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# Report on Principles-Based Reserves for Variable Universal Life with Guaranteed Minimum Death Benefits 

# Presented by the American Academy of Actuaries' Variable Universal Life Subgroup of the Life Reserves Work Group 

## Presented to the National Association of Insurance Commissioners' Life and Health Actuarial Task Force (LHATF)

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## Executive Summary

This report studies a Variable Universal Life (VUL) policy with a specified premium secondary guarantee for male issue ages 45 and 75 . Each cell is modeled separately for both the Deterministic ${ }^{1}$ and Stochastic Reserve in order to better isolate the drivers of the reserve levels. In practice, the Stochastic Reserve will be calculated in the aggregate. The product is designed to be profitable under anticipated experience assumptions and to be competitive in the marketplace. The secondary guarantee is aggressive for VUL and more consistent with a UL contract in order to stress test the principles-based reserve methodology. Appendix 1 shows product features and pricing results. Appendix 2 shows the product's competitive position.

The approach taken in the report is to look at the range of reserves under different assumptions. Both Deterministic and Stochastic Reserves are shown for three different sets of Prudent Estimate Assumptions reflecting different margin levels at various policy durations. The objective of this comparison is not to recommend an appropriate level for the margins in the Prudent Estimate Assumptions, but rather to show how reserves vary depending on the margins.

Illustrative historical appreciation rates are used to roll the account value forward from issue to each valuation date (various policy durations over the policy lifetime). The different rates help illustrate the impact of different starting conditions on the level of reserves. For the Deterministic Reserve, gross historical rates of $9 \%$ and $5 \%$ are illustrated. For the Stochastic Reserve, which is calculated only at duration 10 , gross historical rates of $9 \%, 5 \%$, and $0.45 \%$ are illustrated. (All gross rates quoted in this executive summary are before the deduction of investment management fees and mortality and expense (M\&E) charges.)

For the Deterministic Reserve, gross future appreciation rates of $7 \%$ and $5 \%$ are illustrated as the prescribed assumption (prescribed levels that will be specified in section VM-20 of the Valuation Manual have not yet been set). These rates are used to project the account value forward from the valuation date. For the Stochastic Reserve, gross future appreciation rates are stochastically generated. The stochastic scenarios used are briefly described on page 3 of the report.

[^0]Deterministic Reserve results are shown in Tables 1-4. Stochastic Reserve results for duration 10 are shown in Tables 5-6.

The Deterministic Reserve is often governed by the cash surrender value floor, mainly for age 45 and the earlier durations. Deterministic Reserves at levels well above CSV develop in some cases in later durations, specifically for age 75 and the $5 \%$ future separate account return assumption.

For the issue age 45 Stochastic Reserve, the average equity return for the 350 scenarios that were averaged to obtain the 65 CTE reserve was between $5 \%$ and $6 \%$ over time periods 10 to 30 years from the valuation date. Consistent with this, the Stochastic Reserve tended to be close to but lower than the $5 \%$ gross future appreciation rate Deterministic Reserve.

For the issue age 75 Stochastic Reserve, the average equity return for the 350 scenarios that were averaged to obtain the 65 CTE reserve was in a wider range over various time periods than for issue age 45. The Stochastic Reserve tended to be higher than either the $5 \%$ or $7 \%$ Deterministic Reserve because lower rates tended to occur in the early years after the valuation date and there was insufficient time for the separate account assets to recover before claims were paid.

Principles-based reserves are compared to current formulaic reserves. In general, the principlesbased reserves are much lower than 1980 CSO based formulaic reserves. Using 2001 CSO would cut formulaic reserves by about one third, with principles-based generally still remaining lower than formulaic reserves.

# Principles-Based Reserves for Variable Universal Life with Guaranteed Minimum Death Benefits 

## Background

This report illustrates principles-based reserves for two example Variable Universal Life (VUL) policies with guaranteed minimum death benefits, and compares the results to current reserves under CRVM and Actuarial Guideline 37. The actual results for any particular insurer or actual block of business will likely be different than these illustrated results for a variety of reasons, such as the level of guarantees or Prudent Estimate Assumptions. These results do not reflect aggregation with other business.

The policies used for illustration are variable universal life with guaranteed minimum death benefit designs, and the assumed premium pattern is level. Two issue ages are studied, age 45 and age 75, both for select male insureds. No model office result was produced. Details of the product design and pricing are contained in Appendix 1.

The death benefit guarantee modeled is somewhat more aggressive than what is seen in the VUL market place today, but less aggressive than guarantees that exist on fixed universal life products. This was done to ensure that a general account reserve for the guaranteed death benefits would be developed in the calculations. Appendix 2 shows the premium relative to the marketplace.

The policies are priced to be profitable under the anticipated experience assumptions in use as specified in Appendix 3. The valuation assumptions are also shown in Appendix 3.

Both Deterministic and Stochastic Reserves are illustrated for three sets of Prudent Estimate Assumptions reflecting different margin levels as described in the Methodology section below. These reserves were also studied under different starting conditions as represented by different historical appreciation rates from policy issue to the valuation date.

## Methodology

- The Gross Premium Valuation (GPV) method is used for the Deterministic Reserve. The Greatest Present Value of Accumulated Deficiencies (GPVAD) method is used for the Stochastic Reserve, where the Accumulated Deficiency at any projection year is measured as the negative of the projected statement value of general account and separate account assets. These definitions are consistent with recent Requirements for PrinciplesBased Reserves for Life Products exposure drafts and the September 2007 proposed exposure draft.
- The path of discount rates used in the present values equals the path of net asset earned rates generated by the projected general account assets (resulting from net positive transfers from the separate account that exceed benefits and expenses paid from the general account). Positive net cash flows in the general account are invested in 10 year bonds (100 bp gross spread over treasury, 25 bp annual default cost, and 5 bp annual investment expense, for a net spread of 70 bp over treasury). Negative cash flows are covered by borrowing rates specified in Appendix 3.
- The estimated Reported Reserve, and therefore the starting assets, for all reserve calculations in this report, was assumed to equal the separate account account value for the policy being valued. Therefore, general account assets at the projection start date were always set to zero. Thus, the impact of different potential general account starting asset portfolios, which in some cases would be made up of positive assets and in other cases would represent an initial borrowed balance, was not investigated. This was an intentional simplification introduced in order to focus the report on the equity and insurance risks of the variable life product.
- Hedges are not included in the modeling.
- Revenue sharing is included in the projection of cash flows.
- There are no policyholder initiated transfers between the separate account and the general account funds.
- Premium payments and charges are assumed to cease at age 100. Policy charges are deducted to the extent the account value can support them. Once the account value equals zero and if the no lapse guarantee is effective, there are no further policy lapses from that point forward for the life of the contract, regardless of (for simplicity in the projections) whether the account value becomes positive again.
- The September 2007 exposure draft provides that the future separate account gross appreciation rates for the Deterministic Reserve will be prescribed; however, the exact prescribed values have not yet been determined. Further, although the exposure draft
currently ties the prescribed separate account rates to a prescribed pattern of treasury interest rates and spreads over Treasuries, the LRWG is continuing to consider other possibilities, such as applying a CTE measure or percentile to the distribution of cumulative separate account returns from the stochastic generator. It is anticipated that the empirical results obtained in this report for the two different illustrative rates of $7 \%$ level and $5 \%$ level will provide the LRWG and LHATF with some insight as to the ramifications of different prescribed assumptions.
- The deterministic results are presented in Tables 1-4 for issue ages 45 and 75, historical appreciation rates of $9 \%$ and $5 \%$ (before investment management fees and M\&E charges), and future appreciation rates of $7 \%$ and $5 \%$ (before investment management fees and M\&E charges). Historical appreciation rates carry the policy from issue to the indicated valuation date. Future appreciation rates are used going forward from that point. In addition, a Deterministic Reserve using Anticipated Experience has been computed and is shown in the last two columns of each table. The " $9 \%$ Rate" column is used to determine the "PBR Level of Margins" shown at the bottom of the tables.
- The three margin levels reflected in the three illustrative sets of prudent estimate assumptions are as follows:

| Component | Margin 1 | Margin 2 | Margin 3 |
| :--- | :--- | :--- | :--- |
| Interest Rate | $1 \%$ lower | $1 \%$ lower | $1 \%$ lower |
| Mortality | $3.5 / \mathrm{ex}$ | $2001 /$ ex | $2001 / \mathrm{ex}$ |
| Lapse | $1 \%$ higher | $1 \%$ higher | $1 \%$ lower |
| Expense | $5 \%$ higher | $5 \%$ higher | $5 \%$ higher |

For mortality, 3.5/ex means an extra mortality margin equal to 3.5 per thousand (.0035) divided by the expectation of life. 2001/ex means an extra mortality margin equal to the margin implicit in the 2001 CSO table.

