AMERICAN ACADEMY of ACTUARIES

Interim Report of the VAGLB Work Group
To the Innovative Products Working Group
of the NAIC's Life and Health Actuarial (Technical) Task Force (LHATF)
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This report was prepared by the Academy's Variable Annuities with Guaranteed Living Benefits (VAGLB) Work Group of the Committee on State Life Insurance Issues.

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I. Introduction

At the request of the NAIC's Life and Health Actuarial (Technical) Task Force (LHATF), the American Academy of Actuaries formed the Variable Annuities with Guaranteed Living Benefits (VAGLBs) Work Group in January of 1998 to develop recommendations on actuarial issues for these benefits.

Prior VAGLB Work Group reports have focused on topics such as: general descriptions of the benefits, market profiles, nonforfeiture issues, and potential reserve methodologies.

At the June 1999 LHATF meeting and on a subsequent follow-up LHATF conference call, the VAGLB Work Group agreed to continue to explore the feasibility of using an integrated CARVM reserving structure for VAGLBs similar to the structure used in Actuarial Guideline XXXIV (AG34). Specifically, the VAGLB Work Group agreed to:

1. Continue development of a stochastically determined benchmark VAGLB reserves for various GMIB and GMAB designs;
2. Continue to examine potential simplified VAGLB reserve approaches which are consistent with CARVM, relative to the stochastically determined benchmark VAGLB reserves determined in (1) above;
3. Examine cost and reserve implications of variable annuities with both GLBs and MGDBs;
4. Complete further analysis of the historical variable annuity equity fund performance database, including a comparison of equity performance over various time periods;
5. Continue to update the current market profile, as necessary; and
6. Provide illustrative examples of the Keel Method reserve approach.

This report provides a brief update (in outline form) of the status of these initiatives.

II. Market Profile Update

Direct Business - Recent Market Developments

- Further innovative benefit structures are appearing
  - snowflake design, difficult to categorize
  - second generation products
  - specified benefit based on occurrence of event (e.g., 10% annuitization value bonus if account value does not double in 10 years)
  - guaranteed level of partial or systematic withdrawals
- Ancillary benefits are being considered
  - benefit availability based on contingent event (e.g., disability, nursing home)
- Mutual fund MGDB/VAGLB wrappers being considered
- It appears that no major activity has occurred on the pay-out side at this time

Reinsurance

- The VAGLB Work Group is continuing to monitor the reinsurance market for VAGLBs and MGDBs
  - there is little change from the June report in this area
- As noted in prior reports, the reinsurance market continues to go through a period of transition
  - some new reinsurers entering market, others leaving market
  - many reinsurers evaluating whether to enter, leave, or continue in market
  - reinsurers continue to approach market with caution, due to factors such as complexity of guaranteed benefit risks and ability to provide capacity
- Much of the new activity relates to MGDB reinsurance, which is often considered to be a necessary first step before reinsurance of VAGLBs
  - a few insurers, who generally do not engage in reinsurance transactions, are exploring the reinsurance of variable annuities

III. Analysis of Variable Annuity Historical Data

June 1999 VAGLB Work Group Report

- The VAGLB Work Group recommended updated 38 year historical database as basis for Keel Method
- Future initiatives
  - for each fund class and duration, test fit of Keel based returns (based on lognormal distribution) to historical returns
  - compare historical VA equity fund returns over various time periods
  - consider use of more than 5 fund classes, and whether standardized returns should be required

