AMERICAN ACADEMY *of* ACTUARIES

Recommended Approach for Setting Regulatory Risk-Based Capital Requirements for Variable Annuities and Similar Products

Presented by the American Academy of Actuaries' Life Capital Adequacy Subcommittee to the National Association of Insurance Commissioners' Capital Adequacy Task Force

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The following report is a follow up to a proposal from March 2002 and was prepared by the Life Capital Adequacy Subcommittee's C-3 Phase 2 Work Group* (chaired by Bob Brown). The work group is made up of several members of the subcommittee as well as Mike Akers, Frederick Andersen, Robert Berendsen, Tom Campbell, Andrew Eastman, Jack Gies, Geoff Hancock, Jeff Krygiel, Jim Lamson, Jeffrey Leitz, Craig Morrow, John O'Sullivan, Link Richardson, Jim Reiskytl, Dave Sandberg, Van Villaruz, and Albert Zlogar. The work group would also like to thank Philip Barlow, Jan Brown, Bill Carmello, Michael Cebula, Allen Elstein, Mark Evans, Dennis Lauzon, and Mark Tenney for their helpful suggestions and feedback.

(*It should also be noted, that since this project has been on-going for several years, many other individuals contributed to the work that paved the way for this report.)

Background

Several years ago, the NAIC's Life Risk-Based Capital (RBC) Working Group asked the American Academy of Actuaries (Academy) to take a fresh look at the C-3 component of the RBC formula to see if a practical method could be found to reflect the degree of asset/liability mismatch risk of a particular company.

The Academy's Life Capital Adequacy Subcommittee (LCAS) reviewed the request and agreed that more sensitivity to the specifics of product design and funding strategy is appropriate to advance the goal of differentiating weakly capitalized companies from the rest. We have defined C-3 risk to include Asset/Liability risk in general, not just interest rate risk.

Effective December 31, 2000, the NAIC implemented Phase I of this project. Phase I addressed interest rate risk for annuities and single premium life. For Phase I, "annuities" is defined as products with the characteristics of deferred and immediate annuities, structured settlements, guaranteed separate accounts, and GICs (including synthetic GICs, and funding agreements). Equity based variable products were not included in Phase I, but products that guarantee an interest rate index and variable annuities sold as fixed were (if they were cash flow tested). Phase I of the project recommended the determination of capital requirements for interest sensitive products by scenario testing (October 1999 report; available at www.actuary.org). When implemented by the NAIC, the requirement exempted companies from scenario testing based on a significance and stress test of C-3 risk.

In December 2002, the LCAS submitted a Phase II recommendation for capital standards for certain products with equity related risks. That recommendation, when exposed for comments, generated a number of comments, questions, and concerns. This current report is a revised version of the December 2002 report, with several changes to scope and some implementation items. Appendix 5 highlights the main changes from the prior report. Covered products are described in the Scope section.

In this recommendation, the LCAS recommends implementing Phase II to address the equity risk, the interest rate risk, and the expense recovery risk associated with variable annuities, with group annuities which contain death benefit or living benefit guarantees for their equity funds, and for insurance contracts that provide death benefit floors for equity fund performance. (Equity indexed products are excluded from this requirement. Separate account products that guarantee an index are covered in another recommendation from the LCAS which was submitted to the NAIC in December 2002 and adopted by them in June 2003.)

Since the data to be used for the development of these capital requirements is not available to us, we have made no attempt to quantify the overall impact of these requirements. The Alternative Method factors allow an approximate sense of the impact on a company for which exposure data is known. The Capital Adequacy Task Force may wish to consider an analysis of the results of this capital standard following the first submission of results, perhaps with additional breakdowns such as between companies using the Alternative Method and those doing modeling.

In addition, we suggest revisiting all aspects of this methodology: assumption setting, regulatory issues, hedge evaluation, standards, Alternative Method results in practice, areas in need of clarification, etc after two years of regulatory filings. The Academy will be glad to assist in that review.

Recommended Approach

- Aggregate the results of running stochastic scenarios using prudent best estimate assumptions (the more reliable the underlying data is, the smaller the need for margins for conservatism) and calibrated fund performance distribution functions.

- Calculate required capital for each scenario similar to the method used in C-3 Phase I: for each scenario, accumulated statutory surplus is determined for each calendar year-end and its present value calculated. The lowest of these present values is tabulated and the scenarios are then sorted on this measure. For this purpose, statutory surplus is modeled as if the statutory reserve was equal to the Working Reserve.

- Unlike the Phase I project, we favor the approach introduced by the Canadian Institute of Actuaries (CIA) work and recommend the use of a Conditional Tail Expectation (CTE) risk measure to set Total Asset Requirements. Risk Based Capital is calculated as the excess of the Total Asset Requirement above the statutory reserves. The December 2001 report of the CIA Task Force on Segregated Fund Investment Guarantees is available at http://www.actuaries.ca/publications/2002/202012e.pdf. We highly recommend that practitioners read the CIA Task Force report. It covers many stochastic modeling issues of direct relevance to practitioners. Actuaries may find it a useful reference in building and testing their models .

- This RBC is to be combined with the $C1_{CS}$ component for covariance purposes.

- A provision for the interest rate risk of the guaranteed fixed fund option, if any, is to be calculated and combined with the current C3 component of the formula.

- The way grouping (of funds and of contracts), sampling, number of scenarios, and simplification methods are handled is the responsibility of the actuary. However, all these methods are subject to Actuarial Standards of Practice (ASOP), supporting documentation and justification. Section 2.1 and 2.2 of the CIA Task Force report provide a thoughtful discussion of many of these considerations.

- Actuarial certification of the work done to set the RBC level will be required. Essentially, a qualified actuary (referred to throughout this document as "the actuary") will certify that the work has been done in a way that meets all appropriate actuarial standards. The certification should specify that the actuary is not opining on the adequacy of the company's surplus or its future financial condition. The actuary will also note any material change in the model or assumptions from that used previously and the impact of such changes. Changes will require regulatory disclosure and may be subject to regulatory review and approval.

- Realizing that capital is only part of the solution, we feel that good actuarial practice would include stress testing the sensitivity of the RBC result to future equity performance. Although this information will not affect the capital requirement, it provides valuable risk management information for company management and regulators. Such testing may also be required by regulation or actuarial standards.

Glossary

Gross Wealth Ratio – The gross wealth ratio is the cumulative return for the indicated time period and percentile (e.g., 1.0 indicates that the index is at its original level).

Variable Annuity Guaranteed Living Benefit (VAGLB) – A VAGLB is a guaranteed benefit providing, or resulting in the provision that, one or more guaranteed benefit amounts payable or accruing to a living contractholder or living annuitant, under contractually specified conditions (e.g., at the end of a waiting period, upon annuitization, or upon withdrawal of premium over a period of time) will increase contractual benefits should the contract value referenced by the guarantee (e.g., account value) fall below a given level or fail to achieve certain performance levels. Only such guarantees having the potential to provide benefits with a present value as of the benefit commencement date that exceeds the contract value referenced by the guarantee are included in this definition.

Guaranteed Minimum Income Benefit (GMIB) – The GMIB is a VAGLB design for which the benefit is contingent on annuitization of a variable deferred annuity contract or similar contract. The benefit is typically expressed as a contractholder option, on one or more option dates, to have a minimum amount applied to provide periodic income using a specified purchase basis.

Conditional Tail Expectation (CTE) – Conditional Tail Expectation is a statistical risk measure that provides enhanced information about the tail of a distribution above that provided by the traditional use of percentiles. Instead of only identifying a value at the 95th percentile (for example) and ignoring possibly exponentially increasing values in the tail, CTE provides the average over all remaining values in the tail. Thus for many "traditional" loss distributions that are near normal CTE (90) will approximate the 95th percentile, but for distributions with "fat tails" from low probability, high impact events, the use of CTE will provide a higher, more revealing (and conservative) measure than the traditional percentile counterpart.

Clearly Defined Hedging Strategy. The designation of Clearly Defined Hedging Strategy applies to strategies undertaken by a company to manage risks through the future purchase or sale of hedging instruments and the opening and closing of hedging positions. In order to qualify as a Clearly Defined Hedging Strategy, the strategy must meet the principles outlined in Appendix 7 – Principles (particularly Principle 5) and shall, at a minimum, identify

1) the specific risks being hedged (e.g., delta, rho, vega, etc.),
2) the hedge objectives,
3) the risks not being hedged (e.g., variation from expected mortality, withdrawal, and other utilization or decrement rates assumed in the hedging strategy, etc.),
4) the financial instruments that will be used to hedge the risks,
5) the hedge trading rules including the permitted tolerances from hedging objectives,
6) the metric(s) for measuring hedge effectiveness,
7) the criteria that will be used to measure effectiveness,
8) the frequency of measuring hedging effectiveness ,
9) the conditions under which hedging will not take place, and
10) the person or persons responsible for implementing the hedging strategy.

The hedge strategy may be dynamic, static or a combination thereof.

It is important to note that strategies involving the offsetting of the risks associated with variable annuity guarantees with other products outside of the scope of these recommendations (e.g., equity indexed annuities) do not currently qualify as a Clearly Defined Hedging Strategy under these recommendations.

Guaranteed Minimum Death Benefit (GMDB) - The GMDB is a guaranteed benefit providing, or resulting in the provision that, an amount payable on the death of a contractholder, annuitant, participant, or insured will be increased and/or will be at least a minimum amount. Only such guarantees having the potential to produce a contractual total amount payable on death that exceeds the account value, or in the case of an annuity providing income payments, an amount payable on death other than continuation of any guaranteed income payments, are included in this definition. GMDBs that are based on a portion of the excess of the account value over the net of premiums paid less partial withdrawals made (e.g., an Earnings Enhanced Death Benefit) are also included in this definition.

Prudent Best Estimate - The deterministic assumptions to be used for modeling are to be the actuary's "prudent best estimate". This means that they are to be set at the conservative end of the actuary's confidence interval as to the true underlying probabilities for the parameter(s) in question, based on the availability of relevant experience and its degree of credibility. The actuary shall follow the principles discussed in Methodology Notes C3-03 and C3-04 in determining "prudent best estimate" assumptions.

A "prudent best estimate" assumption would normally be defined by applying a margin for estimation error to the "best estimate" assumption. "Best estimate" would typically be the actuary's most reasonable estimate of future experience for a risk factor given all available, relevant information pertaining to the contingencies being valued. Recognizing that assumptions are simply assertions of future unknown experience, the margin for error should be directly related to uncertainty in the underlying risk factor. The greater the uncertainty, the larger the margin. Each margin should serve to increase the liability or provision that would otherwise be held in its absence (i.e., using only the best estimate assumption).

For example, assumptions for circumstances that have never been observed require more margin for error than those for which abundant and relevant experience data are available. Furthermore, larger margins are typically required for contingencies related to contractholder behavior when a given contractholder action results in the surrender or exercise of a valuable option.

Revenue Sharing. Revenue Sharing, for purposes of these requirements, means any arrangement or understanding by which an entity responsible for providing investment or other types of services makes payments to the company (or to one of its affiliates). Such payments are typically in exchange for administrative services provided by the company (or its affiliate), such as marketing, distribution and/or recordkeeping. Only payments that are attributable to charges or fees taken from the underlying variable funds or mutual funds supporting the contracts that fall under the scope of these requirements shall be included in the definition of Revenue Sharing.

Working Reserve - For doing the necessary projections, the concept of a Working Reserve is introduced in order to simplify the calculations.

At any point in the projections, including at the start of the projection, the Working Reserve shall equal the projected Cash Surrender Value.

For a variable payout annuity without a Cash Surrender Value, the Working Reserve shall equal the present value, at the maximum valuation interest rate and the valuation mortality table specified for such a product by the Standard Valuation Law, of future income payments projected using a return based on the valuation interest rate less appropriate asset based charges.

For contracts not covered above including variable payout annuities with liquidity options or variable payout annuities that provide alternative benefit designs, e.g., joint and last survivor, life with period certain, etc., the actuary shall determine the Working Reserve in a manner that is consistent with the above requirements. For example, for many reinsurance contracts and group insurance contracts the working reserve is zero.

Scope

Covered products consist of:

--all variable annuities except for Modified Guaranteed Annuities;

--group annuities containing guarantees similar in nature to VAGLBs or GMDBs; and

--all other products that contain guarantees similar in nature[1] to GMDBs or VAGLBs, even if the company does not offer the funds to which these guarantees relate, where there is no explicit reserve requirement (other than AG VACARVM) for such guarantees. If such a benefit is offered as a part of a contract that has an explicit reserve requirement other than AG CARVM[2], the methods of this capital requirement shall be applied to the benefit on a standalone basis.