These margins are not necessarily meant to represent Prudent Estimate Assumptions per se, but are meant to show sensitivity of the reserves to different margin levels.

- Stochastic reserves measured at the end of duration 10 are illustrated in Tables 5 and 6 for the same three levels of margins as used in Tables 1-4. The corresponding Deterministic Reserves and current formulaic reserves are also shown. Issue ages 45 and

75 are each illustrated on a standalone basis in order to facilitate a more detailed understanding of the drivers of the results. The actual Stochastic Reserves specified by the current VM-20 exposure draft would be calculated on an aggregate basis. The results can be viewed as those for a single policy issued 10 years prior at either age 45 or 75 , or for a block of either 45 or 75 year olds where there were no lapses over the 10 -year period. The results for each issue age are illustrated for historical separate account appreciation rates of $.45 \%$ (a net return rate of $0 \%$ after revenue sharing and expenses but before M\&E), $5 \%$ and $9 \%$. The account value is rolled forward from issue to duration 10 using the indicated separate account appreciation rate.

- We used 1,000 stochastic treasury rate and large-cap equity return scenarios based on March 31, 2006 market data developed using Global CAP:Link ${ }^{\mathrm{TM}}$. We believe these scenarios meet both the current C3P1 and C3P2 stochastic scenario calibration criteria requirements. We understand that the treasury rate scenario requirements for meeting C3P1 are in the process of being updated, but we do not believe changes in C3P1 scenario requirements would have a significant impact on these results because we are modeling a VUL product with the account value $100 \%$ invested in equities.
- The Formulaic Total Reserve shown in Tables 1-6 includes CRVM as well as AG37 reserves. Reserves were capped at the net single premium.


## Tables of Results

- The following Tables 1-4 show the Deterministic Reserves described previously. The tables also show margin levels in the reserves. The reserves with margin are labeled (1) (3), and the associated margins are described at the bottom of each column and in the Methodology section above.
- The top sections of Tables 1-4 show for the whole policy the policy values, formulaic reserves, and the PBR Deterministic Reserves generated by the various assumption sets before application of the cash surrender value floor (except the last column which is the anticipated experience basis with the floor applied).
- The middle sections of Tables 1-4 show the split of the whole policy Deterministic Reserve, after application of the cash surrender value floor, into a separate account reserve and a general account reserve. The formulaic reserve in excess of the variable account value is also shown. The separate account reserve shown is the variable account
value. ${ }^{2}$ The general account reserve is the calculated reserve less the variable account value. Sometimes the general account reserve is negative and sometimes it is positive.
- Finally, the bottom sections of Tables 1-4 show the margin in the reserves for each assumption set by taking the difference between the total Deterministic Reserve without floor and the total anticipated experience reserve without floor.
- Tables 5-6 summarize the Stochastic Reserves described previously, along with the comparable Deterministic and formulaic reserves. The set of margins used and the future SA rate assumption are identified for each reported item as applicable.

[^1]Table 1

| Deterministic Terminal Reserves by Policy Year <br> Best Class, \$1M face <br> Gross Premium of $\$ 10,000$ is paid through age 100 |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Policy Death <br> Duratior Benefit |  | Variable <br> Fund Value | Variable <br> Surr Value | Formulaic Total Res | Deterministic Reserves before CSV floor |  |  |  |  |  | 9\% Rate <br> Ant Exp <br> PBReserve | Ant Exp <br> PBR <br> w/CSV floor |
|  |  | Future |  |  | SA Rate of 7 |  | Future S | A Rate of 5\% |  |  |  |
|  |  | (1) |  |  | (2) | (3) | (1) | (2) | (3) |  |  |
| 0 | 1,000,000 |  | - | - | - | $(10,743)$ | $(6,209)$ | $(8,485)$ | $(5,876)$ | (715) | 5,437 | $(12,959)$ | - |
| 1 | 1,000,000 |  | 7,250 | - | 19,734 | $(14,045)$ | $(9,404)$ | $(11,510)$ | $(8,944)$ | $(3,704)$ | 2,590 | $(16,335)$ | - |
| 2 | 1,000,000 | 15,000 | 4,000 | 37,733 | $(6,139)$ | $(1,237)$ | $(3,425)$ | (560) | 5,019 | 11,744 | $(8,666)$ | 4,000 |
| 3 | 1,000,000 | 22,750 | 11,750 | 56,623 | 1,926 | 7,098 | 4,827 | 8,020 | 13,947 | 21,126 | (835) | 11,750 |
| 4 | 1,000,000 | 31,500 | 20,500 | 76,526 | 11,025 | 16,452 | 14,050 | 17,577 | 23,851 | 31,298 | 8,013 | 20,500 |
| 5 | 1,000,000 | 40,500 | 29,500 | 97,481 | 20,500 | 26,185 | 23,641 | 27,524 | 34,152 | 41,098 | 17,240 | 29,500 |
| 10 | 1,000,000 | 97,000 | 91,500 | 219,467 | 80,472 | 87,339 | 83,712 | 89,059 | 97,472 | 105,009 | 75,906 | 91,500 |
| 20 | 1,000,000 | 316,500 | 316,500 | 542,998 | 290,196 | 297,255 | 291,652 | 294,076 | 303,108 | 299,850 | 284,207 | 316,500 |
| 30 | 1,000,000 | 765,250 | 765,250 | 765,255 | 727,295 | 731,309 | 725,490 | 731,384 | 735,089 | 730,276 | 721,794 | 765,250 |
| 40 | 1,766,000 | 1,766,000 | 1,766,000 | 1,766,035 | 1,718,276 | 1,724,040 | 1,720,004 | 1,721,242 | 1,726,510 | 1,722,911 | 1,714,487 | 1,766,000 |
| 50 | 3,846,000 | 3,846,000 | 3,846,000 | 3,845,976 | 3,804,758 | 3,805,823 | 3,804,919 | 3,804,948 | 3,806,054 | 3,805,130 | 3,804,636 | 3,846,000 |
| 60 | 8,410,500 | 8,410,500 | 8,410,500 | 8,410,500 | 8,430,359 | 8,428,897 | 8,429,699 | 8,429,565 | 8,428,205 | 8,428,952 | 8,431,248 | 8,431,248 |


| Policy | Sep Account | Formulaic General Acc | PBR General Account Reserve w/CSV Floor |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Duration | Reserve | Reserve | (1) | (2) | (3) | (1) | (2) | (3) |
| 0 | - | - | - | - | - | - | - | 5,437 |
| 1 | 7,250 | 12,484 | $(7,250)$ | $(7,250)$ | $(7,250)$ | $(7,250)$ | $(7,250)$ | $(4,660)$ |
| 2 | 15,000 | 22,733 | $(11,000)$ | $(11,000)$ | $(11,000)$ | $(11,000)$ | $(9,981)$ | $(3,256)$ |
| 3 | 22,750 | 33,873 | $(11,000)$ | $(11,000)$ | $(11,000)$ | $(11,000)$ | $(8,803)$ | $(1,624)$ |
| 4 | 31,500 | 45,026 | $(11,000)$ | $(11,000)$ | $(11,000)$ | $(11,000)$ | $(7,649)$ | (202) |
| 5 | 40,500 | 56,981 | $(11,000)$ | $(11,000)$ | $(11,000)$ | $(11,000)$ | $(6,348)$ | 598 |
| 10 | 97,000 | 122,467 | $(5,500)$ | $(5,500)$ | $(5,500)$ | $(5,500)$ | 472 | 8,009 |
| 20 | 316,500 | 226,498 | - | - | - | - | - | - |
| 30 | 765,250 | 5 | - | - | - | - | - | - |
| 40 | 1,766,000 | 35 | - | - | - | - | - | - |
| 50 | 3,846,000 | (24) | - | - | - | - | - | - |
| 60* | 8,410,500 | - | 19,859 | 18,397 | 19,199 | 19,065 | 17,705 | 18,452 |