Comparison of Keel based returns to Historical Returns

- Appendix A
  - graphs compare cumulative returns based on:
    - ⇨ Historical Data
    - ⇨ Keel Method based on lognormal distribution (fine-tuned from 6/99 report)
    - ⇨ AG34 immediate drops and assumed returns
  - 14 graphs include 11 fund classes, plus weighted equity, bond, total fund classes
  - tabular data shows cumulative returns, 1 year forward returns, and percentile rankings of Keel method returns versus historical returns
- Conclusions reached from Appendix A
  - Keel returns based on lognormal distribution provide a reasonable fit to historical data
  - Keel method returns are adequate between 72% and 100% of the time for all durations for all fund classes
  - Keel method returns for most fund classes are conservative until later durations
  - resulting Keel Based VAGLB reserves will normally exceed reserves based on historical data
- Other Statistical Distributions were also reviewed
  - Normal distribution (based on annual returns) does not achieve a good fit to historical data

- Modified normal distribution (with varying volatility for each of 120 monthly time periods)
  - ⇨ Very complex to implement
  - ⇨ Log normal usually produced better fit
- Modified log normal distribution (with varying volatility for each of 120 monthly time periods)
  - ⇨ Volatility based on linear regression, to produce optimal fit to historical data
  - ⇨ Method very complex, with little impact on VAGLB reserves

➢ Comparison of AG34 cumulative returns to Keel returns

- AG34 produces lower returns in durations 1-2, normally followed by higher returns in subsequent directions
- reinforces conclusion that AG34 returns are not appropriate for long-term nature of VAGLBs

Comparison of VA historical data over different time periods

➢ Appendix B

- compares VA historical means, volatility, and adequacy percentile of Keel Method
- Morningstar 1986-98 VA return database supplemented by weighted representative indices for pre-1986 returns

➢ Conclusions reached from Appendix B

- Mean fund returns over 38 year period are lower than most other time periods
- Volatility over 38 year period is lower than most longer time periods
- Overall, the Keel method (based on 38 year time period) produces acceptable adequacy percentiles versus other time periods

IV. Possible Hedging Approaches for VAGLBs

Background

- VAGLB costs, as observed by the VAGLB Work Group, appear to behave in a manner similar to the value of certain derivative instruments
  - typically, the VAGLB cost is zero under most asset appreciation scenarios
  - under the more extreme scenarios the cost can be significant
- This observation leads one to conclude that a hedging strategy using derivatives could be used to manage VAGLB risks
- Several different hedging strategies could potentially be used
  - each one presents its own accounting and valuation issues
  - the VAGLB Work Group is examining these issues

Possible Hedging Approaches for VAGLB Risks

- Possible approaches include
  - Reinsurance
  - Custom Puts
  - Publicly Traded Puts
  - Dynamic Hedging
  - VAGLB Risk Retention ("Going Naked")
  - Combinations of the above
- Appendix C describes these strategies in more detail, including the effectiveness of each of the strategies, and the accounting and valuation issues that each strategy presents

Open Issues

- In order to properly reflect overall VAGLB risk, the reserve methodology may need to consider
  - the way the assets backing the reserve are to be invested; and
  - how those assets will be accounted for on a statutory basis

- The VAGLB Work Group is discussing the following issues and will recommend potential solutions
  - how reinsurance should be treated within the reserve methodology
  - how any accounting mismatch should be addressed

    ⇨ including the mismatch between reserve valuation (i.e., 80th to 85th percentile and observed historical volatility) and the valuation for any hedging assets (i.e., market value using "expected" value and implied volatility)
- This could potentially result in a recommendation to employ an alternative reserve method for specific circumstances or specific VAGLB designs
  - similar to the approach in Actuarial Guideline 35 which allows an alternative reserve calculation if a company is "hedged as required"
  - such an approach would have to thoroughly address any criteria need to employ such an alternative approach
- The VAGLB Work Group will report on the extent to which these hedging strategies are being used by VAGLB writers