--Separate account products that guarantee an index and do not offer GMDBs or VAGLBs are excluded from the scope of this requirement.

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[1] The term "similar in nature", as used above is intended to capture both current products and benefits as well as product and benefit designs that may emerge in the future. Examples of the currently known designs are listed in footnote #2 below. Any product or benefit design that does not clearly fit the Scope should be evaluated on a case-by-case basis taking into consideration factors that include, but are not limited to, the nature of the guarantees, the definitions of GMDB and VAGLB and whether the contractual amounts paid in the absence of the guarantee are based on the investment performance of a market-value fund or market-value index (whether or not part of the company's separate account).

[2] For example, a group life contract that wraps a GMDB around a mutual fund would generally fall under the scope of the this requirement since there is not an explicit reserve requirement for this type of group life contract. However, for an individual variable life contract with a GMDB and a benefit similar in nature to a VAGLB, this requirement would generally apply only to the VAGLB-type benefit, since there is an explicit reserve requirement that applies to the variable life contract and the GMDB.

Method

All covered products that contain any living benefit guarantees, whether written directly or assumed through reinsurance, must utilize scenario testing to establish capital requirements. Variable annuities with no such guarantees may use scenario testing or the "Alternative Method" described below. Other covered products must utilize scenario testing, unless sufficient modeling is done to allow adjustment of the Alternative Method factors.

Modeling Methodology

The proposed methodology involves running a cash flow testing model over a number of scenarios, calculating a value for each and basing the total asset requirement (including reserves) on the distribution of those results. The RBC requirement is the difference between the total asset requirement and the reserve with an adjustment for differences between tax reserves and statutory reserves.

1. Scenarios

   Scenarios will consist of a sufficient number of equity scenarios, adequate for the purpose, created by the company. The equity scenarios will need to meet the calibration methodology and requirements outlined in Appendix 2. Guaranteed Fund results need to reflect the risk of interest rate shocks and several alternatives for doing so are available (see Appendix 6). If stochastic interest rate scenarios are not part of the model being used, the GMIB results need to reflect the impact of the uncertainty in interest margins (see Appendix 3).

2. Asset/Liability Model

   Asset/Liability models are to be run that reflect the dynamics of the expected cash flows for the entire contract, given the guarantees provided under the contract. Federal Income Tax, insurance company expenses (including overhead and investment expense), fund expenses, contractual fees and charges, revenue sharing income received by the company (net of applicable expenses), and cash flows associated with any reinsurance or hedging instruments are to be reflected on a basis consistent with the requirements herein. Cash flows from any fixed account options should also be included. Any market value adjustment assessed on projected withdrawals or surrenders shall also be included (whether or not the Cash Surrender Value reflects market value adjustments).

3. Assets

For the projections of accumulated statutory surplus, the value of assets at the start of the projection shall be set equal to the approximate value of statutory reserves at the start of the projection. The mix of assets between separate account and general account assets should be consistent with that used for cash flow testing. 100% of separate account assets held in support of these products should be included in the modeling. If specific "hedge assets", such as equity put options, are being held for the benefit of these products, these are reflected in the model in full and other general account assets assigned are reduced accordingly. In many instances the initial general account assets may be negative, resulting in an interest expense. Since the capital definition depends on statutory surplus projections, assets should be valued at their annual statement value.

4. Fund categorization

The funds offered in the product may be grouped for modeling. In Methodology Note C3-01 (part of this report), various current practices are provided. Regardless of the method chosen, fundamental characteristics of the fund should be reflected and the parameters should have the appropriate relationship to the required calibration points of the S&P 500. The modeling should reflect characteristics of the efficient frontier (i.e., returns generally cannot be increased without assuming additional risk).

5. Modeling of Hedges

The appropriate costs and benefits of hedging instruments that are currently held by the company in support of the contracts falling under the scope of these requirements shall be included in the projections. If the company is following a clearly defined hedging strategy and the modeling method is used, the stochastic modeling should take into account the appropriate costs and benefits of hedge positions expected to be held in the future through the execution of that strategy. This recognizes that a hedging strategy may not require hedge positions to be held at a particular point in time; however, allowance for the impact of hedge positions not currently held, is only permitted if the insurer is following a clearly defined hedging strategy that is in accordance with the investment policy adopted by the Board of Directors, or an authorized committee. To the degree either the currently held hedge positions or the hedge positions expected to be held in the future introduce basis, gap, price, or assumption risk, a suitable reduction for effectiveness of hedges should be made. Appendix 10 details the standards for this modeling.

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

6. Revenue Sharing

Projections of Accumulated Deficiencies may include income from projected future Revenue Sharing, as defined in the glossary, net of applicable projected expenses ("Net Revenue Sharing Income") if the following requirements are met:

(a) the Net Revenue Sharing Income is received and controlled by the company[3];

(b) signed contractual agreement or agreements are in place as of the valuation date and support the current payment of the Net Revenue Sharing Income; and

(c) the Net Revenue Sharing Income is not already accounted for directly or indirectly as a company asset.

The amount of Net Revenue Sharing Income to be used shall reflect the actuary's assessment factors that include but are not limited to the following (not all of these factors will necessarily be present in all situations):

(a) the terms and limitations of the agreement(s), including anticipated revenue, associated expenses and any contingent payments incurred or made by either the company or the entity providing the Net Revenue Sharing as part of the agreement(s);

(b) the relationship between the company and the entity providing the Net Revenue Sharing Income that might affect the likelihood of payment and the level of expenses;

(c) the benefits and risks to both the company and the entity paying the Net Revenue Sharing Income of continuing the arrangement.

(d) the likelihood that the company will collect the Net Revenue Sharing Income during the term(s) of the agreement(s) and the likelihood of continuing to receive future revenue after the agreement(s) has ended;

(e) the ability of the company to replace the services provided to it by the entity providing the Net Revenue Sharing Income or to provide the services itself, along with the likelihood that the replaced or provided services will cost more to provide; and

(f) the ability of the entity providing the Net Revenue Sharing Income to replace the services provided to it by the company or to provide the services itself, along with the likelihood that the replaced or provided services will cost more to provide.

[3] As in other sections of the report, the term "the company" is used exclusively as a reference to the insurance company writing the business falling under the scope of these requirements. The term "entity providing the Net Revenue Sharing Income" is self-explanatory and is used consistently in this subsection.

The amount of projected Net Revenue Sharing Income shall also reflect a margin for error (which decreases the assumed Net Revenue Sharing Income) directly related to the uncertainty of the revenue. The greater the uncertainty, the larger the margin[4].

To the extent the agreement(s) guarantees[5] the payment of Net Revenue Sharing Income to the company, the net revenue may be included in full over the period for which it is guaranteed[6].

All expenses required or assumed to be incurred by the company in conjunction with the arrangement providing the Net Revenue Sharing Income, as well as any expenses assumed to be incurred by the company in conjunction with the assumed replacement of the services provided to it (as discussed above) shall be included in the projections as a company expense under the requirements of section 2 (Asset/Liability Model), above. In addition, expenses incurred by either the entity providing the Net Revenue Sharing Income or an affiliate of the company shall be included in the applicable expenses that reduce the Net Revenue Sharing Income.
The actuary is responsible for reviewing the revenue sharing agreements, verifying compliance with these requirements, and documenting the rationale for any source of Net Revenue Sharing Income used in the projections.

7. Expected Interest Rates

For discounting future surplus needs and for earnings on projected general account investments (beyond the maturity of the current assets), companies that do not use an integrated model are to use the implied forward rates from the swap curve. Companies that do have an integrated model may use the rates generated by that model or the swap curve, but must use the method chosen consistently from year to year. Whether from a model or from the swap curve, the discount rates need to be reduced for Federal Income Tax. Interest earnings on existing fixed assets should be reduced to reflect expected credit losses.

Assumptions for GMIB purchase rate margins are discussed in Appendix 3.

8. Interest Rate Risk

[4] Because the uncertainty would be expected to increase over time, it may be necessary to decrease the portion for later periods.

[5] Provisions such as one that gives the entity paying the Net Revenue Sharing Income the option to stop or change the level of income paid would prevent the income from being guaranteed. However, if such an option becomes available only at a future point in time, and the revenue up to that time is guaranteed, the income is considered guaranteed up to the time the option first becomes available.

[6] If the agreement allows the company to unilaterally take control of the underlying fund fees that ultimately result in the Net Revenue Sharing Income then the revenue is considered guaranteed up until the time at which the company can take such control. Since it is unknown whether the company can perform the services associated with the revenue sharing arrangement at the same expense level, it is presumed that expenses will be higher in this situation. Therefore, the Net Revenue Sharing Income shall be reduced to account for any actual or assumed additional expenses.

In addition to the equity risk of products subject to these requirements, there is a traditional credit risk and C3 interest rate risk for funds supporting the guaranteed fund option. Credit risk is currently picked up directly in the overall C1 calculation, since the calculation of this component doesn't exclude assets supporting variable annuities. We recommend that this practice be continued. The current formula also includes (in C1) a reflection of the risk of "CARVM allowance recovery." This separate calculation is no longer needed because it is considered in the calculations recommended by this report in other ways. (Although for a variable annuity with no living or death guarantees the Alternative Method continues to use this formula as a part of C3).

C3 interest rate risk for the guaranteed options in these contracts is considered in the C3 Phase I calculation but only for "variable annuities sold as fixed." The current formula does not recognize this risk for other variable annuities with guaranteed fund options.

We recommend that the C3 interest rate risk be recognized for all variable annuities in calculating RBC according to methods outlined in this report. There are a number of ways in which this may be accomplished (see Appendix 6) In reflecting this risk:

i) Companies may combine the guaranteed fund portions of variable annuities and similar contracts with the other interest sensitive products included in C3 interest risk or may handle them separately, and differently.

ii) If the company is "exempt" from regular C-3 Phase 1 scenario testing, it may elect to be non-exempt for the variable annuity portion or for all C3 interest rate testing. However, a company that makes such a choice may not revert to the factor method without regulatory approval.

8. Liabilities

For the purposes of capital determination, "statutory surplus" is based on a liability value at time t equal to the Working Reserve. This will result in a surplus at the start of the projections equal to the excess of the starting value of assets included in the model over the Working Reserve.

9. Asset Requirements for a Specific Scenario

The Additional Asset Requirement (AAR) for a particular scenario is the negative of the lowest present value of statutory surplus at any year-end, including the current one. This value may be negative (sufficient) or positive (deficient). The Scenario Specific Total Asset Requirement for that scenario is the sum of the AAR plus the starting assets.

10. Determination of Total Asset Requirement and Risk Based Capital using CTE in the NAIC RBC framework

Having determined the Total Asset Requirement for each scenario, the values are sorted by amount and the average of the highest 10% is taken. This is the Total Asset Requirement for the business being evaluated.

The Risk Based Capital requirement is the Total Asset Requirement adjusted for taxes, minus the statutory reserve actually held.

Tax Adjustment: Under the U.S. IRC the tax reserve is defined. It can never exceed the statutory reserve nor be less than the cash surrender value. If tax reserves assumed in the projection are set equal to Working Reserves and if tax reserves actually exceed Working Reserves at the beginning of the projection, a tax adjustment is required.

A tax adjustment is not required in the following situations:

- Tax reserves are projected directly; that is, it is not assumed that projected tax reserves are equal to Working Reserves, whether these are cash values or other approximations.
- Tax reserves at the beginning of the projection period are equal to Working Reserves.
- Tax reserves at the beginning of the projection period are lower than Working Reserves. This situation is only possible for contracts without cash surrender values and when these contracts are significant enough to dominate other contracts where tax reserves exceed Working Reserves. In this case the modeled tax results are overstated each year for reserves in the projection, as well as the projected tax results reversed at the time of claim.

If a tax adjustment is required the Total Asset Requirement (TAR) must be increased on an approximate basis to correct for the understatement of modeled tax expense. The additional taxable income at the time of claim will be realized over the projection and will be measured approximately using the "duration to worst", i.e. the duration producing the lowest present value for each scenario. The method of developing the approximate tax adjustment is described below.

The increase to TAR may be approximated as the corporate tax rate (i.e. 35%) times "f" times the difference between tax reserves and Working Reserves at the start of the projections. For this calculation, f is calculated as follows. For the scenarios reflected in calculating 90 CTE, the lowest of these present values of accumulated statutory surplus is determined for each calendar year-end and its associated projection duration is tabulated. At each such duration, the ratio of the number of contracts in force (or covered lives for group contracts) to the number of contracts in force (or covered lives) at the start of the modeling projection is calculated. The average ratio is then calculated, over all 90 CTE scenarios, and f is one minus this average ratio. If instead, RBC is determined under the standard scenario method then f is based on the ratio at the worst duration under that scenario. If the Alternative Method is used, f is approximated as .5.