| Reserve Margins = Reserve with margin less Anticipated Experience reserve <br> Policy |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Duration | Formulaic | (1) | (2) | (3) | (1) | (2) | (3) |  |
| 0 | 12,959 | 2,216 | 6,750 | 4,474 | 7,083 | 12,244 | 18,396 |  |
| 1 | 36,069 | 2,290 | 6,931 | 4,825 | 7,391 | 12,631 | 18,925 |  |
| 2 | 46,399 | 2,527 | 7,429 | 5,241 | 8,106 | 13,685 | 20,410 |  |
| 3 | 57,458 | 2,761 | 7,933 | 5,662 | 8,855 | 14,782 | 21,961 |  |
| 4 | 68,513 | 3,012 | 8,439 | 6,037 | 9,564 | 15,838 | 23,285 |  |
| 5 | 80,241 | 3,260 | 8,945 | 6,401 | 10,284 | 16,912 | 23,858 |  |
| 10 | 143,561 | 4,566 | 11,433 | 7,806 | 13,153 | 21,566 | 29,103 |  |
| 20 | 258,791 | 5,989 | 13,048 | 7,445 | 9,869 | 18,901 | 15,643 |  |
| 30 | 43,461 | 5,501 | 9,515 | 3,696 | 9,590 | 13,295 | 8,482 |  |
| 40 | 51,548 | 3,789 | 9,553 | 5,517 | 6,755 | 12,023 | 8,424 |  |
| 50 | 41,340 | 122 | 1,187 | 283 | 312 | 1,418 | 494 |  |
| 60 | $(20,748)$ | (889) | $(2,351)$ | $(1,549)$ | $(1,683)$ | $(3,043)$ | $(2,296)$ |  |
| Interest Rate Margin |  | 1\% lower | 1\% lower | 1\% lower | 1\% lower | 1\% lower | 1\% lower | none |
| Mortality Margin |  | 3.5 /ex | 2001/ex | 2001/ex | 3.5 /ex | 2001/ex | 2001/ex | none |
| Lapse Margin |  | 1\% higher | 1\% higher | 1\% lower | 1\% higher | 1\% higher | 1\% lower | none |
| Expense Margin |  | 5\% | 5\% | 5\% | 5\% | 5\% | 5\% | none |

[^2]Table 2

| Deterministic Terminal Reserves by Policy Year 45 Issue Age <br> Best Class, $\$ 1 \mathrm{M}$ face $5 \%$ Separate Account Historical Ap preciation $R$ <br> Gross Premium of $\$ 10,000$ is paid through age 100  |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Policy Death Duratior Benefit |  | Variable <br> Fund Value | Variable <br> Surr Value | Formulaic <br> Total Res | Deterministic Reserves before CSV floor |  |  |  |  | (3) | 9\% Rate <br> Ant Exp <br> PBReserve | Ant Exp PBR w/CSV floor |
|  |  | Future SA Rate of 7\% |  |  | Future SA Rate of 5\% |  |  |  |  |
|  |  | (1) |  |  | (2) | (3) | (1) | (2) |  |  |  |
| 0 | 1,000,000 |  | - | - | - | $(10,743)$ | $(6,209)$ | $(8,485)$ | $(5,876)$ | (715) | 5,437 | $(12,959)$ |  |
| 1 | 1,000,000 |  | 7,000 | - | 19,734 | $(14,269)$ | $(9,623)$ | $(11,715)$ | $(9,147)$ | $(3,904)$ | 2,436 | $(16,552)$ | - |
| 2 | 1,000,000 | 14,000 | 3,000 | 37,366 | $(7,039)$ | $(2,113)$ | $(4,247)$ | $(1,365)$ | 4,222 | 11,140 | $(9,539)$ | 3,000 |
| 3 | 1,000,000 | 21,000 | 10,000 | 55,628 | 346 | 5,562 | 3,385 | 6,622 | 12,564 | 20,088 | $(2,367)$ | 10,000 |
| 4 | 1,000,000 | 28,250 | 17,250 | 74,671 | 8,083 | 13,595 | 11,364 | 14,997 | 21,304 | 29,342 | 5,155 | 17,250 |
| 5 | 1,000,000 | 35,750 | 24,750 | 94,504 | 16,186 | 21,998 | 19,698 | 23,779 | 30,456 | 38,972 | 13,045 | 24,750 |
| 10 | 1,000,000 | 76,500 | 71,000 | 206,504 | 61,447 | 68,968 | 66,288 | 73,487 | 82,453 | 96,000 | 57,318 | 71,000 |
| 20 | 1,000,000 | 194,750 | 194,750 | 490,074 | 176,360 | 187,875 | 185,977 | 202,890 | 218,873 | 242,962 | 171,687 | 194,750 |
| 30 | 1,000,000 | 320,750 | 320,750 | 729,741 | 323,676 | 348,536 | 366,948 | 367,460 | 393,377 | 432,313 | 299,068 | 320,750 |
| 40 | 1,000,000 | 355,500 | 355,500 | 844,261 | 525,565 | 555,009 | 605,592 | 549,261 | 577,880 | 632,064 | 495,380 | 495,380 |
| 50 | 1,000,000 | - | - | 930,211 | 725,433 | 742,462 | 793,536 | 725,433 | 742,462 | 793,536 | 722,782 | 722,782 |
| 60 | 1,000,000 | - | - | 1,000,000 | 850,461 | 860,187 | 895,950 | 850,461 | 860,187 | 895,950 | 849,693 | 849,693 |
|  |  |  |  | Formulaic |  |  |  |  |  |  |  |  |
| Policy |  | Sep Account |  | Gen Acc |  |  | RR General | count Res | e w/CSV F |  |  |  |
| Duration |  | Reserve |  | Reserve | (1) | (2) | (3) | (1) | (2) | (3) |  |  |
| 0 |  | - |  | - | - | - | - | - | - | 5,437 |  |  |
| 1 |  | 7,000 |  | 12,734 | $(7,000)$ | $(7,000)$ | $(7,000)$ | $(7,000)$ | $(7,000)$ | $(4,564)$ |  |  |
| 2 |  | 14,000 |  | 23,366 | $(11,000)$ | $(11,000)$ | $(11,000)$ | $(11,000)$ | $(9,778)$ | $(2,860)$ |  |  |
| 3 |  | 21,000 |  | 34,628 | $(11,000)$ | $(11,000)$ | $(11,000)$ | $(11,000)$ | $(8,436)$ | (912) |  |  |
| 4 |  | 28,250 |  | 46,421 | $(11,000)$ | $(11,000)$ | $(11,000)$ | $(11,000)$ | $(6,946)$ | 1,092 |  |  |
| 5 |  | 35,750 |  | 58,754 | $(11,000)$ | $(11,000)$ | $(11,000)$ | $(11,000)$ | $(5,294)$ | 3,222 |  |  |
| 10 |  | 76,500 |  | 130,004 | $(5,500)$ | $(5,500)$ | $(5,500)$ | $(3,013)$ | 5,953 | 19,500 |  |  |
| 20 |  | 194,750 |  | 295,324 | - | - | - | 8,140 | 24,123 | 48,212 |  |  |
| 30 |  | 320,750 |  | 408,991 | 2,926 | 27,786 | 46,198 | 46,710 | 72,627 | 111,563 |  |  |
| 40 |  | 355,500 |  | 488,761 | 170,065 | 199,509 | 250,092 | 193,761 | 222,380 | 276,564 |  |  |
| 50 |  | - |  | 930,211 | 725,433 | 742,462 | 793,536 | 725,433 | 742,462 | 793,536 |  |  |
| 60 |  | - |  | 1,000,000 | 850,461 | 860,187 | 895,950 | 850,461 | 860,187 | 895,950 |  |  |