V. VAGLB Reserve Methodology

Background

- The Work Group is developing a VAGLB reserve recommendation based on the integrated CARVM reserve structure outlined in AG34
  - VAGLB "solved for" reserves are the difference between the:
    - ⇨ integrated CARVM reserve for the entire contract, including the VAGLB; and
    - ⇨ reserve held in the absence of the VAGLB.
  - Goal is to develop a "simplified approach" used to reflect VAGLB costs in CARVM integrated benefit streams
  - "Simplified approach" currently under consideration is the "Keel" Method
    - ⇨ produces a standardized, simplified, single scenario "stress-test" used to project account values to determine cost of VAGLB to be reflected in CARVM integrated benefit stream
    - ⇨ single scenario "stress test" is a series of cumulative returns, varying by duration, each of which are based on 83.33rd percentile returns
    - ⇨ better reflects the long-term risks associated with VAGLBs
    - ⇨ method can be tailored to produce scenarios that vary by fund or fund class (much like AG34 drops and returns that vary by fund class)
    - ⇨ based on historical VA fund return data
    - ⇨ irregularities in historical data are smoothed by fitting data to a lognormal distribution

Keel Method Reserve Approach

- See Appendix D for an example of the Keel Method reserve approach calculation

Benchmark Reserves

- "Benchmark" reserves are being used to test appropriateness of Keel Method
  - reserves are stochastically determined for each major benefit type and fund type
  - various policy durations and surrender charge patterns, as well as different account value vs. "accrued benefit" situations (i.e., different levels of being "in the money"), are being examined
  - the Keel Method is deemed to be "appropriate" for a given benefit design if it produces a VAGLB CARVM reserve that falls within a reasonable percentile of the stochastically determined and ranked VAGLB "benchmark" CARVM reserves

- various Keel Method percentiles are being examined
  - ⇨ it is important to note that simplified methods which are "appropriate" at the X^{th} percentile could be more or less than X% adequate from an asset adequacy perspective
  - ⇨ VAGLB Work Group will provide input, but will look to LHATF for guidance on the specific percentile

Analysis of Roll-up GMAB Designs

- The Keel Method was analyzed with Roll-up GMABs to determine how close calculated reserves are to benchmark reserves
  - numerous benefit designs were tested
  - for each design, three fund allocations (100% growth, 100% money market, and 100% aggressive growth), five valuation dates, and three "in the money percentages" were analyzed
  - the results of the analysis is contained in Appendix F
- Results were comparable to those of other analysis performed in conjunction with prior reports
  - Keel Method reserves at issue are typically 0 in the 75^{th} - 90^{th} percentile range
  - reserves increase at later duration, particularly when the benefit is "in the money"
  - for those Roll-up GMAB designs modeled, the Keel Method applied at the 83^{rd} percentile typically produces reserves that fall in the 85^{th} – 90^{th} percentile benchmark reserve range
- Based on the analysis, the VAGLB Work Group concludes that the approach outlined above, using the Keel Method at the 83^{rd} percentile, is an appropriate reserve methodology for those Roll-up GMAB designs that are current offered in today's market

Analysis of Ratchet GMAB Designs

- The Keel Method was also analyzed with Ratchet GMAB designs to determine how close calculated reserves are to benchmark reserves
  - although there are currently no ratchet design GMABs in the market, these were analyzed as an interim step towards modeling ratchet design GMIBs
    - ⇨ we also wanted to test the effectiveness of the Keel Method approach applied to potential future designs
  - a few benefit designs were tested

- for each design, three fund allocations (100% growth, 100% money market, and 100% aggressive growth), five valuation dates, and three "in the money percentages" were also analyzed
- the results of the analysis is also contained in Appendix F

➢ The following observations can be made:

- Keel Method reserves are identical to those calculated for Roll-up-type GMABs
- Benchmark reserves vary significantly from Keel Method reserves
- Benchmark reserves for ratchet designs are higher at early durations than they are with Roll-up-type GMAB designs, but the increase at later durations is not high

➢ Based on the analysis, the VAGLB Work Group concludes that the single scenario Keel Method approach outlined above is not an appropriate reserve methodology for Ratchet GMAB designs

