,917
70%	954,661	666	962,916	8,255	265	962,632	7,971	135	962,592	7,930
80%	954,661	618	963,373	8,711	950	962,649	7,988	319	962,608	7,947
90%	954,661	751	967,109	12,448	751	965,152	10,491	888	962,673	8,012
100%	954,661	914	990,678	36,017	914	987,395	32,734	175	984,358	29,697

Statistics on Scenario Reserves with 0 Duration Mismatch

Measure	Sys 1	Sys 2	Sys 3
mean:	964,054	963,450	963,040
Median:	962,888	962,615	962,566
st devn:	3,342	2,769	2,048
cte(50):	965,251	964,308	963,550
cte(70):	966,819	965,431	964,197
cte(90):	972,651	970,341	967,366

C. Conclusions drawn from results

Both a 0 duration mismatch and a 1-year duration mismatched were valued as part of the Analysis Subgroup approach. This was done to identify differences in the modeling system default calculations that are contributing to differences in the results. These default assumptions are often part of a system's initial set-up. The 0 mismatch results in lower reserves since the model does not generate excessive capital losses in the worst case scenarios. The 1-year mismatch does contribute more to capital losses in the worst case scenarios. This in turn lowers the portfolio yield, and results in an increased reserve.

Appendix 2 – Modeling System Default Settings Differences

A. Purpose of appendix

This document is a summary of key actuarial modeling system default assumptions and/or calculations that contribute to differences in the outcome of Principles-Based Reserve Models for non-variable annuities. Modeling system default settings can create differences in the results from each system. These default settings include assumptions regarding the timing of decrements, fractional decrements, and portfolio yield rates. As each monthly projection determines slightly different crediting rates, there is a cyclical effect that occurs by feeding this rate into the dynamic lapse assumption. Additionally, slightly different insurance cash flows change the yields that include capital gains and losses which change the discount rates.

B. Analysis subgroup methodology

In order to test the Principles-Based Reserve methodology created by the ARWG, the Analysis Subgroup has adopted a methodology that utilizes five separate actuarial modeling systems. The systems currently in use are AXIS, MG-ALFA, MoSes, Prophet, and TAS.

In order to establish a baseline result, each system is required to program pre-generated assumptions, product features, and scenarios for an SPDA product with no unusual features, as well as a portfolio of assets backing the SPDA liabilities. The method required that each system team submit their results for direct comparison with the other systems. The purpose of this baseline comparison was to quantify the system differences (including default assumptions and methodologies) so the more complex products could be programmed by paired modeling system teams. The dual system approach would provide built-in peer review and validation of results. Additionally, the baseline SPDA product model comparison would provide a general direction and magnitude for known system differences.

When the ARWG AS discovered that the system default settings were contributing what was, in the judgment of the ARWG as a whole, a difference worth further disclosure, we summarized the various causes as part of our documentation process. Below is a summary of the key system defaults that drive differences in the ARWG AS Principle-Based Reserve Models.

All of the decrements used in the examples provided are summarized in Exhibit I.

C. System Differences

The differences in Principles-Based Reserves results for each system are due to differences in projected cash flows. Our simplified SPDA product has a crediting rate strategy determined via a portfolio yield method less a spread. In our analysis of the Greatest Present Value of Accumulated Deficiencies, we determined that the main differences are caused by the determination of the yield rate for the portfolio.

However, the cycle begins with small decrement differences summarized later in this note. In general, these decrement-related differences are small but over the 20 year projection period, they can result in a significant difference in the remaining number of policies in force. The resulting differences in the insurance cash flows create differences in the remaining asset portfolios. Each modeling system estimates the portfolio yield using a different and yet acceptable methodology. These different portfolio yield rates are, in turn, used to calculate the dynamic lapse assumptions, future crediting rates and valuation discount rates. At this point, the differences become magnified as the cycle continues to impact future projections. Each system difference assumption is detailed below.

C. 1 Decrement Timing

Decrements occur at the beginning, in the middle and at the end of each monthly period. The timing of decrements is an actuarial assumption that is partially tied to the nature of the product features involved. Exhibit II demonstrates how the timing of decrements can impact the number of policies at the end of the year.

These examples calculate the policies in force using both mortality and lapses for 10 lives aged 68. The timing for death decrements in relation to lapse decrements is considered in the following instance:

CASE 1: Half of the deaths occur at mid-month, immediately followed by all lapses, and with the remaining deaths occurring at the end of the month.
CASE 2: All deaths occur at the end of the period after lapses.
CASE 3: All deaths occur at the end of the period before lapses
CASE 4: All deaths occur simultaneously with lapses.