-- Existing NAIC RBC Framework - Three key characteristics are important to consider here:

- Early Warning - RBC is designed to serve as an early warning system for companies that could be headed towards insolvency.
- Percentile basis - The required capital level for individual risk elements is often set at the 95th percentile over a multi-year time horizon. Use of a percentile measure ignores the extreme tail, or assumes that there are no high impact, low probability events in the tail.
- Volatility - For most risks, the current measures used (asset rating, face amount, reserves and premium) result in stable RBC levels from year to year, with linear relationships to changes in the measures.. The only exceptions to this are the economic related measures, the C-3 calculation for those companies required to do C-3 Phase I testing, and the C-1 calculation for bonds whose credit rating is changed.

- Shortcomings of Formulas to Assess Economic Risk

  Formulas must be based on assumptions about product design, policyholder behavior and economic relationships and conditions. The increasing economic volatility seen over the last few decades, combined with increasingly complex products, have made attempts to use formulas for measuring economic based risk less successful. This has led to mandating cash flow testing for life insurance and the exploration of an economic based modeling approach for annuities (this project).

- Volatility

  Since this is an economic risk that is being assessed, it will, by its nature (unless adequately hedged), be more volatile than traditional risk measures and may show dramatic changes from year to year in response to large changes in equity values. Although this volatility is a reflection of the true economic values of the embedded options, we believe that reflecting these changes in the "trend test" of the RBC formula would be an inappropriate extrapolation of recent market performance, and so we recommend this change should be excluded from "trend".

  The high volatility of an economic risk measure can limit the effectiveness of the early warning objective of RBC. One approach could be to mandate an even higher level of capital be held as a way of ensuring that there will be funds available. However, this confuses reserves with RBC and also ignores the economics of these tail events. For example, assume the following distribution of worst 10 outcomes of 100 scenarios: 0, 0, 0, -3, -7, -12, -22, -38, -58, -100. CTE 90 = -24 and CTE 95 =-46. If the worst-case scenario occurs, neither the CTE 90 nor CTE 95 standard will be adequate. In addition, if the economic climate worsens next year, both standards will need to post additional capital and the level of this additional amount is unrevealed by the current CTE value. Yet, the information can be readily captured via sensitivity testing. The early warning effectiveness will be strengthened through the required disclosure of this sensitivity, since this allows both the company and regulators to get a better sense of the risk exposure. Duration measures show the impact of future interest rate changes on today's asset values. A demonstration of how equity growth of -20 percent, -10 percent, and 0 percent over the next few years will impact future capital levels is just as valuable to demonstrate the levels of exposures held by a company.

11. <u>Timing of Calculations</u>

In order to allow time for the work required to develop the capital requirements, an estimated value is permitted for the year-end annual statement. For the electronic filing of risk-based capital the reported Authorized Control Level Risk-Based Capital should be no less than the amount required, using year-end data, by the NAIC Instructions which include this methodology for Variable Annuities and Similar Products. If the reported Authorized Control Level Risk-Based Capital for a company exceeds that printed in the annual statement by more than 5 percent, or if the reported Risk-Based Capital triggers regulatory action, a revised filing of the annual statement with the reported results is required to be made to the NAIC and the state of domicile by June 15; otherwise re-filing is permitted but not required.

12. C-1 Expense Allowance Elimination for Covered Products

The current RBC formula has a charge for the expense allowance in reserves of 2.4 percent (pre-tax) if the surrender charges are based on fund contributions and the fund balance exceeds the sum of premium less withdrawals; otherwise the charge is 11 percent. This amount provides for the possible non-recovery of the full "CARVM Allowance", if the stock market performs poorly. Since this impact will be captured directly in the Phase II modeling or in the Alternative Method, this separate requirement is no longer necessary for products covered by C-3, Phase II. For variable annuities with no living or death benefit guarantees, the Alternative Method continues to use this calculated amount.

Alternative Method

A company may choose to develop capital requirements for Variable Annuity contracts with no VAGLBs, by using the Alternative Method, as defined in Appendix 8 of this report instead of using scenario testing if it hasn't used scenario testing for this purpose in previous years. Companies are encouraged to develop models to allow scenario testing for this purpose. Once a company uses the stochastic modeling methodology for a block of business, the option to use the Alternative Method is no longer available for that part of its business. Contracts containing VAGLBs must be evaluated by scenario testing. Contracts not containing VAGLBs but that differ from those for which Alternative Method factors are provided may use a modified set of factors as described in Appendix 8.

Actuarial Memorandum

An actuarial memorandum should be constructed documenting the methodology and assumptions upon which the required capital is determined. The memorandum should also include sensitivity tests that the actuary feels appropriate, given the composition of their block of business (i.e., identifying the key assumptions that, if changed, produce the largest changes in the RBC amount.). This memorandum will be confidential and available to regulators upon request.

Companies using the Alternative Method do not have to opine on the underlying assumptions and model. Certification that expense, revenue, fund mapping, and product parameters have been properly reflected will be required.

Regulatory Communication

If there is a material change in assumptions from the previous year, an executive summary should be sent to the state of domicile communicating such change and quantifying the impact it has on the results. Such communication shall remain confidential.

Appendices and Methodology Notes

All Appendices and Methodology Notes to this Report are to be considered as included in the Recommendation.

Appendix 1 – General Methodology

Projections using stochastic market scenarios are run for the book of business (in aggregate) for all contracts falling under the scope of this requirement, reflecting product features, anticipated cash flows, the parameters associated with the funds being used, expenses, fees, Federal Income Tax, hedging, and reinsurance. Cash flows from any fixed account options should also be included.

For each scenario, the C-3 asset increase needed is the smallest of the series of present values S(t)*pv(t), where S(t) is statutory assets less liabilities for the products in question at the end of year t, and pv(t) is the accumulated discount factor for t years using the after-tax swap rates (or post-tax one year Treasury rates for that scenario, if applicable). For this purpose, t should range from 0 (i.e. the valuation date) to a point such that the effect of further extension is not material.

Appendix 2 – Scenario Requirements

This Appendix outlines the requirements for the stochastic models used to simulate fund performance. Specifically, it sets certain standards that must be satisfied and offers guidance to the actuary in the development and validation of the scenario models. Background material and analysis are presented to support the recommendation. The Appendix focuses on the S&P500 as a proxy for returns on a broadly diversified U.S. equity fund, but there is also advice on how the techniques and requirements would apply to other types of funds. General modeling considerations such as the number of scenarios and projection frequency are also discussed.

General Guidelines

The LCAS believes Actuarial Standard of Practice No.7 (ASOP 7) applies to the recommended requirements since it involves cash flow testing.[7]. Any conflict between ASOP 7 and the statutory requirements should be disclosed in the documentation. Specifically, such disclosure should make it clear that the analysis was performed in accordance with the requirements of the applicable law.

The calibration points given in this appendix are applicable to gross returns (before the deduction of any fees or charges). To determine the net returns appropriate for the financial projections, the actuary must consider the costs of managing the investments and converting the assets into cash when necessary[8]. Specifically, the simulations must reflect applicable fees and policyholder charges in the development of projected account values.

As a general rule, funds with higher expected returns should have higher expected volatilities and in the absence of well-documented mitigating factors (e.g., a highly reliable and favorable correlation to other fund returns), should lead to higher capital requirements[9].

State dependent models are not prohibited, but must be justified by the historic data and meet the calibration criteria. To the degree that the model uses mean-reversion or path-dependent dynamics, this must be well supported by research and clearly documented in the Memorandum supporting the required actuarial certification.

The equity scenarios used to determine capital levels must be available in an electronic format to facilitate any regulatory review.

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[7] Actuarial Standard of Practice No. 7, Adopted by the Actuarial Standards Board June 2002, section 1.2(b).

[8] Ibid., section 3.4.1(d)

[9] While the model need not strictly adhere to 'mean-variance efficiency', prudence dictates some form of consistent risk/return relationship between the proxy investment funds. In general, it would be inappropriate to assume consistently 'superior' expected returns (i.e., risk/return point above the frontier) for long-term capital modeling.

Probability Measure

In general, there are two probability measures for simulating investment returns. The *Q*-measure, or "risk neutral" distribution, is a convenient framework used for pricing securities and is predicated on the concept of replication under a 'no arbitrage' environment. Under the *Q*-measure, risk is hedged (hence, securities are expected to earn the risk-free rate) and derivatives (options) can be priced using their expected discounted cashflows. The *Q*-measure is crucial to option pricing, but equally important is the fact that it tells us almost nothing about the true probability distribution. The *Q*-measure is relevant only to pricing ("fair market value" determination) and replication (a fundamental concept in hedging); any attempt to project values ("true outcomes") for a risky portfolio must be based on an appropriate (and unfortunately subjective) "real world" probability model. This is the so-called physical measure, or *P*-measure.

The "real world" model should be used for all cash flow projections, consistent with the risk preferences of the market. This is the basis for the valuation of required capital and is the focus of the remainder of this appendix. However, the risk neutral measure is relevant if the company's risk management strategy involves the purchase or sale of derivatives or other financial instruments in the capital markets.

Equity Market Returns

Short period distributions of historic equity returns typically show negative skewness, positive kurtosis (fat tails)[10] with time varying volatility[11] and increased volatility in bear markets. The measure of kurtosis declines when looking at returns over longer time horizons and successive application of a short-term model with finite higher moments will result in longer horizon returns that converge towards normality.[12] Ideally the distribution of returns for a given model should reflect these characteristics. Of course, due to random sampling, not every scenario would show such attributes.

[10] Harry H. Panjer et al., *Financial Economics* (Illinois: The Actuarial Foundation, 1998): pp438

[11] John Y. Campbell et al., *The Econometrics of Financial Markets*, (New Jersey: Princeton University Press, 1997): pp379

[12] John Y. Campbell et al., *The Econometrics of Financial Markets*, (New Jersey: Princeton University Press, 1997): pp0

Unfortunately, at longer time horizons the small sample sizes of the historic data make it much more difficult to make credible inferences about the characteristics of the return distribution, especially in the tails. As such, the calibration criteria are derived from a model (fitted to historic S&P500 monthly returns) and not based solely on empirical observations. However, the calibration points are not strictly taken from one specific model for market returns; instead, they have been adjusted slightly to permit several well known and reasonable models (appropriately parameterized) to pass the criteria. Statistics for the observed data are offered as support for the recommendations.

Calibration Criteria for Equity Returns

Table 1 provides the proposed standard for the calibration of equity return models.

Table 1: Calibration Standard for Total Return Wealth Factors

Percentile	1 Year	5 Years	10 Years	20 Years
2.5%	0.78	0.72	0.79	n/a
5.0%	0.84	0.81	0.94	1.51
10.0%	0.90	0.94	1.16	2.10
90.0%	1.28	2.17	3.63	9.02
95.0%	1.35	2.45	4.36	11.70
97.5%	1.42	2.72	5.12	n/a

The 'wealth factors' are defined as gross accumulated values (i.e., before the deduction of fees and charges) with complete reinvestment of income and maturities, starting with a unit investment. These can be less than 1, with "1" meaning a zero return over the holding period.

To interpret the above values, consider the 5-year point of 0.72 at the $\alpha = 2.5^{th}$ percentile. This value implies that there is a 2.5 percent probability of the accumulated value of a unit investment being less than 0.72 in 5-years time, ignoring fees and expenses and without knowing the initial state of the process (i.e., this is an unconditional[13] probability). For left-tail calibration points (i.e., those quantiles less than 50%), lower factors after model calibration are required. For right-tail calibration points (quantiles above 50%), the model must produce higher factors.

Unfortunately, the historic data do not permit credible inferences about long-term equity returns in the tails of the distribution (see the section entitled "Reasonableness for the

[13] In this context, the term "unconditional" should be interpreted to mean that the resulting values would be obtained "on average over the long term". This can be determined by using long-run or neutral values (e.g., median) for the initial state variables or by running the model with "current" state parameters over a longer period and ignoring the returns for the first 10 years.

Calibration Points" later in this Appendix). As such, factors for the 20-year horizon at the 2.5% and 97.5% points are deliberately excluded from the calibration.

Using the Calibration Points

The actuary may need to adjust the model parameters in order to satisfy the calibration criteria in Table 1. This can be accomplished in a variety of ways, but a straightforward approach would modify the parameters controlling 'drift' (expected continuous return) and 'volatility' (standard deviation of returns). This might be accomplished analytically, but in most practical applications would require simulation.