Table 3

| Deterministic Terminal Reserves by Policy Year 75 Issue Age <br> Best Class, $\$ 1 \mathrm{M}$ face $\mathbf{9 \%}$ Separate Account Historical Ap preciation R <br> Gross Premium of $\$ 10,000$ is paid th rough age 100  |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Policy Death Duration Benefit |  | Variable <br> Fund Value | Variable Surr Value | Formulaic <br> Total Res | Deterministic Reserves before CSV floor |  |  |  |  |  | 9\% Rate <br> Ant Exp <br> PBReserve | Ant Exp <br> PBR <br> w/CSV floor |
|  |  | Future |  |  | SA Rate of 7 |  | Future S | R ate of 5\% |  |  |  |
|  |  | (1) |  |  | (2) | (3) | (1) | (2) | (3) |  |  |
| 0 | 1,000,000 |  | - | - | - | $(24,810)$ | 808 | 9,365 | $(5,355)$ | 20,933 | 42,935 | $(37,294)$ | - |
| 1 | 1,000,000 |  | 33,000 | - | 92,243 | $(41,737)$ | $(16,794)$ | $(7,971)$ | $(21,494)$ | 3,098 | 22,645 | $(54,326)$ | - |
| 2 | 1,000,000 | 65,250 | 21,750 | 171,610 | $(4,709)$ | 20,494 | 29,667 | 17,138 | 41,985 | 62,181 | $(17,915)$ | 21,750 |
| 3 | 1,000,000 | 96,750 | 53,250 | 250,561 | 32,674 | 58,039 | 67,160 | 56,103 | 81,105 | 101,003 | 19,329 | 53,250 |
| 4 | 1,000,000 | 126,500 | 83,000 | 329,746 | 69,718 | 95,165 | 104,026 | 94,654 | 119,689 | 139,527 | 56,414 | 83,000 |
| 5 | 1,000,000 | 155,250 | 111,750 | 407,860 | 106,492 | 131,923 | 140,102 | 132,932 | 157,492 | 178,066 | 93,766 | 111,750 |
| 10 | 1,000,000 | 304,500 | 282,750 | 811,171 | 294,417 | 319,289 | 321,972 | 326,844 | 356,943 | 373,626 | 289,286 | 289,286 |
| 20 | 1,000,000 | 881,000 | 881,000 | 924,886 | 870,412 | 871,365 | 871,132 | 870,708 | 871,816 | 871,576 | 869,907 | 881,000 |
| 30 | 2,337,750 | 2,337,750 | 2,337,750 | 2,337,750 | 2,343,421 | 2,343,009 | 2,343,237 | 2,343,201 | 2,342,817 | 2,343,030 | 2,343,661 | 2,343,661 |
| 40 | 5,061,750 | 5,061,750 | 5,061,750 | 5,061,750 | 5,068,001 | 5,067,782 | 5,067,925 | 5,067,867 | 5,067,656 | 5,067,794 | 5,068,174 | 5,068,174 |


| Policy | Sep Account | Formulaic General Acc |  |  | R General | count Rese | w/CSV F |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Duration | Reserve | Reserve | (1) | (2) | (3) | (1) | (2) | (3) |
| 0 | - | - | - | 808 | 9,365 | - | 20,933 | 42,935 |
| 1 | 33,000 | 59,243 | $(33,000)$ | $(33,000)$ | $(33,000)$ | $(33,000)$ | $(29,902)$ | $(10,355)$ |
| 2 | 65,250 | 106,360 | $(43,500)$ | $(43,500)$ | $(35,583)$ | $(43,500)$ | $(23,265)$ | $(3,069)$ |
| 3 | 96,750 | 153,811 | $(43,500)$ | $(38,711)$ | $(29,590)$ | $(40,647)$ | $(15,645)$ | 4,253 |
| 4 | 126,500 | 203,246 | $(43,500)$ | $(31,335)$ | $(22,474)$ | $(31,846)$ | $(6,811)$ | 13,027 |
| 5 | 155,250 | 252,610 | $(43,500)$ | $(23,327)$ | $(15,148)$ | $(22,318)$ | 2,242 | 22,816 |
| 10 | 304,500 | 506,671 | $(10,083)$ | 14,789 | 17,472 | 22,344 | 52,443 | 69,126 |
| 20 | 881,000 | 43,886 | - | - | - | - | - | - |
| 30* | 2,337,750 | - | 5,671 | 5,259 | 5,487 | 5,451 | 5,067 | 5,280 |
| 40* | 5,061,750 | - | 6,251 | 6,032 | 6,175 | 6,117 | 5,906 | 6,044 |



Duration 30,40 results show reserves greater than death benefit due to modeling inconsistencies where commissions are charged and m\&e revenue is not generated.

Table 4


| Policy | Sep Account | Formulaic General Acc | PBR General Account Reserve w/CSV Floor |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Duration | Reserve | Reserve | (1) | (2) | (3) | (1) | (2) | (3) |
| 0 | - | - | - | 808 | 9,365 | - | 20,933 | 42,935 |
| 1 | 31,500 | 61,197 | $(31,500)$ | $(31,500)$ | $(31,500)$ | $(31,500)$ | $(29,196)$ | $(9,338)$ |
| 2 | 61,000 | 110,353 | $(43,500)$ | $(42,023)$ | $(31,268)$ | $(43,500)$ | $(21,185)$ | (228) |
| 3 | 88,000 | 160,686 | $(43,500)$ | $(32,958)$ | $(20,671)$ | $(36,357)$ | $(11,216)$ | 10,068 |
| 4 | 112,250 | 212,986 | $(43,500)$ | $(21,766)$ | $(7,920)$ | $(24,622)$ | 370 | 21,551 |
| 5 | 133,500 | 267,736 | $(34,319)$ | $(8,384)$ | 6,762 | $(10,990)$ | 12,066 | 37,865 |
| 10 | 216,500 | 588,010 | 55,444 | 89,903 | 117,433 | 80,754 | 115,731 | 149,674 |
| 20 | 115,250 | 814,961 | 484,388 | 504,946 | 552,115 | 486,313 | 506,853 | 554,063 |
| 30 | - | 1,000,000 | 850,490 | 860,223 | 895,981 | 850,490 | 860,223 | 895,981 |
| 40 | - | 1,000,000 | 916,319 | 919,025 | 940,208 | 916,319 | 919,025 | 940,208 |


| Reserve Margins = Reserve with margin less Anticipated Experience reserve |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Policy | Formulaic |  |  | R: Level of | Margins |  |  |  |
| Duration | Total Res | (1) | (2) | (3) | (1) | (2) | (3) |  |
| 0 | 37,294 | 12,484 | 38,102 | 46,659 | 31,939 | 58,227 | 80,229 |  |
| 1 | 148,436 | 13,408 | 38,387 | 47,782 | 33,423 | 58,043 | 77,901 |  |
| 2 | 193,289 | 15,609 | 40,913 | 51,668 | 36,825 | 61,751 | 82,708 |  |
| 3 | 237,633 | 18,415 | 43,989 | 56,276 | 40,590 | 65,731 | 87,015 |  |
| 4 | 282,261 | 21,721 | 47,509 | 61,355 | 44,653 | 69,645 | 90,826 |  |
| 5 | 327,876 | 25,821 | 51,756 | 66,902 | 49,150 | 72,206 | 98,005 |  |
| 10 | 568,460 | 35,894 | 70,353 | 97,883 | 61,204 | 96,181 | 130,124 |  |
| 20 | 334,848 | 4,275 | 24,833 | 72,002 | 6,200 | 26,740 | 73,950 |  |
| 30 | 150,279 | 769 | 10,502 | 46,260 | 769 | 10,502 | 46,260 |  |
| 40 | 84,829 | 1,148 | 3,854 | 25,037 | 1,148 | 3,854 | 25,037 |  |
| Interest Rate Margin |  | 1\% lower | 1\% lower | 1\% lower | 1\% lower | 1\% lower | 1\% lower | none |
| Mortality Margin |  | 3.5 /ex | 2001/ex | 2001/ex | 3.5 lex | 2001/ex | 2001/ex | none |
| Lapse Margin |  | 1\% higher | 1\% higher | 1\% lower | 1\% higher | 1\% higher | 1\% lower | none |
| Expense Margin |  | 5\% | 5\% | 5\% | 5\% | 5\% | 5\% | none |