Any model that increases lapses will pay more cash surrender value benefits and any model that increases deaths will pay more account value death benefits. Since these decrements ultimately impact the cash flows, the small differences determine different remaining assets in the portfolios between systems. The determination of a portfolio yield is impacted by the remaining assets. These small differences do contribute to outstanding difference between the system's insurance cash flows as projections continue for 20 or 30 years into the future. Exhibit II demonstrates how these timing difference impact policies in force over one year.

C. 2 Fractional Decrements

All of the modeling projections in the ARWG AS are performed monthly. The primary methods used by the modeling software to estimate fractional decrements are the exponential and uniform distribution methods. There are some differences created via monthly projections by these methods.

As with the timing differences, these differences also impact the remaining portfolio assets. The remaining assets determine the yield rate for the portfolio which in turn impacts the dynamic lapse assumption and future insurance cash flows. The ending 20 year projected policies in force from our models differ by more than 10% when comparing the uniform and exponential fractional decrement assumptions.

Exhibit III demonstrates the impact of the fractional decrement assumption over a one year period. The larger the annual decrement, the larger the fractional differences are over time.

C. 3 Portfolio Yield Rates

The ARWG AS baseline SPDA product uses a portfolio rate crediting interest rate strategy. For products using a portfolio method crediting rate, there are several different methods employed by the modeling software to calculate a portfolio yield. General descriptions of the portfolio rate determination methods are included below:

1. Take the face amount-weighted coupon rates divided by the remaining book value. This is illustrated in Exhibit IV, Calculation 1.
2. Determine the portfolio rate using cash flows assuming the standard approximation i = (2*I) / (A + B – I). This is illustrated in Exhibit IV, Calculation 2.
3. Determine the portfolio rate using cash flows and exact timing of the cash flow during the period. This is illustrated in Exhibit IV, Calculation 3.
4. Adjustments for defaults may or may not be included in these calculations.

These differences can cause up to 200 bps differences in the crediting rates which in turn feed the excess lapse formula. This causes cash flows and asset sales to be significantly different for each of the modeling systems (increasing existing differences for fractional decrements and timing of decrements).

The competitor's rate is being calculated using a simple approximation of the 5-year Treasury rate + 50 bps. The method does not require the calculation of a portfolio yield rate. This does not cause any additional volatility.

C.4 Discount Rate

The discount rate is equal to the portfolio yield including capital gains and losses. We will allow negative yield rates to be included in the calculations. The asset return could be zero or less than zero when assets run out. This causes the discounting to be zero. This can cause large differences in the present value of accumulated deficiencies.

In order to generate reasonable results, we have substituted the 1-year Treasury yield + 200 bps when assets fall below 1% of their initial levels. The use of the 1-year Treasury rate is not a suggestion but rather a functional solution to be able to check GPVAD calculations.

C.5 Conclusion

Together these variances can cause significant differences in the single scenario calculations. The main cause of this is the portfolio yields. In the case where there is an extreme mismatch between the durations of assets and liabilities, we have observed that this can cause the Greatest Present Value of Accumulated Deficiency for a single scenario to differ between systems by as much as 3.60% of account value. In this same mismatched example, the meaningful Scenario Reserves (above the 70^{th} percentile) generate an average difference in reserves of over 1.0% of the initial account value.

These differences were important discoveries in the modeling analysis done by the ARWG. While they were not a goal of the process, they were a key step in building in peer review. These discoveries make clear the importance of ownership, transparency and consistency in modeling usage for financial reporting.