Applicability of Analysis/Conclusions

➢ As noted above, the VAGLB Work Group believes that the Keel Method reserve approach is appropriate for the Roll-up GMAB designs in today's market, but is not appropriate for Ratchet GMAB designs

- this leads to the conclusion that the Keel Method reserve approach may not work as well for path dependent benefit designs, such as Ratchet GMAB designs
- the VAGLB Work Group also recognizes that the Keel Method reserve approach may not necessarily be appropriate for any newly developed GMAB designs
- as a result, the recommended Keel Method approach may need to be modified, or an alternative approach may need to be developed, for these designs

➢ The VAGLB Work Group is considering the following solutions to address this issue

- Integrated CARVM with modified single scenario Keel Method
  - ⇨ the VAGLB Work Group has already examined several potential modifications to the Keel single scenario that can be used for Ratchet GMAB designs
  - ⇨ all of the modified single scenarios examined either fail to work or work only for specific designs and/or specific percentiles
- Integrated CARVM with multiple scenarios
  - ⇨ multiple scenarios would be used to project VAGLB costs within the CARVM Integrated Benefit Streams
  - ⇨ a large number of stochastic scenarios (e.g., 10,000) could theoretically be used, but practicality suggests that a small number of representative scenarios (e.g., 2-7) be used

- ⇨ the reserve could then be based on the greatest of a predetermined number of scenarios capturing the risks associated with the VAGLB design
- ⇨ this entails using a less "simplified" approach than the Keel Method approach
- ⇨ standardized assumptions (i.e., means and volatilities by fund type) could be used
- ⇨ a disadvantage to this approach would be its extreme complexity and its difficulty to administer (especially with a large number of scenarios)
- ⇨ the CARVM greatest PV concept may produce excessive reserves when applied to multiple scenarios
- ⇨ a significant amount of VAGLB Work Group analysis and modeling would need to take place, potentially delaying the project
- ⇨ there is no guarantee that this approach will work for all future VAGLB designs (particularly if it uses a small number of representative scenarios)

- Integrated CARVM with Option Cost methods (similar to Actuarial Guideline 35)
  - ⇨ reflects theoretical cost of options needed to provide for VAGLB costs in the integrated CAVRM reserve
  - ⇨ difficult in practice, since in most cases no such options exist
  - ⇨ may match up assets and liabilities well for companies purchasing options to reduce the VAGLB risk
- Integrated CARVM with scenarios developed by the valuation actuary
  - ⇨ this requires more reliance on the valuation actuary
  - ⇨ requires less detail for the methodology used to incorporate VAGLB costs into CARVM integrated benefit streams
  - ⇨ some possible options (may be used in combination):
    - simplified scenarios chosen by the valuation actuary, based on stochastic scenario (or other benchmarking tests) could be permitted
    - the method could require some standardized assumptions to be used
    - product filings could be required to include recommended scenarios to be used for reserves
    - a separate actuarial opinion or certification could be required for VAGLB reserves
- UVS "S" Curve/Valuation Actuary Approach
  - ⇨ this would presumably include some form of asset adequacy analysis, supplemented by disclosures
  - ⇨ not CARVM compliant (would therefore require changes to the model SVL)

⇨ a great deal of work would need to be done to develop details

- Combinations of the above methods could be used
  - for example, the Keel Method may be used for, say, Roll-up-type designs, while one or more of the alternative approaches would be applied to other designs
  - "Safe harbor" methods with alternative methods available upon approval/certification, could also be used
- Conclusions
  - the VAGLB Work Group believes the Keel Method approach has merit for many VAGLB designs in today's market

    ⇨ we will continue to pursue application of this approach to other VAGLB designs (including GMIBs)
  - the VAGLB Work Group will pursue Integrated CARVM with scenarios developed by the valuation actuary
  - based on the results of the survey of companies' hedging strategies, the VAGLB Work Group will also consider pursuing the Integrated CARVM with Option Cost approach with respect to companies following certain hedging strategies
  - the VAGLB Work Group agrees with the long-term direction of the UVS project