As a first step, the actuary should determine which tail (left, right or both) is most relevant for the business being valued and then identify those calibration points not satisfied by the current scenario set. All else being equal, lowering drift will decrease the resulting wealth factors, while raising volatility will decrease the left-tail factors (i.e., those quantiles < 50%) and increase the right. Changes to both drift[14] and volatility parameters can obviously affect the entire shape of the curve, but as a general rule the 'drift' terms have less impact over the shorter holding periods (i.e., the 1-year 'tail factors' are more affected by volatility).

As an example, suppose the company is using the independent lognormal ("ILN") model for equity returns. This is a two-parameter model whereby the log (i.e., continuous) returns are normally distributed with constant mean μ and variance σ^2. From the historic monthly S&P500TR data (December 1955 to December 2003, inclusive) we obtain the monthly maximum likelihood estimators of μ = 0.008356 (10.03% annualized) and σ = 0.042558 (14.74 % annualized)[15].

[14] The term "drift" generically refers to those parameters which control the trend in the return process. The term volatility is reserved for the model components which affect the standard deviation of returns. For some models, such a fine distinction is not possible.

[15] Here, the parameters μ and σ are respectively the annualized mean and standard deviation of the associated normal distribution for the log (i.e., continuous) returns. μ is sometimes called the "drift" or "trend" parameter and is the expected log return over a 1 year horizon. The volatility parameter σ is the annualized standard deviation of the log returns.

Without adjustment, ILN scenarios generated from these parameters would not satisfy the calibration requirements. Nevertheless, lowering the drift to μ = 0.006667 (8% annualized) and increasing the standard deviation to σ = 0.050518 (17.5% annualized) would satisfy Table 1. This ILN model has an expected total return of 10% per annum. However, the resulting wealth factors would be too fat-tailed over the longer holding periods (relative to the criteria imposed by Table 1), indicating more conservatism than would strictly be necessary. As such, it should be clear that a two-parameter model (such as the ILN) does not offer much flexibility – to obtain a 'better fit', it would be necessary to introduce more parameters[16].

The scenarios need not strictly satisfy all calibration points, but the actuary should be satisfied that any differences do not materially reduce the resulting capital requirements. In particular, the actuary should be mindful of which tail most affects the business being valued. If capital is less dependent on the right (left) tail for all products under consideration (e.g., a return of premium guarantee would primarily depend on the left tail, an enhanced benefit equal to a percentage of the gain would be most sensitive to the right tail, etc.), it is not absolutely necessary to meet the right (left) calibration points.

If the scenarios are 'close' to the calibration points, an acceptable method to true up the scenarios is to start with the lowest bucket not meeting the calibration criteria (e.g., one year factor at α = 2.5%) and randomly duplicate (or re-generate) a scenario meeting this criteria until the set of scenarios meets this calibration point. If a fixed number of scenarios is required, a scenario can be eliminated at random in the first higher bucket that satisfies the calibration criteria. The process would continue until all one-year calibration points are achieved and then be repeated for the 5, 10 and 20-year criteria. However, on completing the 'bucket' for a given holding period, it may be necessary to redo the tests for the other horizons to ensure they still meet the calibration points. It is acknowledged that this method is not statistically correct, but it is not anticipated that the process would introduce any material bias in the calculated capital requirements.

It is possible to parameterize some path and/or state dependent models to produce higher volatility (and/or lower expected returns) in the first 20 years in order to meet the calibration criteria, but with lower volatility (and/or higher expected returns) for other periods during the forecast horizon. While this property may occur for certain scenarios (e.g., the state variables would evolve over the course of the projection and thereby affect future returns), it would be inappropriate and unacceptable for a company to alter the model parameters and/or its characteristics for periods beyond year 20 in a fashion not contemplated at the start of the projection and primarily for the purpose(s) of reducing the volatility and/or severity of ultimate returns.[17]

[16] In particular, parameters are needed to model time-varying volatility.

[17] Such adjustments must be clearly documented and justified by the historic data.

For models that require starting quantities for certain state variables[18], long-term ('average' or 'neutral') values should be used for calibration. The same values should normally be used to initialize the models for generating the actual projection scenarios unless alternative values can be clearly justified[19]. It should be noted that a different set of initialization parameters might produce scenarios that do not satisfy all the calibration points shown in Table 1.

Development of the Calibration Points

The first step in the process involved fitting a model to monthly historic data and then using the model to generate gross wealth ratios for a range of probabilities over various holding periods. The required constraints (the "calibration criteria") were then obtained by making modest adjustments (up or down) to the gross wealth ratios so that a range of suitably parameterized models would pass (described further in the next section).

A stochastic log volatility ("SLV") model was used for the analysis and to develop preliminary ("unadjusted") calibration points. This model is not prescribed or 'preferred' above others, but was chosen because it captures many of the dynamics noted earlier, including "volatility clustering" (i.e., "regimes" of high and low volatility).

The SLV model parameters were determined by "constrained" maximum likelihood estimation applied to monthly S&P500 total return data from December 1955 to December 2003 inclusive. In the estimation process, some subjective restrictions were imposed to ensure an unconditional[20] expected total annualized return of 8.75% effective.

The historic data suggest a higher expected return (i.e., over 10% per annum) than what might currently (i.e., as at December 2004) be obtained using an equity risk premium ("ERP")[21] model. However, this historical average also reflects the historical risk (i.e., the volatility and higher moments of the return distribution) "embedded" in the data series. Accordingly, if the parameters are modified to produce a lower mean then logically the "risk" should also be adjusted (e.g., by changing the other moments of the return distribution).

[18] For example, the stochastic log volatility ("SLV") model described later in this appendix requires the starting volatility. Also, the regime-switching lognormal model requires an assumption about the starting regime.

[19] A clear justification exists when state variables are observable or "known" to a high degree of certainty and not merely estimated or inferred based on a "balance of probabilities".

[20] The term "unconditional" is used since the starting volatility was set equal to its long-run average.

[21] Commensurate with the underlying risk, ERP models typically assume that the expected return on equities is a spread over the return available on risk-free investments.

To recognize model risk and parameter uncertainty it was agreed that the some constraints should be introduced. For practical reasons, this was accomplished by adjusting the parameters to reduce the expected return. We believe such refinements are consistent with the concept of "prudent best estimate" assumptions and furthermore that the "adjusted" model produces returns that are within the long-term reasonable expectations of practitioners[22]. An unconditional mean total return of 8.75% seemed reasonable for the following reasons:

1. Over the last 50 and 20 years respectively, the average returns on 3-month Treasury bills were approximately 5.30% and 5.15% (annual effective). Hence, taking a long-term perspective (i.e., the forecast horizon is at least 20 years), the range 5 – 5.25% seems sensible for future risk-free rates.
2. A so-called "equity risk premium" (above risk-free rates) in the range 3.5 – 3.75% per annum does not seem excessive given the return characteristics of the equity model (i.e., volatility clustering, negative skewness and positive kurtosis).

The monthly SLV model is governed by the following equations. The parameter values are given in Table 2.

$$\tilde{v}(t) = Min\left[v^{+}, (1-\phi)\times v(t-1) + \phi\times\tau\right] + \sigma_v \times {}_vZ_t$$

$$v(t) = Max\left\{v^{-}, Min\left[v^{*}, \tilde{v}(t)\right]\right\}$$

$$\mu(t) = A + B\times\sigma(t) + C\times\sigma^2(t)$$

$$\ln\left[\frac{S(t+1)}{S(t)}\right] = \frac{\mu(t)}{12} + \frac{\sigma(t)}{\sqrt{12}}\times {}_sZ_t$$

$S(t) =$ stock index level at time t

$v(t) =$ natural logarithm of annualized volatility in month t

$\sigma(t) =$ annualized volatility of stock return process in month $t = \exp\left[v(t)\right]$

$\mu(t) =$ mean annualized log return ("drift") in month t

$v^{-} =$ lower bound for log volatility = $\ln\sigma^{-}$

$v^{+} =$ upper bound for log volatility (before random component) = $\ln\sigma^{+}$

$v^{*} =$ absolute upper bound for log volatility = $\ln\sigma^{*}$

${}_vZ_t, {}_sZ_t$ are random samples from the standard bi-variate normal distribution with constant correlation co-efficient $\rho\left({}_vZ_t, {}_sZ_t\right) = \rho$. Note that $\mu(t)$ is a *deterministic* quadratic function of $\sigma(t)$. In Table 2, $v^{-} = \ln\sigma^{-}$, $v^{+} = \ln\sigma^{+}$ and $v^{*} = \ln\sigma^{*}$

[22] In this group we include only those practitioners who have *at least* a moderate understanding of stochastic models for equity market returns.

Table 2: Stochastic Log Volatility Monthly Parameters
(Fit to S&P500 Dec 1955 – Dec 2003 Log Total Returns)

τ	0.12515	Long-run target volatility (annualized)
ϕ	0.35229	Strength of mean reversion (monthly)
σ_v	0.32645	Standard deviation of the log volatility process (monthly)
ρ	–0.2488	Correlation co-efficient between ${}_vZ_t$, ${}_sZ_t$
A	0.055	Drift of stock return process as $\sigma(t) \to 0$ (i.e., intercept)
B	0.560	Co-efficient of quadratic function for $\mu(t)$
C	–0.900	Co-efficient of quadratic function for $\mu(t)$
$\sigma(0)$	0.1475	Starting volatility (annualized)
σ^-	0.03	Minimum volatility (annualized)
σ^+	0.30	Maximum volatility (annualized), before random component
σ^*	0.7988	Maximum volatility (annualized), after random component

Given $\sigma(t)$, the log (i.e., continuous) returns in any month are normally distributed with mean $\frac{\mu(t)}{12}$ and standard deviation $\frac{\sigma(t)}{\sqrt{12}}$.

It is worth noting that due to the aforementioned subjective constraint on the unconditional expected return, the historic data period is relevant only in estimating the volatility parameters (τ, ϕ, σ_v), correlation coefficient (ρ) and the *general* relationship between drift ($\mu(t)$) and volatility ($\sqrt{v(t)}$. Specifically, the parameters *A*, *B* and *C* were not estimated from the data per se, but rather set to produce an unconditional expected return of 8.75% effective. The historic period is sufficiently long to capture several economic cycles and adverse events – including episodes of high and low volatility – and was thereby deemed appropriate to the fitting of a model designed for long-term cash flow projections.

Chart 1 illustrates the unconditional probability density function (i.e., relative frequency graph) for the monthly log total returns. For comparison, the probability density functions for *calibrated* lognormal[23] ("ILN") and regime-switching lognormal[24] ("RSLN2") models are also shown. We can interpret the SLV p.d.f as invariant ("long run") since the starting volatility is 14.75% annualized, roughly equal to the long-term average value for the S&P500. Clearly, the SLV returns are not normally distributed, but exhibit negative skewness[25] (–0.66) and positive kurtosis[26] (4.12) characteristic of the historic data. For reference, the monthly observed data show a skewness of –0.59 and a kurtosis of 2.42. Indeed, over a one month period, the SLV distribution is even more peaked and fatter-tailed than the RSLN2.

Charts 2A through 2C provide some insight into the volatility paths created by the SLV model. As a benchmark, the S&P500 "realized" volatilities[27] (by month) are shown for the historic period (December 1995 to December 2003). The simulations were initialized by setting the starting volatility to 10.48% (the volatility for December 1955) to facilitate a comparison to history. As can be seen, the SLV model produces very realistic volatility profiles consistent with experience.

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[23] This is the classic lognormal model in which the log (continuous) returns in non-overlapping time periods of equal length are assumed to be independent and identically distributed normal variates with constant mean and variance. Chart 1 includes a lognormal model where the total expected return is 9% per annum and the annualized volatility is 16.5%.

[24] See Mary R. Hardy, "A Regime-Switching Model of Long-Term Stock Returns", North American Actuarial Journal, , 5.2:41-53 for an extensive review of the RSLN2 model.

[25] Skewness measures symmetry about the mean. The normal distribution has a skewness of 0, indicating perfect symmetry.

[26] Kurtosis is a measure of 'peakedness' relative to the tails of the distribution. By convention, the normal distribution has a kurtosis of zero, although some definitions give a kurtosis of 3. Except for this constant, the definitions are equivalent.

[27] The realized volatility is calculated as the standard deviation of daily log returns for the trading days within the calendar month. Values are annualized by multiplying by $\sqrt{252}$.