Table 5 Duration 10 Results with Varying Historical Appreciation Rates

| Basis | Margins | Future |  | Issue Age 45 |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | Historical Appreciation Rate |  |  |  |  |
|  |  | SA Rate |  | 0.45\% |  | 5.00\% |  | 9.00\% |
| Account Value |  |  | \$ | 58,500 | \$ | 76,500 | \$ | 97,000 |
| Cash Surrender Value |  |  | \$ | 53,000 | \$ | 71,000 | \$ | 91,500 |
| Formulaic Total Reserve |  |  | \$ | 195,839 | \$ | 206,504 | \$ | 219,467 |
| Principles-Based Deterministic GPV : Anticipated Experience | None | 9\% | \$ | 40,999 | \$ | 57,318 | \$ | 75,906 |
| Principles-Based Deterministic GPV | Margin 1 | 7\% | \$ | 44,789 | \$ | 61,447 | \$ | 80,472 |
| Principles-Based Deterministic GPV | Margin 2 | 7\% | \$ | 53,113 | \$ | 68,968 | \$ | 87,339 |
| Principles-Based Deterministic GPV | Margin 3 | 7\% | \$ | 51,532 | \$ | 66,288 | \$ | 83,712 |
| Principles-Based Deterministic GPV | Margin 1 | 5\% | \$ | 60,018 | \$ | 73,487 | \$ | 89,059 |
| Principles-Based Deterministic GPV | Margin 2 | 5\% | \$ | 69,893 | \$ | 82,453 | \$ | 97,472 |
| Principles-Based Deterministic GPV | Margin 3 | 5\% | \$ | 88,614 | \$ | 96,000 | \$ | 105,009 |
| Principles-Based Deterministic GPV With CSV floor | Margin 1 | 7\% | \$ | 53,000 | \$ | 71,000 | \$ | 91,500 |
| Principles-Based Deterministic GPV With CSV floor | Margin 1 | 5\% | \$ | 60,018 | \$ | 73,487 | \$ | 91,500 |
| Principles-Based Stochastic GPVAD (65 CTE) : Margin 1 | Margin 1 | Stochastic | \$ | 56,050 | \$ | 70,168 | \$ | 87,688 |
| Principles-Based Stochastic GPVAD (65 CTE) : Margin 2 | Margin 2 | Stochastic | \$ | 65,322 | \$ | 78,564 | \$ | 95,251 |
| Principles-Based Stochastic GPVAD (65 CTE) : Margin 3 | Margin 3 | Stochastic | \$ | 78,325 | \$ | 86,951 | \$ | 99,846 |
| Reserve for Guaranteed Death Benefit (Reported Reserve less CSV) |  |  |  |  |  |  |  |  |
| Reported = Maximum (Margin 1: 7\% Deterministic, Margin 1 Stochastic) | Margin 1 | Reported | \$ | 3,050 | \$ | - | \$ | - |
| Reported = Maximum (Margin 1: 5\% Deterministic, Margin 1 Stochastic) | Margin 1 | Reported | \$ | 7,018 | \$ | 2,487 | \$ | - |
| Stochastic GPVAD (65 CTE) / Deterministic 7\% Future w/ CSV Floor | Margin 1 |  |  | 106\% |  | 99\% |  | 96\% |
| Stochastic GPVAD (65 CTE) / Deterministic 5\% Future w/ CSV Floor | Margin 1 |  |  | 93\% |  | 95\% |  | 96\% |
| Stochastic GPVAD (65 CTE) / Cash Surrender Value | Margin 1 |  |  | 106\% |  | 99\% |  | 96\% |
| Stochastic GPVAD (65 CTE) / Total Formulaic Reserve | Margin 1 |  |  | 29\% |  | 34\% |  | 40\% |
| The gross separate account appreciation rate before investment advisory expenses and m\&e is shown. |  |  |  |  |  |  |  |  |

Table 6

## Duration 10 Results with Varying Historical Appreciation Rates

| Basis | Margins | Future SA Rate | Issue Age 75 |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | Historical Appreciation Rate |  |  |  |  |  |
|  |  |  |  | 0.45\% |  | 5.00\% |  | 9.00\% |
| Account Value |  |  | \$ | 143,000 | \$ | 216,500 | \$ | 304,500 |
| Cash Surrender Value |  |  | \$ | 121,250 | \$ | 194,750 | \$ | 282,750 |
| Form ulaic Total Reserve |  |  | \$ | 798,785 | \$ | 804,510 | \$ | 811,171 |
| Principles-Based Deterministic GPV : Anticipated Experience | None | 9\% | \$ | 243,659 | \$ | 236,050 | \$ | 289,286 |
| Principles-Based Deterministic GPV | Margin 1 | 7\% | \$ | 264,134 | \$ | 271,944 | \$ | 294,417 |
| Principles-Based Deterministic GPV | Margin 2 | 7\% | \$ | 301,114 | \$ | 306,403 | \$ | 319,289 |
| Principles-Based Deterministic GPV | Margin 3 | 7\% | \$ | 343,491 | \$ | 333,933 | \$ | 321,972 |
| Principles-Based Deterministic GPV | Margin 1 | 5\% | \$ | 280,154 | \$ | 297,254 | \$ | 326,844 |
| Principles-Based Deterministic GPV | Margin 2 | 5\% | \$ | 316,221 | \$ | 332,231 | \$ | 356,943 |
| Principles-Based Deterministic GPV | Margin 3 | 5\% | \$ | 361,238 | \$ | 366,174 | \$ | 373,626 |
| Principles-Based Deterministic GPV With CSV floor | Margin 1 | 7\% | \$ | 264,134 | \$ | 271,944 | \$ | 294,417 |
| Principles-Based Deterministic GPV With CSV floor | Margin 1 | 5\% | \$ | 280,154 | \$ | 297,254 | \$ | 326,844 |
| Principles-Based Stochastic GPVAD (65 CTE) : Margin 1 | Margin 1 | Stochastic | \$ | 315,683 | \$ | 334,368 | \$ | 360,413 |
| Principles-Based Stochastic GPVAD (65 CTE) : Margin 2 | Margin 2 | Stochastic | \$ | 376,105 | \$ | 389,237 | \$ | 405,467 |
| Principles-Based Stochastic GPVAD (65 CTE) : Margin 3 | Margin 3 | Stochastic | \$ | 435,417 | \$ | 437,297 | \$ | 436,845 |
| Reserve for Guaranteed Death Benefit (Reported Reserve less CSV) |  |  |  |  |  |  |  |  |
| Reported = Maximum (Margin 1: 7\% Deterministic, Margin 1 Stochastic) | Margin 1 | Reported | \$ | 194,433 | \$ | 139,618 | \$ | 77,663 |
| Reported = Maximum (Margin 1:5\% Deterministic, Margin 1 Stochastic) | Margin 1 | Reported | \$ | 194,433 | \$ | 139,618 | \$ | 77,663 |
| Stochastic GPVAD (65 CTE) / Deterministic 7\% Future w/ CSV Floor | Margin 1 |  |  | 120\% |  | 123\% |  | 122\% |
| Stochastic GPVAD (65 CTE) / Deterministic 5\% Future w/ CSV Floor | Margin 1 |  |  | 113\% |  | 112\% |  | 110\% |
| Stochastic GPVAD (65 CTE) / Cash Surrender Value | Margin 1 |  |  | 260\% |  | 172\% |  | 127\% |
| Stochastic GPVAD (65 CTE) / Total Formulaic R eserve | Margin 1 |  |  | 40\% |  | 42\% |  | 44\% |
| The gross separate account appreciation rate before investment advisory expenses and m\&e is shown. |  |  |  |  |  |  |  |  |