    ⇨ since many of the details of this project are currently unresolved, the VAGLB Work Group will not pursue this approach at this point

    ⇨ we will continue to monitor the progress of this project and provide input as necessary

    ⇨ we will continue to pursue other short-term integrated CARVM approaches
  - because of the disadvantages noted above, the VAGLB Work Group recommends that the Integrated CARVM with modified single and multiple scenarios approaches not be pursued

    ⇨ such approaches will not likely yield a single solution for all designs

    ⇨ the VAGLB Work Group views these approaches as subsets of Integrated CARVM with scenarios developed by the valuation actuary (i.e., the applicability of these approaches to specific VAGLB designs could be analyzed by the valuation actuary)

VI. Recommended Next Steps

The VAGLB Work Group will continue to work on the following next steps:

1. Further pursue the VAGLB reserve methods discussed in the Conclusion portion Section V. above;
2. Examine cost and reserve implications of variable annuities with both GLBs and MGDBs;
3. Make a recommendation on how many VAGLB fund classes should be required, and whether standardized fund performance should be required; and
4. Continue to update the current market profile, as necessary.

The VAGLB Work Group will continue to provide quarterly updates of its progress to the Innovative Products Working Group of LHATF.

If there are questions or comments, please address them to either Stephen Preston or Thomas Campbell, co-chairpersons of the VAGLB Work Group.

Appendix B

Variable Annuity Historical Cumulative Return Comparison

Growth & Income Fund

Time Period	Years	Net Annual Mean Return	Annual Volatility	Adequacy Percentile of Keel-Based Lognormal *						
				1 Month	6 Months	1 Year	2 Year	3 Year	5 Year	10 Year
1986 - 98	13	13.80%	11.80%	88%	88%	89%	99%	99%	100%	100%
1976 - 98	23	14.50%	13.10%	89%	89%	89%	98%	99%	100%	100%
1966 - 98	33	12.10%	14.30%	86%	83%	83%	90%	88%	87%	81%
1961 - 98	**38**	**11.70%**	**14.10%**	**86%**	**83%**	**83%**	**90%**	**90%**	**86%**	**77%**
1956 - 98	43	11.70%	14.10%	85%	83%	83%	90%	90%	88%	80%
1946 - 98	53	12.80%	14.50%	86%	84%	84%	91%	90%	90%	85%
1936 - 98	63	12.10%	15.80%	84%	82%	81%	85%	86%	88%	85%
1926 - 98	73	12.40%	20.40%	82%	80%	78%	83%	83%	82%	80%

**** Based on 83.33 percentile of 38 year database***

Appendix B

Variable Annuity Historical Cumulative Return Comparison

Growth Fund

Time Period	Years	Net Annual Mean Return	Annual Volatility	Adequacy Percentile of Keel-Based Lognormal *						
				1 Month	6 Months	1 Year	2 Year	3 Year	5 Year	10 Year
1986 - 98	13	14.70%	13.10%	86%	85%	88%	99%	99%	100%	100%
1976 - 98	23	16.00%	14.10%	88%	87%	90%	99%	99%	100%	100%
1966 - 98	33	13.40%	15.70%	85%	80%	83%	88%	86%	84%	85%
1961 - 98	**38**	**13.00%**	**15.30%**	**85%**	**81%**	**83%**	**90%**	**88%**	**85%**	**80%**
1956 - 98	43	12.90%	15.30%	85%	82%	83%	90%	89%	87%	83%
1946 - 98	53	13.50%	15.50%	85%	83%	84%	90%	90%	89%	87%
1936 - 98	63	13.50%	17.40%	84%	82%	81%	87%	86%	88%	89%
1926 - 98	73	14.00%	23.20%	82%	80%	79%	84%	82%	83%	84%