Chart 1: Relative Frequency of Monthly Log Returns
Calibrated SLV, ILN and RSLN2 Models

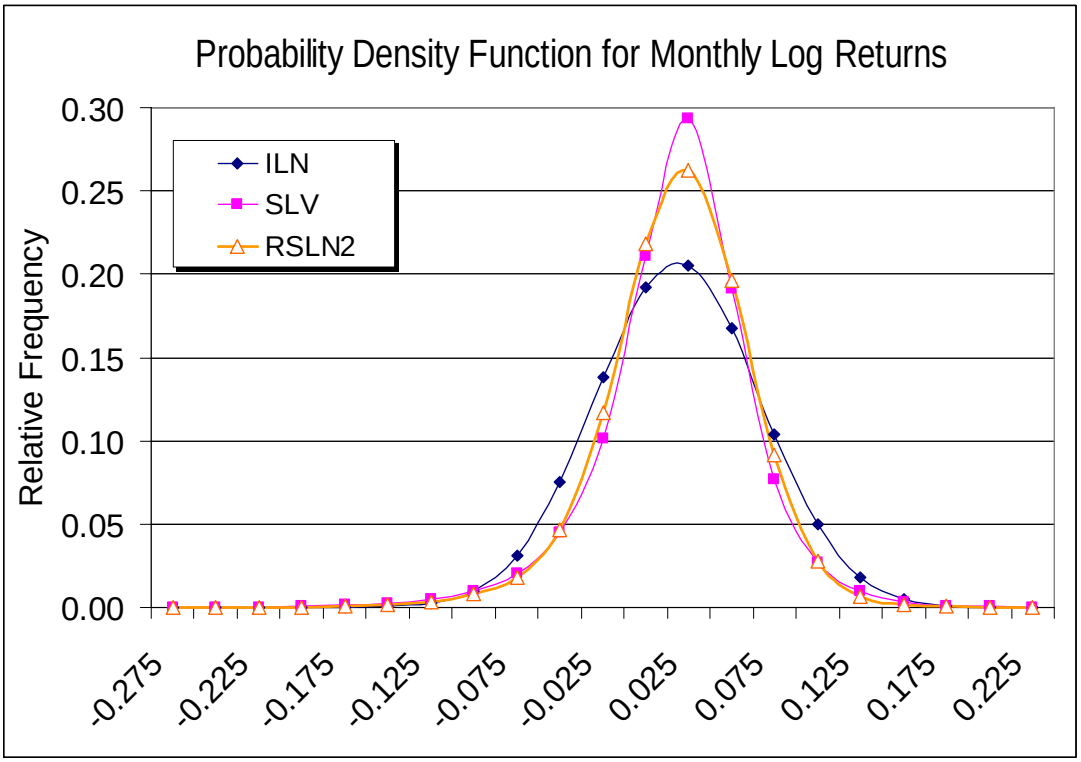


Chart 2A: Stochastic Log Volatility Model
Sample "Low Volatility" Path

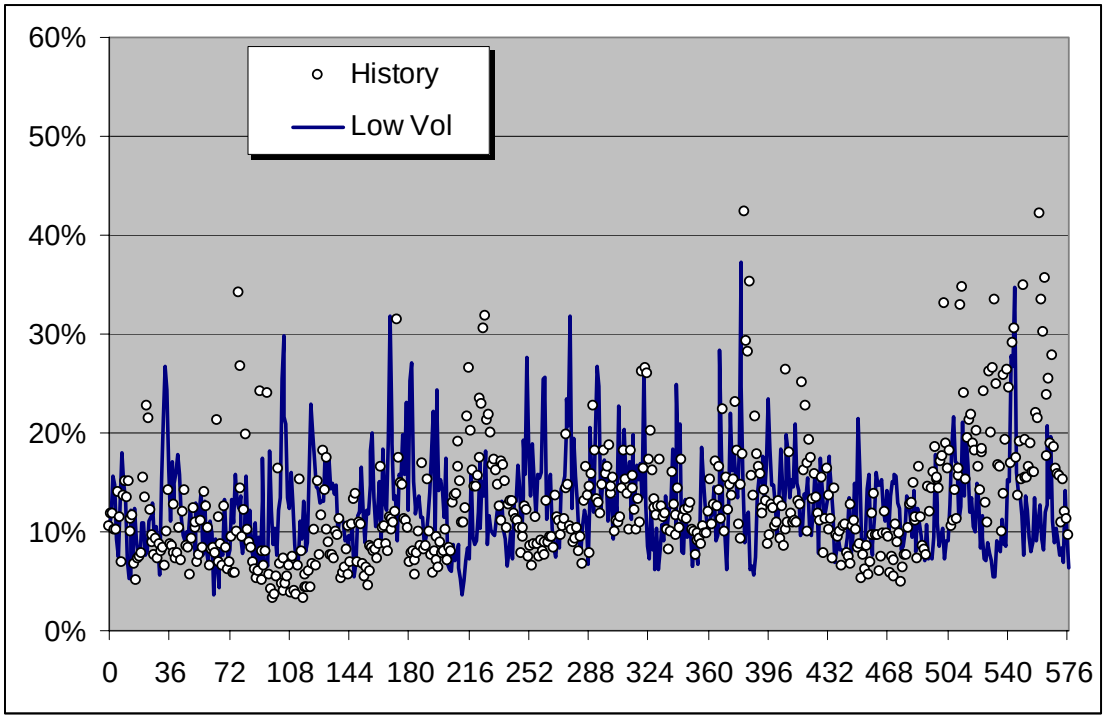


Chart 2B: Stochastic Log Volatility Model
Sample "Median Volatility" Path

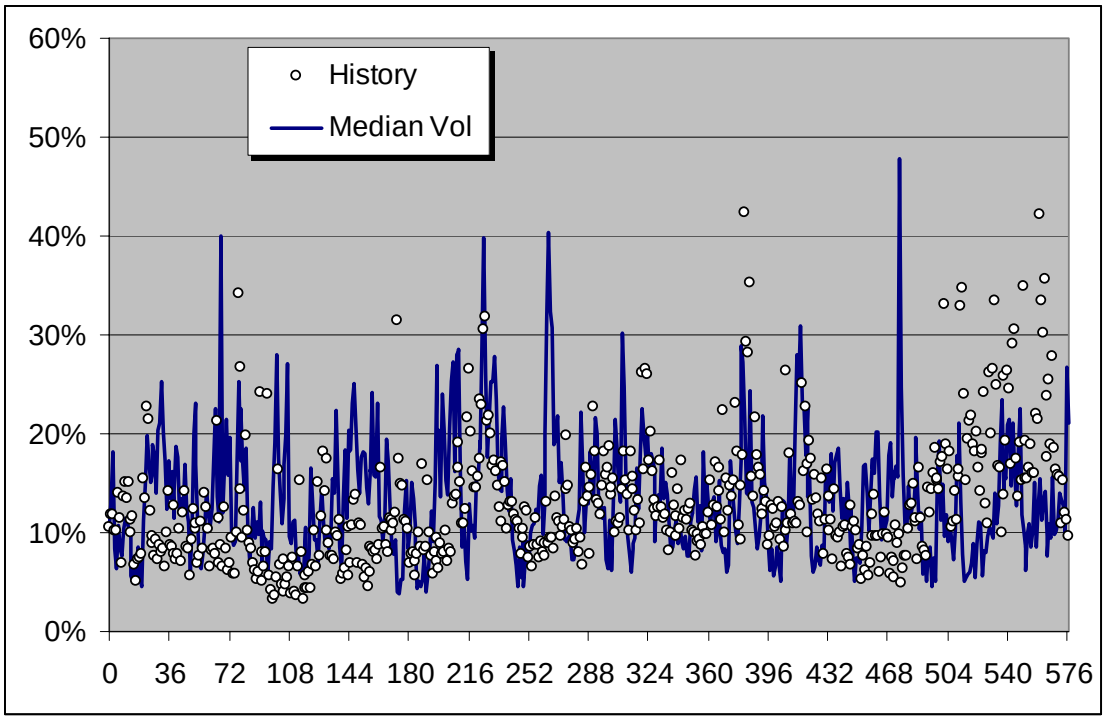
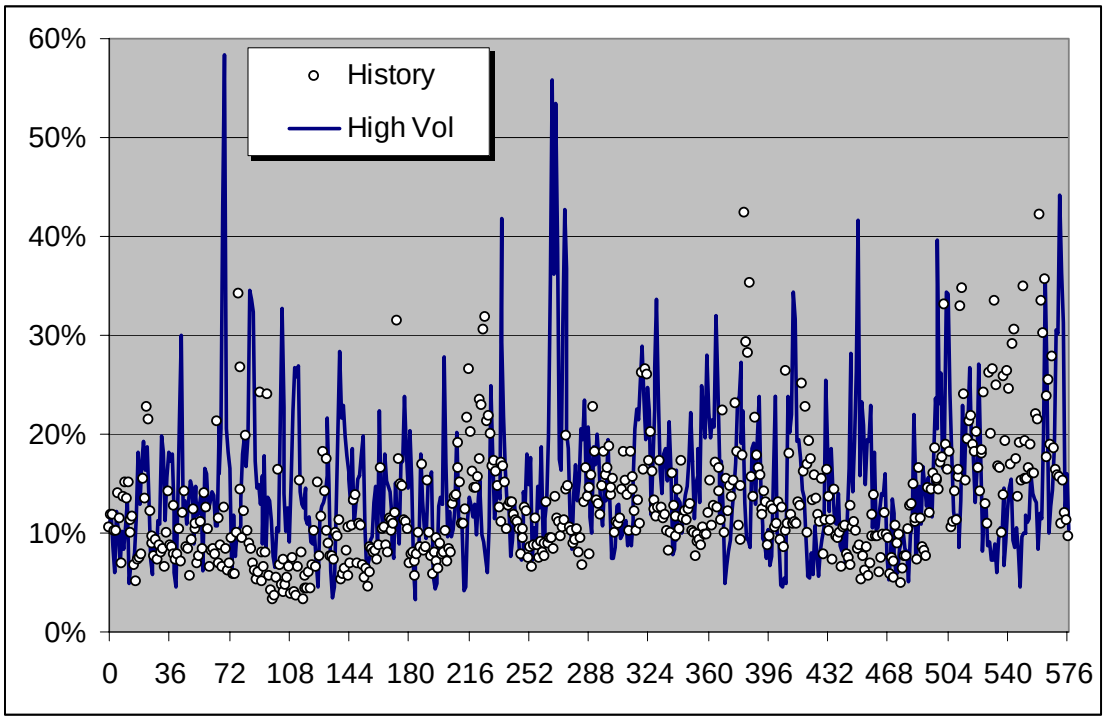


Chart 2C: Stochastic Log Volatility Model
Sample "High Volatility" Path



The SLV parameters in Table 2 were used to generate "preliminary" 1, 5, 10 and 20-year wealth factors at the calibration percentiles as shown in Table 3. Other statistics for the SLV model wealth factors are shown in Table 4.

As noted previously, the calibration criteria in Table 1 are not directly based on the SLV model. Rather, it was deemed reasonable and appropriate to make some modest adjustments to the total return gross wealth factors so that a range of common (yet suitably parameterized) models would pass the standard. Table 5 in the next section shows the models considered in this adjustment process.

Table 3: Total Return Wealth Factors for the SLV Model

Percentile	1 Year	5 Years	10 Years	20 Years
2.5%	0.776	0.719	0.785	1.122
5.0%	0.828	0.810	0.929	1.403
10.0%	0.888	0.931	1.116	1.790
90.0%	1.294	2.193	3.823	10.063
95.0%	1.362	2.462	4.525	12.869
97.5%	1.424	2.720	5.218	16.041

Table 4: Stochastic Log Volatility Model – Statistics for Gross Wealth Ratios Annualized Unconditional Mean, Median, Standard Deviation and Skewness

	1 Year	5 Years	10 Years	20 Years
Mean	1.0874	1.5207	2.3124	5.3553
Median	1.0842	1.4519	2.0923	4.3097
Std Deviation	0.1612	0.5151	1.1379	4.0386
Skewness	0.1915	0.9028	1.4196	2.9321

Other Models Considered in the Development of the Calibration Criteria

Over the last few decades, increasingly sophisticated models have been developed to capture the observed dynamics of equity returns (i.e., negative skewness, positive kurtosis, volatility clustering, auto-correlation, etc.). Yet, while some models are demonstrably better than others (particularly for short-term forecasting), there is no clear "winner" for long-term equity projections. No one has yet developed the model that unequivocally "does it all, over all forecast horizons". In short, every model has strengths and weaknesses.

In recognizing these facts, it was felt that the calibration criteria should permit a wide range of reasonable and popular models, provided such models are suitably parameterized. It is the calibration itself that establishes the "common ground" and helps to narrow the range of acceptable practice[28] without dictating the specific form of the model or parameters. Indeed, the shortcomings of simpler models can often be overcome by accepting certain compromises and adjusting the parameters.