## Observations

- There are not many products with aggressive guaranteed minimum death benefits currently in the VUL market place. We developed a more aggressive guarantee to stress test the principles-based reserve approach. The Total Formulaic Reserves (CRVM plus AG37) generated by this more aggressive guarantee are well in excess of cash values, often 5-10 times the cash value or more in the first 10 policy durations. The drop in reserve from Total Formulaic to PBR at certain durations in Tables 1-6 is higher than it might otherwise be as the AG37 reserve is based on 1980 CSO mortality. Using 2001 CSO would lower the Total Formulaic Reserve by about one-third. The principles-based reserve levels shown are well below these formulaic reserve levels.
- In many cases, the Deterministic Reserve is governed by the cash surrender value floor. In those cases, the general account reserve is a negative amount representing the surrender charge. This result happens more often for issue age 45 , for the earlier durations, or for the $7 \%$ future SA appreciation assumption. Significant Deterministic Reserves above cash values develop in some cases however, particularly for issue age 75 , or where more prolonged periods of lower historical SA appreciation (5\%) have occurred prior to valuation, or for the $5 \%$ future SA appreciation assumption.
- The Stochastic Reserve was calculated at duration 10. For issue age 45, the average equity return for the 350 scenarios that made up the 65 CTE reserve was between $5 \%$ and $6 \%$ over time periods ranging from 10 to 30 years from the valuation date. Consistent with that, the Stochastic Reserve is somewhat lower than, but close to, the $5 \%$ future separate account return rate Deterministic Reserve and higher than the 7\% Deterministic Reserve.
- For the Stochastic Reserve for issue age 75, the average equity return for the 350 scenarios that made up the 65 CTE reserve was in a wider range over various time periods than for issue age 45. Average returns ranged from a little more than $4 \%$ for the first 10 years after the valuation date (i.e., attained ages 85 to 95 ) to close to $7 \%$ for the first 20 years after the valuation date (i.e., attained ages 85 to 105 ). Because the lower returns occur in the early years after the valuation date and there is insufficient time for the separate account assets to recover before claims are paid, the Stochastic Reserve is higher than both the 5\% and 7\% Deterministic Reserve.
- Note that as historical separate account appreciation rates increase the Stochastic Reserves increase (due to higher initial account values on the valuation date leading to higher projected surrender and death benefits).
- The Reported Reserve in excess of CSV, which can perhaps be considered to be a measure of the reserve for the death benefit guarantee, decreases as historical separate account appreciation rates increase because the guaranteed minimum death benefits are further out-of-the-money.
- It is not always obvious when a lapse rate has a margin. To illustrate this we show lapse rates with margins that are both higher (margin (2)) and lower (margin (3)) than the anticipated experience. As you move through time and circumstances change, or depending on the level of the other assumptions, the direction of the lapse margin may need to change. For example, at some valuation points and depending on the levels of either the historical returns or the assumed future returns, high lapse rates are conservative and in others low lapse rates are conservative.
- In the latest durations, for the $9 \%$ historical return, the PBR reserve is larger than the death benefit. That is because the product modeled is still paying asset based trail commissions beyond age 100 even though M\&E charges are not being assessed. This was an unintended result; however in the interest of time, coding was not changed and results not re-run. To the extent that there are expenses that are not covered by premium payments or policy charges, this type of result can occur.
- For the Stochastic Reserve, 1,000 scenarios may or may not be enough to accurately estimate a model's CTE 65 reserve. Stated another way, a CTE 65 reserve estimated using integrated, correlated scenarios may not be sufficiently near the exact CTE 65 reserve implied by the valuation model. Two ways to test if the estimate is reasonable are: 1) run more random scenarios and see that the CTE 65 reserve estimate does not change much from the initial scenario set run; or 2) calculate the standard deviation of the CTE estimator. The standard deviation calculation was used in this report.

The variance of the CTE estimator is described in an article in the North American Actuarial Journal, Vol. 9, No. 2, April 2005, "Variance of the CTE Estimator", Manistre and Hancock. The calculation for a given sample is:

$$
\operatorname{VAR}(\mathrm{CTE}) \approx \frac{\operatorname{Var}\left(\mathrm{x}_{1}, \ldots, \mathrm{x}_{(k)}\right)+\alpha \cdot\left(\mathrm{CTE}-\mathrm{x}_{(6)}\right)^{2}}{\mathrm{k}}
$$

where
$x_{(i)}$ is the ith sample order statistic, i.e., the ith largest reserve
$\alpha=1-(\mathrm{k} / \mathrm{n})=$ the CTE level percentage, where $\mathrm{n}=$ the total number of scenarios and $\mathrm{k}=$ the number of
scenarios used in the CTE calculation

CTE $=1 / k \cdot \sum \mathbf{x}_{()}$for $1 \leq \mathrm{j} \leq \mathrm{k}$

In Appendix 4, the distribution of the stochastic results for Margin 1 is shown. In addition several summary statistics are provided, including $\sigma$ (CTE65). On page 23 , for the $.45 \%$ historical growth with margin 1 scenario set, VAR $($ CTE65 $)=489,895$ so $\sigma($ CTE65 $)=700$. The standard error of the CTE65, $\sigma / \mu=.012$. Both measures suggest that the sample scenarios produced a CTE65 reserve estimate acceptably close to the valuation model's exact CTE65 reserve, and that the number of scenarios simulated was sufficient. Results are shown for other historical growth rates and for the age 75 sets on the second set of charts in Appendix 4.

## Appendix 1: Product Design and Pricing

## Product Description and Pricing:

Plan of Insurance:
Insured Life:

Amount of Insurance:
Length of premium paying period:
Mode of premium payment:
Target Premium:
Lifetime NLG Premium:

Pre-Tax IRR on Distr. Earnings
Profit Margin (PV of Profit/PV of Premium) at 6\%
Breakeven Year (Profit Accum at 6\%)

* Required Surplus was calculated as $3.6 \%$ of CRVM expense allowance plus . $10 \%$ of assets plus $\$ 1.20$ per 1000 of Net Amount at Risk


## Product Description and Pricing:

Plan of Insurance:
Insured Life:

Amount of Insurance:
Length of premium paying period:
Mode of premium payment:
Target Premium:
Lifetime NLG Premium:

Pre-Tax IRR on Distr. Earnings
Profit Margin (PV of Profit/PV of Premium) at 6\%
Breakeven Year (Profit Accum at 6\%)

* Required Surplus was calculated as $3.6 \%$ of CRVM expense allowance plus. $10 \%$ of assets plus $\$ 1.20$ per 1000 of Net Amount at Risk


## Issue Age 45

Variable Universal Life with Guaranteed Minimum Death Benefits Male Age 45 Best NonTobacco
\$1,000,000 face
To Age 100
Annual
\$11,000
\$10,000
W/ AG37 reserves
6.9\%
14.6\%

26

## Issue Age 75

Variable Universal Life with Guaranteed Minimum Death Benefits
Male Age 75 Best NonTobacco
\$1,000,000 face
To Age 100
Annual
\$58,000
\$50,000

## W/AG37 reserves

7.1\%
9.0\%

16

## Appendix 2: Competitive Position

|  | Market Pespective |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Issue Age 45 Non Tobacco \$1,000000 |  |  | Issue Age 75 Non Tobacco \$1,000000 |  |
|  | Company | Lifetime Guaranteed DB Premium * | Company | Lifetime Guaranteed DB Premium * |
| 1 | Company M: Hybrid | 8,286 | 1 Company I: Hybrid | 38,433 |
| 2 | Company B: Hybrid/2001 | 8,289 | 2 Company G: 2001 | 40,001 |
| 3 | Company I: Hybrid | 8,309 | 3 Company B: Hybrid/2001 | 46,733 |
| 4 | Company G: 2001 | 8,901 | 4 Company M: Hybrid | 47,628 |
| 5 | Company C: 2001 | 9,260 | 5 LRWG - VUL | 50,000 |
| 6 | LRWG - VUL | 10,000 | 6 Company O | 50,290 |
| 7 | Company H: Hybrid | 10,614 | 7 Company H: Hybrid | 51,218 |
| 8 | Company E | 12,360 | 8 Company O | 52,020 |
| 9 | Company F | 13,200 | 9 Company E | 58,080 |
| 10 | Company A | 13,230 | 10 Company F | 60,600 |
| 11 | Company F | 13,920 | 11 Company F | 67,080 |
| 12 | Company D | 17,000 | 12 Company F | 67,440 |
| 13 | Company L | 17,377 | 13 Company A | 70,830 |
| 14 | Company J | 17,480 | 14 Company N | 71,950 |
| 15 | Company K | 17,480 | 15 Company D | 89,090 |
| 16 | Company O | 18,370 | 16 Company L | 95,623 |
| 17 | Company B | 18,930 | 17 Company B | 96,750 |
| 18 | Company N | 19,038 | 18 Company I | 98,468 |
| 19 | Company I | 19,218 | 19 Company N | 99,781 |
| 20 | Company N | 19,294 | 20 Company C: 2001 | N/A |
| 21 | Company O | 21,190 | 21 Company J | N/A |
|  |  |  | 22 Company K | N/A |