**** Based on 83.33 percentile of 38 year database***

Appendix B

Variable Annuity Historical Cumulative Return Comparison

Aggressive Growth Fund

Time Period	Years	Net Annual Mean Return	Annual Volatility	Adequacy Percentile of Keel-Based Lognormal *						
				1 Month	6 Months	1 Year	2 Year	3 Year	5 Year	10 Year
1986 - 98	13	18.40%	17.50%	86%	85%	88%	99%	99%	100%	100%
1976 - 98	23	21.30%	19.70%	88%	88%	89%	99%	100%	100%	100%
1966 - 98	33	18.00%	22.80%	85%	80%	81%	85%	82%	84%	86%
1961 - 98	**38**	**17.70%**	**21.90%**	**86%**	**81%**	**81%**	**87%**	**84%**	**86%**	**81%**
1956 - 98	43	17.30%	21.60%	87%	83%	82%	88%	86%	88%	84%
1946 - 98	53	16.30%	21.40%	86%	83%	83%	87%	86%	90%	88%
1936 - 98	63	18.40%	26.60%	84%	82%	82%	84%	85%	88%	90%
1926 - 98	73	19.40%	37.70%	82%	79%	79%	81%	82%	82%	87%

**** Based on 83.33 percentile of 38 year database***

Appendix C

Possible Hedging Approaches for VAGLB Risks

- Reinsurance
  - this could cede all or a portion of the "unknown" VAGLB risk from the direct writing company in exchange for a "known" reinsurance premium
  - the direct writer does assume the counter-party risk of the reinsurer
  - the direct writer may be able to take a reinsurance reserve credit to offset all or a portion of the VAGLB reserve
- Custom Puts
  - in the current market, the cost of a custom put may be prohibitively expensive
  - custom puts would be purchased from a broker or bank to fit the VAGLB
  - risks retained by insurer
    - ⇒ surrender, annuitization, and fund transfer risks
    - ⇒ tracking error of custom puts versus underlying funds (particularly for "buy and hold" strategies)
    - ⇒ counter party risk of put issuer
  - put would presumably be held at market (or "fair") value
    - ⇒ may also be possible also to hold at book value equal to amortized cost plus change in intrinsic value
  - ideally, the carrying value of the VAGLB reserve should be close to the carrying value of the assets
    - ⇒ this assumes that the put effectively hedges the VAGLB risk
    - ⇒ to the extent the Keel Method reserve approach is not consistent with the carrying value of the custom put, a mismatch will occur
- Publicly Traded Puts
  - the direct writer may attempt to hedge its VAGLB risk by purchasing a portfolio of publicly traded puts
  - while expensive, current market costs may be less prohibitive than that for custom puts
  - unlikely to remove all the risk from the writer
    - ⇒ most publicly traded puts are on specific assets or indices
    - ⇒ most publicly traded puts are for shorter durations than the VAGLB risk
    - ⇒ custom put risks retained by insurer also apply here

- accounting would presumably be the same as for a custom put
- potential for accounting mismatch between assets and liabilities as with custom puts

  $\Rightarrow$ may be masked by any mismatch between actual and theoretical puts

- Dynamic Hedging
  - a combination of puts, calls, and futures can be used to replicate the VAGLB risk
  - the capability to monitor and change the invested position frequently is needed
  - cost may be less prohibitive than that for a custom put
  - risks associated with publicly traded puts are retained
  - risks such as friction costs due to volatility and the potentiality that a company may not be able to fully follow the desired strategy are also added
  - accounting would presumably be the same as for a custom put, with any bonds that may be held at amortized cost
  - same accounting issues as noted with above put strategies
- VAGLB Risk Retention ("Going Naked")
  - for example, a company may simply invest in bonds or similar instruments
  - may be more than adequate under most scenarios, but may be grossly inadequate in others
  - accounting follows that used for the assets that are held, typically amortized cost
  - since there is no hedging, any accounting mismatch should be reflected in earnings
- Combinations
  - two or more of these strategies may be used in combination
  - may be necessary if reinsurance is used and reinsurer is willing to only assume a portion of the risk
  - accounting follows strategies used (as noted above)