Table 5 provides a brief description of the models considered. Table 6 shows the total return "gross wealth ratios" for these models under different parameterizations. The starting regime is randomized according to the invariant state probabilities for all regime-switching models. The models (with the indicated parameters) in Table 6 pass the calibration shown in Table 1.

[28] The focus of the calibration is on tail returns under the real world probability measure. A different view of "acceptable practice" would emerge under the risk neutral measure.

Table 5: Description of Some Common Real-World Equity Return Models

Model	Description
Independent Lognormal (ILN)	▪ The log returns in non-overlapping time intervals of equal length are independent and identically distributed with constant mean and variance. Path and state independent. ▪ The "workhorse" of financial economics. Extensively studied and documented. ▪ Despite its known shortcomings (e.g., no skewness or kurtosis), the ILN is used widely due to its simplicity and tractability.
Monthly Regime-Switching Lognormal Model with 2 Regimes (RSLN2)	▪ Highly publicized, well documented (see footnote 13) and increasingly popular among insurance practitioners. ▪ The log return in each regime is normally distributed with constant mean and variance. ▪ The regime transition probabilities are typically state dependent only (not path dependent). ▪ One of the easiest ways to capture the benefits of stochastic volatility within a tractable model. ▪ Parameter estimation is straightforward using standard spreadsheet tools.
Monthly Regime-Switching Lognormal Model with 3 Regimes (RSLN3-M)	▪ This is an extension of the RSLN2. Theoretically, any finite number of regimes can be used with any cashflow frequency. ▪ 3 regimes allows the model to capture "low", "high" and "median" volatility states. ▪ Marginally more difficult to use and parameterize than the RSLN2. Extending beyond 3 regimes is very unwieldy.
Daily Regime-Switching Lognormal Model with 3 Regimes (RSLN3-D)	▪ This is an extension of the RSLN3 to daily return data.
Stochastic Log Volatility with Varying Drift (SLV)	▪ This is the model previously discussed in this Appendix and the driving influence behind the calibration. ▪ Captures the full benefits of stochastic volatility in an intuitive model suitable for real world projections. ▪ Stochastic volatility models are widely used in the capital markets to price derivatives and exotic instruments. ▪ Produces very "realistic" volatility paths and underlying returns. ▪ Relatively easy to implement, but difficult to parameterize.

Table 6: Total Return Gross Wealth Ratios for Calibrated Real-World Equity Return Models

FOOTNOTE:	1	2	3	4	5	6	7	8	9	10	11	12	13
	SLV Param	RSLN Param	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly	Daily	N/A	N/A	N/A	N/A
	tau	mu1	0.12757	0.12515	0.010675	0.011806	0.011664	-0.026525	-0.001357	0.005347	0.006047	0.006666	0.006970
	phi	sigma1	0.35305	0.35229	0.034126	0.034562	0.036337	0.072203	0.020050	0.046188	0.047631	0.050518	0.051962
	sigma(v)	trans_1-2	0.32645	0.32645	0.039219	0.044323	0.045740	0.302565	0.042003	0.000000	0.000000	0.000000	0.000000
	rho	trans_1-3	-0.24880	-0.24880				0.000000	0.002886				
	A	mu2	0.05250	0.05500	-0.013616	-0.015200	-0.017416	0.010405	0.000317	0.005347	0.006047	0.006666	0.006970
	B	sigma2	0.61600	0.56000	0.060858	0.062210	0.068350	0.039801	0.008886	0.046188	0.047631	0.050518	0.051962
	C	trans_2-1	-1.10000	-0.90000	0.193709	0.192584	0.247814	0.039969	0.007189	1.000000	1.000000	1.000000	1.000000
	vol[0]	trans_2-3	0.14750	0.14750				0.011085	0.011022				
	Min	mu3	0.00500	0.00500				0.013100	0.000730				
	Max1	sigma3	0.30000	0.30000				0.021837	0.004899				
	Max2	trans_3-1	0.79882	0.79882				0.000000	0.001126				
		trans_3-2						0.051339	0.014449				
		invariant_1			0.8316	0.8129	0.8442	0.0980	0.0931	1.0000	1.0000	1.0000	1.0000
		invariant_2			0.1684	0.1871	0.1558	0.7418	0.5210	0.0000	0.0000	0.0000	0.0000
		invariant_3			#N/A	#N/A	#N/A	0.1602	0.3859				
		E[R]	8.85%	8.75%	9.60%	10.00%	10.50%	10.65%	9.85%	8.00%	9.00%	10.00%	10.50%
		sigma	15.37%	15.08%	14.18%	14.72%	15.31%	15.05%	14.91%	16.00%	16.50%	17.50%	18.00%
		Start Date	1955.12	1955.12	1953.12	1953.12	1964.12	1955.12	1955.12	n/a	n/a	n/a	n/a
		End Date	2003.12	2003.12	2003.12	2003.12	2003.12	2003.12	2003.12	n/a	n/a	n/a	n/a
Holding Period (years)	Percentile	Calibration Points	SLV-6 E[R]=8.85%	SLV-7 E[R]=8.75%	RSLN2 E[R]=9.6%	RSLN2 E[R]=10.0%	RSLN2 E[R]=10.5%	RSLN3-M E[R]=10.65%	RSLN3-D E[R]=9.85%	ILN E[R]=8.0%	ILN E[R]=9.0%	ILN E[R]=10.0%	ILN E[R]=10.5%
1	2.5%	**0.78**	0.771	0.776	0.759	0.741	0.746	0.747	0.755	0.779	0.778	0.769	0.764
1	5.0%	**0.84**	0.824	0.828	0.819	0.804	0.809	0.812	0.813	0.820	0.820	0.812	0.809
1	10.0%	**0.90**	0.886	0.888	0.887	0.876	0.880	0.882	0.879	0.869	0.870	0.866	0.863
1	90.0%	**1.28**	1.299	1.294	1.302	1.316	1.328	1.322	1.312	1.309	1.328	1.356	1.369
1	95.0%	**1.35**	1.368	1.362	1.364	1.381	1.397	1.392	1.376	1.387	1.411	1.445	1.462
1	97.5%	**1.42**	1.431	1.424	1.421	1.439	1.459	1.459	1.439	1.459	1.486	1.527	1.547
5	2.5%	**0.72**	0.713	0.719	0.686	0.656	0.679	0.679	0.703	0.684	0.697	0.693	0.690
5	5.0%	**0.81**	0.804	0.810	0.791	0.765	0.789	0.786	0.805	0.765	0.783	0.784	0.784
5	10.0%	**0.94**	0.926	0.931	0.927	0.906	0.931	0.930	0.935	0.871	0.896	0.903	0.907
5	90.0%	**2.17**	2.219	2.193	2.313	2.401	2.462	2.470	2.349	2.180	2.306	2.463	2.545
5	95.0%	**2.45**	2.494	2.462	2.588	2.700	2.778	2.767	2.641	2.483	2.637	2.840	2.945
5	97.5%	**2.72**	2.750	2.720	2.849	2.983	3.080	3.034	2.928	2.779	2.962	3.212	3.344
10	2.5%	**0.79**	0.775	0.785	0.754	0.715	0.759	0.745	0.778	0.705	0.743	0.752	0.756
10	5.0%	**0.94**	0.920	0.929	0.913	0.877	0.927	0.917	0.936	0.826	0.876	0.896	0.905
10	10.0%	**1.16**	1.108	1.116	1.129	1.101	1.159	1.156	1.152	0.993	1.059	1.095	1.113
10	90.0%	**3.63**	3.893	3.823	4.176	4.438	4.645	4.721	4.288	3.633	4.032	4.523	4.787
10	95.0%	**4.36**	4.620	4.525	4.927	5.280	5.546	5.611	5.113	4.366	4.874	5.530	5.887
10	97.5%	**5.12**	5.333	5.218	5.672	6.120	6.451	6.415	5.904	5.121	5.745	6.584	7.043
20	5.0%	**1.51**	1.386	1.403	1.412	1.352	1.501	1.479	1.469	1.112	1.268	1.367	1.417
20	10.0%	**2.10**	1.777	1.790	1.888	1.845	2.038	2.030	1.957	1.442	1.658	1.817	1.899
20	90.0%	**9.02**	10.347	10.063	12.126	13.394	14.637	15.173	12.666	9.027	10.990	13.503	14.947
20	95.0%	**11.70**	13.314	12.869	15.443	17.294	18.954	19.673	16.158	11.707	14.369	17.944	20.025

Footnotes for Table 6

1	▪ Applicable to the SLV-6 (footnote 3) and SLV-7 (footnote 4) models.
2	▪ Applicable to the RSLN2 and RSLN3 models.
3	▪ Monthly SLV model. Unconditional expected return constrained to 8.85% effective.
4	▪ Monthly SLV model. This model produced the "preliminary" calibration. The unconditional expected return was constrained to 8.75% annual effective.
5	▪ Monthly RSLN2. Unconditional expected return constrained to 9.6% effective.
6	▪ Monthly RSLN2. Unconditional expected return constrained to 10% effective.
7	▪ Monthly RSLN2. Unconditional expected return constrained to 10.5% effective.
8	▪ Monthly RSLN3. Unconditional expected return constrained to 10.65% effective.
9	▪ Daily RSLN3. Unconditional expected return constrained to 9.85% annual effective.
10	▪ ILN with an expected return of 8% effective and annualized 16% volatility
11	▪ ILN with an expected return of 9% effective and annualized 16.5% volatility
12	▪ ILN with an expected return of 10% effective and annualized 17.5% volatility
13	▪ ILN with an expected return of 10.5% effective and annualized 18% volatility

Note:

- The RSLN2, RSLN3-M and RSLN3-D parameters match the periodicity of the model.
- The ILN parameters are monthly. The expected return for the lognormal model is given by:

$$E[R] = \exp\left(\bar{\mu} + \frac{1}{2}\cdot\bar{\sigma}^2\right) - 1$$

where $\bar{\mu} = 12\cdot\mu$ is the annualized "drift" and $\bar{\sigma} = \sqrt{12}\cdot\sigma$ is the annualized volatility.

Reasonableness for the Calibration Points

To analyze the reasonableness of the calibration table, it is worthwhile examining the historic data over a long period of time. The December 1903 to December 2003 monthly S&P500 total return data series (1201 monthly data points) permits 1200 non-overlapping end-of-month return observations; 100 non-overlapping observations of annual returns, 20 non-overlapping observations of five-year returns and 10 non-overlapping observations of ten-year returns.

However, there are several non-overlapping series to choose from since we can select different starting points for the calculations. For example, there would be 11 sets of 99 non-overlapping returns for annual periods corresponding to different monthly starting points of January to January, … , November to November. The December 'start month' would give 1 set of 100 annual return observations. These "sets" are not independent, but provide slightly different empirical estimates of the underlying distributions.

Tables 6A through 6C summarize the left and right-tail returns based on these empirical observations. To interpret Table 6A, the 1% quantile for the one-year return is based on the worst[1] result of 99 independent observation periods of annual returns (100 for the December 'start month'), where 1 percent = $1 \div (N+1) = 1 \div 100$. The 2% result is based on the second worst result (i.e., $2 \div 100$), etc. Because there are 11 possible starting points for the 99 years of non-overlapping returns and 1 set of 100 annual returns, corresponding to the various starting months, the "empirical" range shows the minimum and maximum of the results from the possible non-overlapping series. For reference, the mid-point (average of minimum and maximum) is also included.

The ranges corresponding to the calibration criteria quantiles have been imputed (interpolated) from neighboring empirical values and are shown as shaded rows. For the 5- and 10-year holding periods, the empirical quantiles (α-level) are provided as ranges.

[1] Strictly, the lowest return for the scenario set with a December 'start month' gives an estimate of the 0.99% = $1 \div 101$ quantile. We have ignored this technicality in the calculations.

Table 6A: Non-overlapping 1-year Accumulation Factors
S&P500TR Dec 1903 – Dec 2003

	Empirical Range			
Quantile(α)	**Minimum**	**Maximum**	**Mid**	**Cal. Point**
1.0%	0.324	0.659	0.492	
2.0%	0.503	0.766	0.635	
2.5%	0.556	0.769	0.663	**0.78**
3.0%	0.608	0.772	0.690	
5.0%	0.734	0.828	0.781	**0.84**
10.0%	0.851	0.895	0.873	**0.90**
90.0%	1.353	1.390	1.372	**1.28**
95.0%	1.394	1.495	1.445	**1.35**
97.0%	1.443	1.576	1.510	
97.5%	1.452	1.707	1.579	**1.42**
98.0%	1.460	1.838	1.649	
99.0%	1.463	2.629	2.046	

Table 6B: Non-overlapping 5-year Accumulation Factors
S&P500TR Dec 1903 – Dec 2003

	Empirical Range			
Percentile	**Minimum**	**Maximum**	**Mid**	**Cal. Point**
5.0%	0.386	1.043	0.714	**0.81**
10.0%	0.629	1.154	0.891	**0.94**
90.0%	2.310	3.556	2.933	**2.17**
95.0%	2.473	4.673	3.573	**2.45**

Table 6C: Non-overlapping 10-year Accumulation Factors
S&P500TR Dec 1903 – Dec 2003

	Empirical Range			
Percentile	**Minimum**	**Maximum**	**Mid**	**Cal. Point**
10.0%	0.602	1.935	1.269	**1.16**
90.0%	4.083	6.969	5.526	**3.63**

While it might be argued that the pre-WWII data are not especially relevant to current and future market conditions due to fundamental changes in the economy, the above

statistics clearly suggest that the calibration points are not unduly conservative or aggressive when examining the empirical data over very long timeframes.