[^3]Appendix 3: Experience Assumptions

## Valuation Assumptions Issue Age 45

| Attained age | Mortality rates |  |  |
| :---: | :---: | :---: | :---: |
|  | Pricing Estimate per | with mortality margin of 3.5 | with 2001 |
|  | 1000 | ex | CSO margin |
| 45 | 0.2813 | 0.3645 | 0.6284 |
| 46 | 0.4122 | 0.4974 | 0.7815 |
| 47 | 0.5314 | 0.6187 | 0.9243 |
| 48 | 0.6280 | 0.7175 | 1.0461 |
| 49 | 0.7104 | 0.8022 | 1.1553 |
| 50 | 0.7950 | 0.8892 | 1.2686 |
| 51 | 0.8798 | 0.9765 | 1.3840 |
| 52 | 0.9700 | 1.0694 | 1.5069 |
| 53 | 1.0763 | 1.1785 | 1.6482 |
| 54 | 1.2463 | 1.3514 | 1.8557 |
| 55 | 1.3965 | 1.5048 | 2.0459 |
| 56 | 1.6659 | 1.7775 | 2.3583 |
| 57 | 1.9469 | 2.0619 | 2.6853 |
| 58 | 2.2653 | 2.3840 | 3.0530 |
| 59 | 2.5505 | 2.6730 | 3.3911 |
| 60 | 2.9004 | 3.0270 | 3.7978 |
| 61 | 3.2322 | 3.3632 | 4.1908 |
| 62 | 3.6383 | 3.7739 | 4.6627 |
| 63 | 4.0717 | 4.2123 | 5.1672 |
| 64 | 4.5611 | 4.7070 | 5.7333 |
| 65 | 5.0969 | 5.2483 | 6.3519 |
| 66 | 5.6951 | 5.8526 | 7.0399 |
| 67 | 6.4157 | 6.5796 | 7.8578 |
| 68 | 7.2148 | 7.3856 | 8.7625 |
| 69 | 8.1245 | 8.3027 | 9.7869 |
| 70 | 9.1022 | 9.2884 | 10.8895 |
| 71 | 10.2531 | 10.4478 | 12.1765 |
| 72 | 11.5673 | 11.7713 | 13.6392 |
| 73 | 13.0314 | 13.2454 | 15.2657 |
| 74 | 14.6012 | 14.8259 | 17.0132 |
| 75 | 16.5055 | 16.7418 | 19.1124 |
| 76 | 18.5090 | 18.7581 | 21.3300 |
| 77 | 20.7674 | 21.0301 | 23.8238 |
| 78 | 23.4040 | 23.6817 | 26.7201 |
| 79 | 26.4708 | 26.7648 | 30.0735 |
| 80 | 29.7182 | 30.0299 | 33.6369 |
| 81 | 33.6283 | 33.9594 | 37.8969 |
| 82 | 37.9923 | 38.3444 | 42.6474 |
| 83 | 42.8760 | 43.2510 | 47.9584 |
| 84 | 47.9476 | 48.3476 | 53.5024 |
| 85 | 53.7720 | 54.1993 | 59.8516 |
| 86 | 60.4335 | 60.8906 | 67.0953 |
| 87 | 67.6116 | 68.1011 | 74.9175 |
| 88 | 75.5387 | 76.0636 | 83.5583 |
| 89 | 84.4779 | 85.0413 | 93.2872 |
| 90 | 94.2091 | 94.8140 | 103.8880 |
| 91 | 104.1101 | 104.7597 | 114.7435 |
| 92 | 114.3815 | 115.0796 | 126.0680 |
| 93 | 125.3591 | 126.1100 | 138.2125 |
| 94 | 137.0957 | 137.9041 | 151.2432 |
| 95 | 149.6560 | 150.5273 | 165.2396 |
| 96 | 163.6224 | 164.5622 | 180.7995 |


| Attained age | Mortality rates |  |  |
| :---: | :---: | :---: | :---: |
|  | $\begin{array}{r} \text { Pricing } \\ \text { Estimate per } \\ 1000 \end{array}$ | with mortality margin of 3.5 <br> ex | with 2001 <br> CSO margin |
| 97 | 178.5908 | 179.6045 | 197.5193 |
| 98 | 211.2181 | 195.5241 | 215.2705 |
| 99 | 194.4315 | 212.3941 | 234.1214 |
| 100 | 229.0296 | 230.2916 | 254.1256 |
| 101 | 244.3807 | 245.7283 | 269.8388 |
| 102 | 260.0610 | 261.4971 | 285.7626 |
| 103 | 272.7194 | 274.2453 | 298.5109 |
| 104 | 286.2665 | 287.8914 | 312.1170 |
| 105 | 300.7187 | 302.4532 | 326.5882 |
| 106 | 316.3960 | 318.2522 | 342.2345 |
| 107 | 333.0225 | 335.0131 | 358.7524 |
| 108 | 350.4663 | 352.6054 | 375.9894 |
| 109 | 368.3879 | 370.6921 | 393.5889 |
| 110 | 388.5546 | 391.0458 | 413.3244 |
| 111 | 409.6854 | 412.3824 | 433.8198 |
| 112 | 432.2250 | 435.1456 | 455.4565 |
| 113 | 456.2760 | 459.4273 | 478.2092 |
| 114 | 481.9272 | 485.2840 | 501.9528 |
| 115 | 509.2932 | 512.7497 | 526.4769 |
| 116 | 458.5020 | 461.7929 | 471.5906 |
| 117 | 489.6270 | 493.2576 | 500.4564 |
| 118 | 522.8255 | 526.7630 | 530.6555 |
| 119 | 568.3739 | 572.4304 | 572.4072 |
| 120 | 1000.0000 | 1000.0000 | 1000.0000 |


| Lapse Rates Level Pay |  |  |  |
| :---: | :---: | :---: | :---: |
|  | Pricing | Higher | Lower |
| Att Age | Estimate | Lapses | Lapses |
| 45 | 4.00\% | 5.00\% | 3.00\% |
| 46 | 3.80\% | 4.80\% | 2.80\% |
| 47 | 3.60\% | 4.60\% | 2.60\% |
| 48 | 3.40\% | 4.40\% | 2.40\% |
| 49 | 3.20\% | 4.20\% | 2.20\% |
| 50-54 | 3.00\% | 4.00\% | 2.00\% |
| 55-64 | 1.80\% | 2.80\% | 0.80\% |
| 65-89 | 1.20\% | 2.20\% | 0.20\% |
| 90+ | 1.00\% | 2.00\% | 0.00\% |
| Lapses include lapse and surrender Dynamic Lapse: $0.00 \%$ while FV < 0 |  |  |  |

Valuation Assumptions Issue Age 75

| Attained age | Mortality rates |  |  |
| :---: | :---: | :---: | :---: |
|  | Pricing Estimate per 1000 | with mortality margin of 3.5 ex | with 2001 <br> CSO margin |
| 75 | 5.4128 | 5.6302 | 7.8103 |
| 76 | 7.5655 | 7.7959 | 10.1760 |
| 77 | 10.3300 | 10.5747 | 13.1764 |
| 78 | 13.8202 | 14.0804 | 16.9268 |
| 79 | 17.7370 | 18.0138 | 21.1297 |
| 80 | 21.2706 | 21.5655 | 24.9776 |
| 81 | 25.5565 | 25.8711 | 29.6121 |
| 82 | 30.0144 | 30.3504 | 34.4554 |
| 83 | 35.3316 | 35.6909 | 40.2006 |
| 84 | 39.5366 | 39.9212 | 44.8790 |
| 85 | 44.8375 | 45.2506 | 50.7150 |
| 86 | 52.3283 | 52.7730 | 58.8090 |
| 87 | 61.1682 | 61.6473 | 68.3180 |
| 88 | 71.0869 | 71.6030 | 78.9721 |
| 89 | 81.5244 | 82.0799 | 90.2110 |
| 90 | 91.2314 | 91.8287 | 100.7885 |
| 91 | 101.2159 | 101.8584 | 111.7319 |
| 92 | 111.7663 | 112.4579 | 123.3431 |
| 93 | 123.1989 | 123.9439 | 135.9515 |
| 94 | 135.4675 | 136.2705 | 149.5211 |
| 95 | 148.8133 | 149.6794 | 164.3043 |
| 96 | 162.5006 | 163.4346 | 179.5699 |
| 97 | 177.0963 | 178.1036 | 195.9043 |
| 98 | 192.7607 | 193.8468 | 213.4752 |
| 99 | 209.6112 | 210.7810 | 232.3948 |
| 100 | 227.7725 | 229.0290 | 252.7596 |
| 101 | 242.9047 | 244.2472 | 268.2670 |
| 102 | 258.8729 | 260.3053 | 284.5088 |
| 103 | 271.8627 | 273.3865 | 297.6188 |
| 104 | 285.7920 | 287.4165 | 311.6352 |
| 105 | 300.7271 | 302.4627 | 326.6114 |
| 106 | 316.4030 | 318.2608 | 342.2636 |
| 107 | 333.0279 | 335.0211 | 358.7919 |
| 108 | 350.4701 | 352.6138 | 376.0473 |
| 109 | 368.3901 | 370.7024 | 393.6796 |
| 110 | 388.5546 | 391.0608 | 413.4735 |
| 111 | 409.6854 | 412.4113 | 434.0782 |
| 112 | 432.2250 | 435.2035 | 455.9169 |
| 113 | 456.2760 | 459.5482 | 479.0502 |
| 114 | 481.9272 | 485.5458 | 503.5146 |
| 115 | 509.2932 | 513.3302 | 529.3628 |
| 116 | 538.4790 | 543.0434 | 556.6324 |
| 117 | 569.6040 | 574.8953 | 585.3872 |
| 118 | 602.8025 | 609.3218 | 615.7665 |
| 119 | 648.3509 | 658.3040 | 658.2472 |
| 120 | 1000.0000 | 1,000.0000 | 1000.0000 |