Appendix D

Example of Keel Method Reserve Approach Calculation

Background – MGDB Reserve Methodology

- Actuarial Guideline XXXIV (AG34) requires that MGDB costs be integrated with other contract benefits in the determination of future Integrated Benefit Streams. This is accomplished by combining three separate benefit streams: A, B and C described below.
  - A is the stream of net amounts at risk, projected using and immediate drop and assumed returns, paid to those expected to die;
  - B is the stream of account values paid to those expected to die, where the account values are projected using the valuation interest rate less asset based charges; and
  - C is the Base Benefit Streams of all other benefits provided, discounted for survivorship based on valuation mortality, where the benefits are projected using the valuation interest rate less asset based charges
- the VAGLB Work Group envisions the Keel Method approach to be consistent with the AG34 structure outlined above

VAGLB Reserve Methodology Applied to GMABs

- The VAGLB reserve methodology for GMABs is similar to the approach used in AG34
  - VAGLB reserve = Integrated CARVM reserve reflecting VAGLBs – Integrated CARVM reserve excluding VAGLBs
- For purposes of this example, the CARVM Integrated Benefit Streams which include GMABs are a combination of three separate benefit streams: X, Y and Z
  - X is the stream of net amounts at risk (i.e., the difference between the GMAB amount and the AV), projected using Keel Method returns, paid to those who utilize the GMAB at or after the end of the waiting period;
  - Y is the benefit stream of account values paid to those who utilize the GMAB, where the account values are projected using the valuation interest rate less asset based charges; and
  - Z is the Base Benefit Streams of all other benefits provided, where the benefits are projected using the valuation interest rate less asset based charges
- X, Y and Z are all discounted to the valuation date for survivorship based on valuation mortality and for interest using the appropriate valuation interest rate(s)

Appendix D

Example Applied to a GMAB

- Assume a variable annuity contract where
  - $1,000 was paid at t=0
  - the contract has a GMAB equal to a return of premium at t=10 (i.e., 10 year waiting period)
  - account value is paid at death (no MGDB)
  - the valuation is being performed at t=5
  - the account value at t=5 is $700
  - M&E charges are 1.35% and VAGLB charges are 1.00%
  - the valuation interest rate is 5.75%

Keel Method Projection

Mean Fund Performance (Gross) =	17.7%
Fund Volatility =	21.9%
Keel Percentile =	83.3%

see Appendix E for more detail on the development of the Keel Method cumulative returns

Year	5	6	7	8	9	10
Cumulative Projected Return	0.0%	-6.1%	-2.2%	3.7%	10.9%	19.3%
Annualized Projected Return	0.0%	-6.1%	4.2%	6.0%	7.0%	7.6%
${}_np_x$	100.0%	98.3%	96.4%	94.3%	92.1%	89.8%

Benefit Stream X

Benefit Stream X includes the net amount at risk equal to the difference between the account value and the GMAB, where both are projected using the returns developed by the Keel Method

Year	5	6	7	8	9	10
Projected Account Value	700	657	685	726	776	835
Projected GMAB	1,000	1,000	1,000	1,000	1,000	1,000
Projected GMAB NAR	-	-	-	-	-	165
PV of Projected GMAB NAR	-	-	-	-	-	112

Appendix D

Benefit Stream Y

Benefit Stream Y includes the portion of the account value which is paid when the GMAB is utilized, where the account value is projected using the valuation interest rates minus M&E charges and VAGLB charges.