Other Markets/Funds

Calibration of other markets (funds) is being left to the judgment of the actuary, but the scenarios so generated must be consistent with the calibration points in Table 1. This does not imply a strict functional relationship between the model parameters for various markets/funds, but it would generally be inappropriate to assume that a market or fund consistently 'outperforms' (lower risk, higher expected return relative to the efficient frontier) over the long term.

The actuary should document the actual 1, 5, 10 and 20-year wealth factors of the scenarios at the frequencies given in Table 1. The annualized mean and standard deviation of the wealth factors for the 1, 5, 10 and 20-year holding periods must also be provided. For equity funds, the actuary should explain the reasonableness of any significant differences from the S&P500 calibration points.

When parameters are fit to historic data without consideration of the economic setting in which the historic data emerged, the market price of risk may not be consistent with a reasonable long-term model of market equilibrium. One possibility for establishing 'consistent' parameters (or scenarios) across all funds would be to assume that the market price of risk is constant (or nearly constant) and governed by some functional (e.g., linear) relationship. That is, higher expected returns can only be garnered by assuming greater risk[2].

Specifically, two return distributions *X* and *Y* would satisfy the following relationship:

$$\text{Market Price of Risk} = \left(\frac{E[R_X]-r}{\sigma_X}\right) = \left(\frac{E[R_Y]-r}{\sigma_Y}\right)$$

where $E[R]$ and σ are respectively the (unconditional) expected returns and volatilities and *r* is the expected risk-free rate over a suitably long holding period commensurate with the projection horizon. One approach to establish consistent scenarios would set the model parameters to maintain a near-constant market price of risk.

A closely related method would assume some form of 'mean-variance' efficiency to establish consistent model parameters. Using the historic data, the mean-variance (alternatively, 'drift-volatility') frontier could be a constructed from a plot of (mean , variance) pairs from a collection of world market indices. The frontier could be assumed to follow some functional form[3], with the co-efficients determined by standard curve fitting or regression techniques. Recognizing the uncertainty in the data, a 'corridor' could be established for the frontier. Model parameters would then be adjusted to move the proxy market (fund) inside the corridor.

[2] As an example, the standard deviation of log returns is often used as a measure of risk.

[3] Quadratic polynomials and logarithmic functions tend to work well.

Clearly, there are many other techniques that could be used to establishing consistency between the scenarios. While appealing, the above approaches do have drawbacks[4] and the actuary should be careful not to be overly optimistic in constructing the model parameters or the scenarios.

Funds can be grouped and projected as a single fund if such grouping is not anticipated to materially reduce capital requirements. However, care should be taken to avoid exaggerating the benefits of diversification. The actuary must document the development of the investment return scenarios and be able to justify the mapping of the company's variable accounts to the proxy funds used in the modeling.

Discount Rates

For discounting future capital strain, the Federal Income Tax adjusted swap curve rates may be used. Alternatively, an economic model built into the scenario generator may be used to simulate 1-year Treasury rates. In the latter case, the rates must start at current levels, approximately satisfy the 'no arbitrage' principle (on an expected basis) and exhibit deviations from expected values generally consistent with the Phase I interest model. In addition, if interest rates are not assumed to be independent of the equity scenarios, the basis for the assumed relationship needs to be well documented.

Correlation of Fund Returns

In constructing the scenarios for the proxy funds, the company may require parameter estimates for a number of different market indices. When more than one index is projected, it is generally necessary to allow for correlations in the simulations. It is not necessary to assume that all markets are perfectly positively correlated, but an assumption of independence (zero correlation) between the equity markets would inappropriately exaggerate the benefits of diversification. An examination of the historic data suggests that correlations are not stationary and that they tend to increase during times of high volatility or negative returns. As such, the actuary should take care not to underestimate the correlations in those scenarios used for the capital calculations.

If the projections include the simulation of interest rates (other than for discounting surplus strain) as well as equity returns, the processes may be independent provided that the actuary can demonstrate that this assumption (i.e., zero correlation) does not materially underestimate the resulting capital.

[4] For example, mean-variance measures ignore the asymmetric and fat-tailed profile of most equity market returns.

Random Number Generator

A good pseudo-random number generator provides a set of values that are statistically indistinguishable from a truly random sequence from the given distribution for a given application. There are many algorithms for generating pseudo-random numbers, but the quality varies widely between them. The user should not indiscriminately deploy a generator without first confirming (through statistical testing) that it performs adequately under the conditions for which it will be used. In particular, the generator should have sufficiently high periodicity[5] and not exhibit material bias or serial correlation[6] unless such attributes are specifically desired for valid and appropriate reasons[7].

Many stochastic simulations require the "mapping" of generated U(0,1) values to the real line $(-\infty\ ,\ +\infty)$ in order to obtain random samples from the Normal or some other distribution. Such mapping can be accomplished by a variety of methods, but some routines are much more robust than others. In particular, the actuary should ensure that the mapping accomplishes the objective of representing the desired distribution within the context of the application (e.g., with a suitable degree of randomness). In the past, issues have arisen in connection with the mapping being "continuous" and 1-to-1 (within the precision of the computer)[8].

Number of Scenarios and Efficiency in Estimation

For straight Monte Carlo simulation (with equally probable "paths" of fund returns), the number of scenarios should typically equal or exceed 1000. The appropriate number will depend on how the scenarios will be used and the materiality of the results. The actuary should ensure that the number of scenarios used provides an acceptable level of precision.

Fewer than 1000 scenarios may be used provided that the actuary has determined through prior testing (perhaps on a subset of the portfolio) that the CTE values so obtained materially reproduce the results from running a larger scenario set.

Suppose the number of scenarios used for simulation is N. Hence, the CTE estimator at the α-confidence level is the average of the $k = N \times (1 - \alpha)$ order statistics (i.e., sample results ordered from highest to lowest). The standard error of the estimator is a function of α, CTE(α) and the (k+1) order statistics divided by the square root of k. So, to increase the precision of the calculations, it may be necessary to increase significantly the number of scenarios.

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[5] Periodicity is defined as the number of values that can be produced by the generator before the sequence repeats itself.

[6] Serial correlation of lag k occurs when values separated by k numbers exhibit significant correlation.

[7] Many variance reduction techniques deliberately introduce bias as a means to improve efficiency in estimation. See the next section for additional commentary.

[8] Small deviations in the U(0,1) sample should be associated with appropriately small deviations in the Normal values.

Variance reduction and other sampling techniques are intended to improve the accuracy of an estimate more efficiently than simply increasing the number of simulations. Such methods can be used provided the actuary can demonstrate that they do not lead to a material understatement of results. Many of the techniques are specifically designed for estimating means, not tail measures, and could in fact reduce accuracy (and efficiency) relative to straight Monte Carlo simulation[9].

The above requirements and warnings are not meant to preclude or discourage the use of valid and appropriate sampling methods, such as Quasi Random Monte Carlo (QRMC) , importance sampling or other techniques designed to improve the efficiency of the simulations (relative to pseudo-random Monte Carlo methods). However, the actuary should maintain documentation that adequately describes any such techniques used in the projections. Specifically, the documentation should include the reasons why such methods can be expected not to result in systematic or material under-statement of the resulting TAR compared to using pseudo-random Monte Carlo numbers.

A practical 'brute force' approach to estimating the standard error of the CTE estimator would be to generate M independent sets of scenarios (using the same model parameters) where each set contains N scenario paths. Provided M is reasonably 'large' (say, $M \geq 10$), a sample variance may be calculated on the M different CTE(α) values. A rough ($100\times\beta$) percent confidence interval for CTE(α) may then be constructed using the normal approximation: $\text{CTE}(\alpha) \pm \sigma \cdot \Phi^{-1}[0.5 \times (1+\beta)]$ where σ is the sample standard deviation of the CTE(α) estimators and Φ^{-1} is the inverse cumulative density function for the standard normal distribution. If the interval appears 'too wide' (e.g., interval width > 10% of the CTE estimate), more scenarios may be required.

Frequency of projection and time horizon

Use of an annual cashflow frequency ("timestep") is generally acceptable for benefits/features that are not sensitive to projection frequency. The lack of sensitivity to projection frequency should be validated by testing wherein the actuary should ensure that the use of a more frequent (i.e., shorter) time step does not materially increase capital requirements. A more frequent time increment should always be used when the product features are sensitive to projection period frequency.

Care must be taken in simulating fee income and expenses when using an annual time step. For example, recognizing fee income at the end of each period after market movements, but prior to persistency decrements, would normally be an inappropriate assumption. It is also important that the frequency of the investment return model be linked appropriately to the projection horizon in the liability model. In particular, the horizon should be sufficiently long so as to capture the vast majority of surplus costs (on a present value basis) from the scenarios[10].

[9] However, with careful implementation, many variance reduction techniques can work well for CTE estimators. See Manistre, B.J. and Hancock, G. (2003), "Variance of the CTE Estimator", *2003 Stochastic Modeling Symposium*, Toronto, ON, September 2003.

[10] As a general guide, the forecast horizon should not be less than 20 years.

Pre-Packaged Scenarios

The American Academy of Actuaries has provided 10,000 scenarios on a website[11] for the following twelve asset classes[12]:

1. 3-month U.S. Treasury yields
2. 7-year U.S. Treasury yields
3. 10-year U.S. Treasury yields
4. Money Market
5. U.S. intermediate-term government bonds
6. U.S. long-term corporate bonds
7. Diversified fixed income
8. Diversified balanced
9. Diversified U.S. equity
10. Diversified international equity
11. Intermediate risk equity
12. Aggressive or specialized equity

The scenarios are available as gross monthly accumulation factors over a 40-year horizon (i.e., a 10000 × 480 matrix for each asset class) in comma-separated value format (*.*csv*). These scenarios have been appropriately correlated so that the Kth scenario for each asset class should be used together and considered one 'future investment return scenario'. Hence, the scenarios can be combined (by blending the accumulation factors[13]) to create additional 'proxy' scenarios for the company's funds.

[11] The pre-packaged scenarios can be found at http://www.actuary.org/life/phase2.htm and are fully documented at http://www.actuary.org/pdf/life/c3supp_nov03.pdf (these are the addresses as of November 2004). This footnote is subject to change after the revised pre-packaged scenarios are produced.

[12] Because the reserves calculated using projections involve cash flow projections, the pre-packaged scenarios were developed on a "real world" basis (as opposed to a "risk-neutral" basis). Therefore, the pre-packaged scenarios may not be appropriate for purposes of projecting the market value of future hedge instruments within a projection (to the extent such instruments are used in the projections). For this purpose, it may be more appropriate to use risk neutral scenarios to determine the market value of hedge instruments in the cash flow projections that are based on real world scenarios.

[13] It is important to blend the accumulation factors (not the returns) in order to achieve the desired asset mix.

For example, suppose the actuary wanted to construct scenarios for a 'balanced fund' that targets a 60/40 allocation between bonds and U.S. equities. If we denote $[\ AF^{X}\ ]$ as the matrix of accumulation factors for asset class X, then the balanced scenarios would be defined by $[\ AF^{BAL}\ ] = 0.60 \times [\ AF^{BOND}\ ] + 0.40 \times [\ AF^{S\&P500}\ ]$. Care should be taken to avoid exaggerating the benefits of diversification. The actuary shall document the development of the investment return scenarios and be able to justify the mapping of the company's variable accounts to the proxy funds used in the modeling.

If all or a portion of these scenarios are used, then the actuary shall verify that the scenario calibration criteria are met.

Appendix 3 – GMIB Purchase Rate Margins

The GMIB purchase rate margin is the difference between the cost to purchase an annuity using the guaranteed purchase basis and the cost using the interest rates prevailing at the time of annuitization. The modeling for this benefit can either use a point estimate for this margin or model the margin directly using a stochastic model of interest rates. If a point estimate is being used, following is guidance on how to apply this method to estimate this margin. If a stochastic model of interest rates is used instead of a point estimate then no such adjustment is needed.