Exhibit I

ARWG Analysis Subgroup – Decrement Assumptions

Age		Annual Mortality	Annual Lapse	Monthly Mortality		Monthly Lapses	
				Exponential	Uniform	Exponential	Uniform
68	0	0.00929	0.05	0.00077731	0.00077400	0.00426532	0.00416667
	1			0.00077731	0.00077400	0.00426532	0.00416667
	2			0.00077731	0.00077400	0.00426532	0.00416667
	3			0.00077731	0.00077400	0.00426532	0.00416667
	4			0.00077731	0.00077400	0.00426532	0.00416667
	5			0.00077731	0.00077400	0.00426532	0.00416667
	6			0.00077731	0.00077400	0.00426532	0.00416667
	7			0.00077731	0.00077400	0.00426532	0.00416667
	8			0.00077731	0.00077400	0.00426532	0.00416667
	9			0.00077731	0.00077400	0.00426532	0.00416667
	10			0.00077731	0.00077400	0.00426532	0.00416667
	11			0.00077731	0.00077400	0.00426532	0.00416667
69	0	0.01016	0.05	0.00085089	0.00084692	0.00426532	0.00416667
	1			0.00085089	0.00084692	0.00426532	0.00416667
	2			0.00085089	0.00084692	0.00426532	0.00416667
	3			0.00085089	0.00084692	0.00426532	0.00416667
	4			0.00085089	0.00084692	0.00426532	0.00416667
	5			0.00085089	0.00084692	0.00426532	0.00416667
	6			0.00085089	0.00084692	0.00426532	0.00416667
	7			0.00085089	0.00084692	0.00426532	0.00416667
	8			0.00085089	0.00084692	0.00426532	0.00416667
	9			0.00085089	0.00084692	0.00426532	0.00416667
	10			0.00085089	0.00084692	0.00426532	0.00416667
	11			0.00085089	0.00084692	0.00426532	0.00416667

Exhibit II

ARWG Analysis Subgroup – Decrement Timing

Time	CASE 1 Deaths Occur Mid Period and End of Period					CASE 2 Deaths Occur End of Period After Lapses				
Month	BOP PIF	Mid Pt Deaths	Laspes	End Pt Deaths	EOP PIF	BOP PIF	Mid Pt Deaths	Laspes	End Pt Deaths	EOP PIF
0	10.0000	0.0039	0.0426	0.0039	9.9496	10.0000	0.0000	0.0427	0.0077	9.9496
1	9.9496	0.0039	0.0424	0.0038	9.8995	9.9496	0.0000	0.0424	0.0077	9.8995
2	9.8995	0.0038	0.0422	0.0038	9.8496	9.8995	0.0000	0.0422	0.0077	9.8496
3	9.8496	0.0038	0.0420	0.0038	9.8000	9.8496	0.0000	0.0420	0.0076	9.7999
4	9.8000	0.0038	0.0418	0.0038	9.7506	9.7999	0.0000	0.0418	0.0076	9.7506
5	9.7506	0.0038	0.0416	0.0038	9.7014	9.7506	0.0000	0.0416	0.0075	9.7014
6	9.7014	0.0038	0.0414	0.0038	9.6525	9.7014	0.0000	0.0414	0.0075	9.6525
7	9.6525	0.0038	0.0412	0.0037	9.6039	9.6525	0.0000	0.0412	0.0075	9.6039
8	9.6039	0.0037	0.0409	0.0037	9.5555	9.6039	0.0000	0.0410	0.0074	9.5555
9	9.5555	0.0037	0.0407	0.0037	9.5074	9.5555	0.0000	0.0408	0.0074	9.5073
10	9.5074	0.0037	0.0405	0.0037	9.4594	9.5073	0.0000	0.0406	0.0074	9.4594
11	9.4594	0.0037	0.0403	0.0037	9.4118	9.4594	0.0000	0.0403	0.0073	9.4118
12	9.4118					9.4118				
			Lapses		Deaths			Lapses		Deaths
	Totals:		0.49769		0.09052			0.49789		0.09035

CASE 3 Deaths Occur End of Period Before Lapses					CASE 4 Deaths and Lapses Simultaneous				
BOP PIF	Mid Pt Deaths	Laspes	End Pt Deaths	EOP PIF	BOP PIF	Mid Pt Deaths	Laspes	End Pt Deaths	EOP PIF
10.0000	0.0000	0.0426	0.0078	9.9496	10.0000	0.0000	0.0427	0.0078	9.9496
9.9496	0.0000	0.0424	0.0077	9.8995	9.9496	0.0000	0.0424	0.0077	9.8994
9.8995	0.0000	0.0422	0.0077	9.8496	9.8994	0.0000	0.0422	0.0077	9.8495
9.8496	0.0000	0.0420	0.0077	9.7999	9.8495	0.0000	0.0420	0.0077	9.7998
9.7999	0.0000	0.0418	0.0076	9.7506	9.7998	0.0000	0.0418	0.0076	9.7504
9.7506	0.0000	0.0416	0.0076	9.7014	9.7504	0.0000	0.0416	0.0076	9.7012
9.7014	0.0000	0.0413	0.0075	9.6525	9.7012	0.0000	0.0414	0.0075	9.6523
9.6525	0.0000	0.0411	0.0075	9.6039	9.6523	0.0000	0.0412	0.0075	9.6036
9.6039	0.0000	0.0409	0.0075	9.5555	9.6036	0.0000	0.0410	0.0075	9.5552
9.5555	0.0000	0.0407	0.0074	9.5073	9.5552	0.0000	0.0408	0.0074	9.5070
9.5073	0.0000	0.0405	0.0074	9.4594	9.5070	0.0000	0.0406	0.0074	9.4591
9.4594	0.0000	0.0403	0.0074	9.4118	9.4591	0.0000	0.0403	0.0074	9.4114
9.4118					9.4114				
		Lapses		Deaths			Lapses		Deaths
		0.49750		0.09074			0.49788		0.09073