Valuation Rate	5.75%
M&E Charge	1.35%
VAGLB Charge	1.00%
Projection Rate	3.40%

Year	5	6	7	8	9	10
Projected Account Value	700	724	748	774	800	827
PV of AV at GMAB Utiliz'n	-	-	-	-	-	562

Benefit Stream Z

Benefit Stream Z includes all other benefits (in this example this is cash surrender value paid on surrender before the end of the waiting period) and death benefits (equal to account value). To determine these other benefits, the account value is projected using the valuation rate minus M&E charges and VAGLB charges.

Projection Rate 3.40% (as determined above)

Year	5	6	7	8	9	10
Projected Account Value	700	724	748	774	800	827
Projected Cash Surrender Value	670	704	738	774	800	827
PV of Cash Surrender Value	670	654	636	617	589	562
Cumulative PV of AV paid at Death		12	25	38	53	68

Appendix D

Combined Integrated Benefit Streams

Combining Benefit Streams X, Y and Z results in the following Integrated Benefit Streams. The present value of each stream is calculated and the reserve held is the greatest present value.

Year	5	6	7	8	9	10
PV of Non-elective Benefits	-	12	25	38	53	68
PV of Elective Benefits						
GMAB	-	-	-	-	-	112
AV at GMAB utilization	-	-	-	-	-	562
Cash Surrender Value	670	654	636	617	589	-
Total (Elective + Non-elective)	670	666	661	655	642	742
Greatest PV	**742**					

Appendix E

The Keel Method Formula

The Keel Method formula for projecting future account values is:

$$Index_t = Index_{t-s} \times e^{ms+Ns\sqrt{s}}$$

Where:
- $Index_t$ = *the index at time t*
- m = *mean gross fund index return (stationary over time)*
- s = *fund index volatility (stationary over time)*
- s = *period in years between t-s and t*
- N = *1-p percentile of standard normal distribution (p=83.3rd%)*

The following example will demonstrate how the account value is projected using the Keel Method formula.

Assume the entire account value is allocated to an aggressive growth sub-account, which implies the use of the following mean fund performance and volatility assumptions.

Keel Method Projection	
Mean Fund Performance (net of fund management fees) =	17.7%
Fund Volatility =	21.9%

The mean fund performance and fund volatility assumptions are both based on annual effective historic returns. To use these values in the Keel Method formula, the mean must to be converted to constant force value. Taking the natural log of the mean fund performance, which equals 16.27%, does this. The next step is to convert the mean fund performance and volatility of what is assumed to be a normal distribution into the mean fund performance and volatility of a lognormal distribution. This results in a mean of 13.87% and a volatility of 18.46%. The last adjustment is to reduce the mean by the M&E and VAGLB charges (13.87% - 1.35% - 1.0% = 11.52%) to get a net mean. The following assumption along with the net mean fund performance and volatility are then used to construct the returns.

- t = Valuation date plus projection period (valuation date = 5, projection period = 0, 1, 2, …, 5)
- $Index_5$ = 700
- N = -0.9673 (16.67th percentile of standard normal distribution, Keel Method at 83.33rd percentile)

Appendix E

Index 5 Calculation

$$Index_5 = 700 \times e^{11.52\%*0+(-0.9673)*18.46\%*\sqrt{0}} = 700$$

Index 6 Calculation

$$Index_6 = 700 \times e^{11.52\%*1+(-0.9673)*18.46\%*\sqrt{1}} = 657$$

Index 7 Calculation

$$Index_7 = 700 \times e^{11.52\%*2+(-0.9673)*18.46\%*\sqrt{2}} = 685$$

Index 8 Calculation

$$Index_8 = 700 \times e^{11.52\%*3+(-0.9673)*18.46\%*\sqrt{3}} = 726$$

Index 9 Calculation

$$Index_9 = 700 \times e^{11.52\%*4+(-0.9673)*18.46\%*\sqrt{4}} = 776$$

Index 10 Calculation

$$Index_{10} = 700 \times e^{11.52\%*5+(-0.9673)*18.46\%*\sqrt{5}} = 835$$