| Lapse Rates |  |  |  |
| :---: | :---: | :---: | :---: |
| Level Pay | Pricing | Higher | Lower |
| Att Age | Estimate | Lapses | Lapses |
| 75 | 2.20\% | 3.20\% | 1.20\% |
| 76 | 2.00\% | 3.00\% | 1.00\% |
| 77 | 1.80\% | 2.80\% | 0.80\% |
| 78 | 1.60\% | 2.60\% | 0.60\% |
| 79 | 1.40\% | 2.40\% | 0.40\% |
| 80-89 | 1.20\% | 2.20\% | 0.20\% |
| 90+ | 1.00\% | 2.00\% | 0.00\% |
| Lapses include lapse and surrender Dynamic Lapse: $0.00 \%$ while FV < 0 |  |  |  |

## Appendix 3: Experience Assumptions

## Valuation Assumptions Issue Ages 45 and 75

| Deterministic Interest Rates | Best <br> Estimate | With <br> Margin |
| :--- | ---: | :---: |
| Gross General Account Rate <br> Based on investment philosophy with level yield curve <br> Borrowing Rate | $7.00 \%$ | $6.00 \%$ |


| Separate Account Deterministic Rates | Best <br> Estimate | With <br> Margin | With <br> Margin |
| :--- | ---: | :---: | :---: |
|  |  |  |  |
| Gross Earned Rate | $9.00 \%$ | $7.00 \%$ | $5.00 \%$ |
| Investment Advisory Expenses | $0.70 \%$ | $0.70 \%$ | $0.70 \%$ |
| Net SA Credited Rate (pre M\&E) | $8.30 \%$ | $6.30 \%$ | $4.30 \%$ |
| Revenue Sharing | $0.25 \%$ | $0.25 \%$ | $0.25 \%$ |


| Expense Assumptions |  |  |  |
| :---: | :---: | :---: | :---: |
|  |  | Best | With 5\% |
| Non Acquisition |  | Estimate | Margin |
| Per Policy |  | \$50.00 | \$52.50 |
| Per Unit |  | \$0.00 | \$0.00 |
| Per Death |  | \$100.00 | \$105.00 |
| Per Surrender |  | \$20.00 | \$21.00 |
| Prem Taxes |  | 2.50\% | 2.63\% |
| Acquisition |  |  |  |
| Per Policy |  | \$73.74 | \$73.74 |
| \% of Targ Prem |  | 10\% | 10\% |
| Per Unit |  | \$1.29 | \$1.29 |
| Commissions | Yrs |  |  |
| \% of Target | 1 | 115\% | 115\% |
| \% of Target | 2-10 | 5\% | 5\% |
| \% of Target | 11+ | 2\% | 2\% |
| Trail Commissions |  |  |  |
| \% Account Value | 11-20 | .15\% | .15\% |
| \% Account Value | 21+ | .10\% | 10\% |

## Appendix 4: Distribution of Stochastic Results

Distribution of Stochastic Results At Duration 10
Issue Age $=45$, Margin 1, Historical Growth $=.45^{\circ}$

| Stochastic Reserves <br> GPVAD Reserve Range | Number of <br> Scenarios |  |
| :--- | ---: | ---: |
| $\$ 0-$ | $\$ 20,000$ | 6 |
| $\$ 20,000-$ | $\$ 40,000$ | 208 |
| $\$ 40,000-$ | $\$ 60,000$ | 694 |
| $\$ 60,000-$ | $\$ 80,000$ | 79 |
| $\$ 80,000-$ | $\$ 100,000$ | 12 |
| $\$ 100,000-$ | $\$ 120,000$ | 1 |
| $\$ 120,000-$ | $\$ 140,000$ | 0 |
| Total |  | 1000 |
|  |  |  |
| Cash Value | $\$ 53,000$ |  |
| Minimum | $\$ 0$ |  |
| Maximum | $\$ 111,132$ |  |
| Average | $\$ 45,856$ |  |
| CTE 65 | $\$ 56,050$ |  |
| Variance of CTE Estimator | 489,895 |  |
| StdDev of CTE Estimator | 700 |  |
| Standard Error |  | $1.2 \%$ |


Issue Age $=45$, Margin 1, Historical Growth $=5 \%$

| Stochastic Reserves GPVAD Reserve Range |  | Number of Scenarios |
| :---: | :---: | :---: |
| $\$ 0$ | - \$20,000 | 3 |
| \$20,000 | \$40,000 | 11 |
| \$40,000 | \$60,000 | 466 |
| \$60,000 | \$80,000 | 475 |
| \$80,000 | \$100,000 | 40 |
| \$100,000 | \$120,000 | 4 |
| \$120,000 | - \$140,000 | 1 |
| Total |  | 1000 |
| Cash Value | \$71,000 |  |
| Minimum | \$0 |  |
| Maximum | \$122,093 |  |
| Average | \$61,000 |  |
| CTE 65 | \$70,168 |  |
| Variance of | CTE Estimator | 361,616 |
| StdDev of CT | E Estimator | 601 |
| Standard Err |  | 0.9\% |



Issue Age $=45$, Margin 1. Historical Growth $=9 \%$

| Stochastic Reserves GPVAD Reserve Range |  | Number of Scenarios |
| :---: | :---: | :---: |
| $\$ 0$ | - \$20,000 | 2 |
| \$20,000 | \$40,000 | 3 |
| \$40,000 | \$60,000 | 22 |
| \$60,000 | \$80,000 | 546 |
| \$80,000 | \$100,000 | 397 |
| \$100,000 | \$120,000 | 27 |
| \$120,000 | \$140,000 | 3 |
| Total |  | 1000 |
| Cash Value | \$91,500 |  |
| Minimum | \$0 |  |
| Maximum | \$127,909 |  |
| Average | \$78,784 |  |
| CTE 65 | \$87,688 |  |
| Variance of CTE Estimator |  | 277,705 |
| StdDev of CTE Estimator |  | 527 |
| Standard Error |  | 0.6\% |

Appendix 4: Distribution of Stochastic Results
Distribution of Stochastic Results At Duration 10
Issue Age $=75$, Margin 1, Historical Growth $=.45 \%$


Issue Age $=75$, Margin 1, Historical Growth $=5 \%$


Issue Age $=75$, Margin 1. Historical Growth $=9 \%$

| Sto chastic Reserves <br> GPVAD Reserve Range | Number of <br> Scenarios |  |
| :--- | ---: | ---: |
| $\$ 280,000-$ | $\$ 315,000$ | 695 |
| $\$ 315,000-$ | $\$ 350,000$ | 113 |
| $\$ 350,000-$ | $\$ 385,000$ | 102 |
| $\$ 385,000-$ | $\$ 420,000$ | 56 |
| $\$ 420,000-$ | $\$ 455,000$ | 29 |
| $\$ 455,000-$ | $\$ 490,000$ | 4 |
| $\$ 490,000-$ | $\$ 525,000$ | 1 |
| Total |  | 1000 |
| Cash Value | $\$ 282,750$ |  |
| Minimum | $\$ 280,134$ |  |
| Maximum | $\$ 499,053$ |  |
| Average | $\$ 315,566$ |  |
| CTE 65 | $\$ 360,413$ |  |
|  |  |  |
| Variance of CTE Estimator | $9,980,873$ |  |
| StdDev of CTE Estimator | 3,159 |  |
| Standard Error |  |  |


[^0]:    ${ }^{1}$ All capitalized terms used herein and not otherwise defined herein shall have the meanings ascribed to such terms in the VM-20 September 2007 exposure draft.

[^1]:    ${ }^{2}$ As indicated in a VM-20 drafting note, the reserve allocation between the general account and the separate account is still being worked on.

[^2]:    Duration 60 results show reserves greater than death benefit due to modeling inconsistencies where commissions are charged and m\&e revenue is not generated.

[^3]:    * Source: Blease Research 9/30/2006 Full Disclosure Software