Exhibit III

ARWG Analysis Subgroup – Fractional Decrement

Time	EOP (Simultaneous) Exponential					EOP (Simultaneous) Uniform					Diff
	BOP	Mid Pt		End Pt	EOP	BOP	Mid Pt		End Pt	EOP	EOP
Month	PIF	Deaths	Lapses	Deaths	PIF	PIF	Deaths	Lapses	Deaths	PIF	PIF
0	10.00000	0.00000	0.04265	0.00777	9.94957	10.00000	0.00000	0.04167	0.00774	9.95059	0.010%
1	9.94957	0.00000	0.04244	0.00773	9.89940	9.95059	0.00000	0.04146	0.00770	9.90143	0.020%
2	9.89940	0.00000	0.04222	0.00769	9.84948	9.90143	0.00000	0.04126	0.00766	9.85251	0.031%
3	9.84948	0.00000	0.04201	0.00766	9.79982	9.85251	0.00000	0.04105	0.00763	9.80383	0.041%
4	9.79982	0.00000	0.04180	0.00762	9.75040	9.80383	0.00000	0.04085	0.00759	9.75540	0.051%
5	9.75040	0.00000	0.04159	0.00758	9.70123	9.75540	0.00000	0.04065	0.00755	9.70720	0.062%
6	9.70123	0.00000	0.04138	0.00754	9.65231	9.70720	0.00000	0.04045	0.00751	9.65924	0.072%
7	9.65231	0.00000	0.04117	0.00750	9.60364	9.65924	0.00000	0.04025	0.00748	9.61151	0.082%
8	9.60364	0.00000	0.04096	0.00747	9.55521	9.61151	0.00000	0.04005	0.00744	9.56403	0.092%
9	9.55521	0.00000	0.04076	0.00743	9.50703	9.56403	0.00000	0.03985	0.00740	9.51677	0.103%
10	9.50703	0.00000	0.04055	0.00739	9.45909	9.51677	0.00000	0.03965	0.00737	9.46976	0.113%
11	9.45909	0.00000	0.04035	0.00735	9.41139	9.46976	0.00000	0.03946	0.00733	9.42297	0.123%
12	9.41139					9.42297					

	Lapses	Deaths	Total		Lapses	Deaths	Total	Avg Diff
Total Decrements:	0.49788	0.09073	0.58861		0.48663	0.09040	0.57703	0.067%
				Diff:	-2.26%	-0.37%	-1.97%	

	Monthly	Annual		Monthly	Annual
	10.00000	10.00000		10.00000	10.00000
	0.49788	0.50000		0.48663	0.50000
	0.09073	0.09288		0.09040	0.09288
	9.41139	9.40712		9.42297	9.40712
Diff:		-0.045%	Diff:		-0.168%

Exhibit IV

ARWG Analysis Subgroup – Portfolio Yield Rates

A Fund at the beginning of the period
B Fund at the end of the period
C Cash Flows (negative or positive)
I Interest Earned

	BOP Book Value	Accrued Interest	Coupon	Insurance Cash Flow	Asset Sale	Capital Gain/Loss	EOP Book Value	Coupon Rate
	420,000	12,600	12,600		(6,269)	(600)	413,731	6.00%
	250,000	1,719	-		(3,731)	(200)	247,987	5.50%
	670,000	14,319	12,600	(21,800)	(10,000)	(800)	661,719	

B = A + C + I

A	670,000
B	661,719
C	(800)
I	3,246

	w/o Cap G/L	with Cap G/L
Calculation 1		
i = Face amount weighted Coupon/ Remaining Face Amounts	5.89%	5.89%
Calculation 2		
i = 2 * I/ (A + B - I)	6.02%	4.51%
Calculation 3		
I = i*A + Σ1t = s [C(t) * ((1+i)^(1-t) - 1)]	4.894%	3.41%