If a point estimate is being used, it is important that the margin assumed reflects:

a) Current market expectations about future interest rates at the time of annuitization, as described more fully below.

b) A downward adjustment to the interest rate assumed in the purchase rate basis since a greater proportion of contract-holders will select an annuitization benefit when it is worth more than the cash surrender value then when it is not. As a practical matter, this effect can be approximated by using an interest rate assumption in the purchase rate basis that is 0.30 percent below that implied by the forward swap curve, described below.

To calculate market expectations of future interest rates, the par or current coupon swap curve is used (documented daily in Federal Reserve H15 with some interpolation needed). Deriving the expected rate curve from this swap curve at a future date is a three step process.

Step 1: Calculate the implied zero coupon rates using a "bootstrap" process. For this process we use the equation $100=C_n * (v + v^2 + \ldots + v^n) + 100v^n$ where the "v^t" terms are used to stand for the discount factors applicable to cash flows 1,2,…n years hence and C_n is the n-year swap rate. However, each of these discount factors are based on the forward curve and therefore are based on different rates (i.e. "v^2" does not equal v times v). Given the one year swap rate, one can solve for v. Given v and the two year swap rate one can then back into v^2, and so on.

Step 2: Convert the zero coupon rates to one year forward rates by calculating the discount factor needed to derive v^t from v^{t-1}.

Step 3: This step recognizes that, for example, the five year forward one year rate is not the rate the market expects on one year instruments five years from now. The reason is that as the bond gets shorter the "risk premium" in the rate diminishes. This is sometimes characterized as "rolling down" the yield curve. Table A shows the historic average risk premium at various durations. The source for these averages is a research report by Solomon Brothers.[14] From this table, we can see that to get the rate the market expects a 1 year swap to have five years from now; we have to subtract the risk premium associated with six year rates (.95%) and add back that associated with 1 year rates (.50%), a net reduction of .45%.

The Exhibit below combines the three steps. Columns A through D convert the swap curve to the implied forward rate for each future payment date. Columns E through H remove the current risk premium, add the risk premium t years in the future (the Exhibit shows the rate curve five years in the future), and uses that to get the discount factors to apply to the 1 year, 2 year,…5 year cash flows 5 years from now.

Table A: Risk Premium by Duration

Duration	Risk Premium	Duration	Risk Premium
1	0.500%	6	0.950%
2	0.750%	7	1.000%
3	0.750%	8	1.100%
4	0.850%	9+	1.150%
5	0.900%		

[14] Solomon Brothers, United States Fixed Income Research Portfolio Strategies, "A Framework for Analyzing Yield Curve Trades – Understanding the Yield Curve: Part 6," November 1995. The bond risk premia were calculated over the period 1970-94, see figure 2.

Exhibit: Derivation of discount rates expected in the future

A	B	C	D	E	F	G	H
Projection Years	Swap Curve Rate	P.V. of Zero Coupon	Forward 1 year Rate	Risk Premium	Risk Premium 5 Years Out	Expected Forward Rate In Five Years	P.V. of Zero Coupon In 5 Years
1	2.57%	0.97494	2.5700%	0.50%			
2	3.07%	0.94118	3.5879%	0.75%			
3	3.44%	0.90307	4.2193%	0.75%			
4	3.74%	0.86231	4.7268%	0.85%			
5	3.97%	0.82124	5.0011%	0.90%			
6	4.17%	0.77972	5.3250%	0.95%	0.50%	4.8750%	0.95352
7	4.34%	0.73868	5.5557%	1.00%	0.75%	5.3057%	0.90547
8	4.48%	0.69894	5.6861%	1.10%	0.75%	5.3361%	0.85961
9	4.60%	0.66049	5.8209%	1.15%	0.85%	5.5209%	0.81463
10	4.71%	0.62303	6.0131%	1.15%	0.90%	5.7631%	0.77024
Cell formulas for Projection Year 10:		=(1-B13* SUM(C4:C12)) /(1+B13)	=C12/C13-1		=E8	=D13-E13+F13	=H12/(1+G13)

Appendix 4 – December 2001 Report of the CIA Task Force on Segregated Fund Investment Guarantees

Due to size constraints, the CIA Task Force report (issued March 2002) is not included in this material. However, it may be obtained electronically at the CIA website via http://www.actuaries.ca/publications/2002/202012e.pdf

Appendix 5 – Significant Changes from the December 2002 LCAS Recommendation Re: C3 Phase II RBC for Variable Annuities

Although the core recommendation is unchanged from December 2002, a number of revisions have occurred. The significant ones are:

a) Scope. We are now excluding variable life insurance. We are now including variable annuities with no living or death benefit guarantees and including group annuities such as 401ks that offer death benefits or living benefits with reference to the performance of the equity investment option and insurance contracts that offer death benefit guarantees for specified investment funds. We are also including similar benefits if included in other products

b) Projected Reserve. We have changed the year to year "working reserve' to simplify its calculation

c) Calibration and Projections. We have changed the calibration standards (reflecting a different historic period), starting assets (to equal estimated statutory reserves), and the asset objective measure (to include "time zero"). The calibration standards in this report are new and materially different than in previous versions. In addition, we clarified that a consistent methodology and parameters must be used over the entire projection period.

d) Alternative Factors for GMDB. We have finalized the assumptions to develop the Alternative Method factors. These factors have been updated to reflect the revised calibration standard.

e) Fixed Account Options. We have added an interest rate risk component for the guaranteed fund option to the equity risk.

f) Impact on C3 calculations for fixed annuities. In order to extend the provision for interest rate risk to the general account portion of variable annuities, we recommend that companies may combine the latter products with those covered under C3 Phase 1 for the purpose of the scenario testing approach defined in the Interest Rate Risk capital requirement.

g) Modeling of Hedges. We have greatly expanded this section

h) Principles. It should be noted that Appendix 7 "Principles" replaces the previous content of Appendix 7 "Volatility of Total Asset Requirement." This material was in the nature of background information, it did not contain any recommendations from the LCAS, and was no longer needed based on actions taken by the NAIC CADTF at the NAIC Summer 2004 meeting.

i) Alternative Method Mortality: We now recommend that companies be allowed to use their Prudent Best Estimate of their mortality or 100% of tabular mortality, instead of all companies using 65% as in our previous recommendation.

j) GMIB Purchase Rate Margins: We have expanded and clarified that material.

k) Tax Adjustment: We have added a required tax adjustment to avoid double counting the federal income tax deductions if the working reserve used at the start of the projection is less than the actual tax reserve.

l) Revenue Sharing: Substantially more direction as to the treatment of revenue sharing, including the need for margins, was added.

m) Mortality Assumptions: A new Methodology Note was added concerning prudent best estimate mortality assumptions, including credibility and mortality improvement assumptions.

Appendix 6 – Methods of Calculating Capital Requirements for

Interest Rate Risk on the Guaranteed Fund of Variable Annuities

The objective is to assign a value for the risk of unexpected interest rate shocks comparable to that assigned to fixed dollar interest sensitive products. This risk may result from either a traditional duration mismatch or from optionality in either the product or the supporting assets.

Ideally, a fully integrated model of equity returns and interest rates, with rate volatility and expectations and frequency and duration of yield curve inversions consistent with the "Phase I" requirements, would be run to develop an estimate of the (combined) market risks. (Documentation of the Phase I model can be found on the AAA web site at www.actuary.org/pdf/life/lrbc_october.pdf.) The US Treasury Fund scenarios within the 10,000 prepackaged scenarios do not qualify as meeting this standard. Although an integrated modeling approach is desirable, we believe a number of simpler approaches are acceptable.

For companies that are modeling their equity risks (i.e., not using the Alternative Method), these methods include:

a) Use the Microsoft® Excel workbook from C3 Phase I to generate 200 interest scenarios and then assign them in rotation to the stochastic equity scenarios being tested.

b) Run the variable annuity model assuming a predetermined fixed crediting rate (not less than the contract guarantees). In the equity modeling, earned interest would equal that rate increased for fees. Then calculate the C3 Phase I values using the scenario testing method as though that (or a higher rate) is the rate to be credited.

c) Run the variable annuity model as though no assets were in the guaranteed fund. Then develop the C3 requirement as if all the assets were in the guaranteed fixed fund. The final requirements for both equity and fixed C3 components would be an appropriate weighted-average of these results. For these calculations, the actual assets and liabilities are increased in proportion to their actual distribution.

For companies that choose not to model the equity risk (i.e., those who choose the Alternative Method for GMDB), either method b) or c) may be used.

If the method used to reflect interest rate risk doesn't develop separate values for interest and equity risk, the factors used for interest rate risk for fixed contracts may be used as an approximate value for combining with other c3 interest rate risk, which the remainder of the RBC being considered equity risk.

Companies not exempt from scenario testing for C3 interest rate risk for fixed products are not exempt for these products either. "Exempt companies" may choose to use scenario testing for these products, either on a free standing basis or consolidated with the interest sensitive fixed products or to use the current factor based process applicable to fixed annuities. If they choose to use scenario testing in one year, they are to continue using that method in the future unless regulatory approval is given to using factors (for example, if the volume of such business has declined significantly).

Appendix 7 - Principles

The projection methodology used to calculate the Total Asset Requirement ("TAR"), as well as the approach used to determine the Alternative Methodology, is based on the following set of principles. These principles should be followed when applying the methodology in these recommendations and analyzing the resulting TAR[15].

Principle 1. The objective of the approach used to determine the TAR is to quantify the amount of statutory capital needed by the insurer to be able to meet contractual obligations in light of the risks to which the company is exposed.

Principle 2. The calculation of TAR is based on the results derived from an analysis of asset and liability cash flows produced by the application of a stochastic cash flow model to equity return and interest rate scenarios. For each scenario the greatest present value of accumulated statutory deficiencies is calculated. The analysis reflects Prudent Best Estimate (see the definition of Prudent Best Estimate in the Glossary of this Report) assumptions for deterministic variables and is performed in aggregate to allow the natural offset of risks within a given scenario. The methodology utilizes a projected total statutory balance sheet approach by including all projected income, benefit, and expense items related to the business in the model and sets the TAR at a degree of confidence using the conditional tail expectation measure applied to the set of scenario specific greatest present values of accumulated statutory deficiencies that is consistent with the quantification of other risks in the NAIC Life RBC formula.

Principle 3. The implementation of a model involves decisions about the experience assumptions and the modeling techniques to be used in measuring the risks to which the company is exposed. Generally, assumptions are to be based on the conservative end of the actuary's confidence interval. The choice of a conservative estimate for each assumption may result in a distorted measure of the total risk. Conceptually, the choice of assumptions and the modeling decisions should be made so that the final result approximates what would be obtained for the Conditional Tail Expectation Amount at the required CTE level if it were possible to calculate results over the joint distribution of all future outcomes. In applying this concept to the actual calculation of the Conditional Tail Expectation Amount, the actuary should be guided by the evolving practice and expanding knowledge base in the measurement and management of risk.

Principle 4. While a stochastic cash flow model attempts to include all real world risks relevant to the objective of the stochastic cash flow model and relationships among the risks, it will still contain limitations because it is only a model. The calculation of TAR is based on the results derived from the application of the stochastic cash flow model to scenarios while the actual capital needs of the company arise from the risks to which the company is (or will be) exposed in reality.

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[15] Note the following when considering these principles:

a. The principles should be considered in their entirety.
b. The Guideline requires companies to meet these principles with respect to only those contracts that fall within the scope of the Guideline and are inforce as of the valuation date to which the requirements are applied.

Principle 5. Neither a cash flow scenario model nor a method based on factors calibrated to the results of a cash flow scenario model, can completely quantify an insurer's exposure to risk. A model attempts to represent reality, but will always remain an approximation thereto and hence uncertainty in future experience is an important consideration when quantifying the TAR using the AAA recommendations. Therefore, the use of assumptions, methods, models, risk management strategies (e.g., hedging), derivative instruments, structured investments or any other risk transfer arrangements (such as reinsurance) that serve solely to reduce the calculated TAR without also reducing risk on scenarios similar to those used in the actual cash flow modeling are inconsistent with these principles. The use of assumptions and risk management strategies should be appropriate to the business and not merely constructed to exploit 'foreknowledge' of the components of the required methodology.

Appendix 8 – Alternative Method

This Appendix describes the Alternative Method in significant detail; how it is to be applied and how the factors were developed. Factor tables have been developed using the Conditional Tail Expectation ("CTE") risk measure at two confidence levels: 65% and 90%. The latter is determined on an "after tax" basis and is required for the RBC C3 Phase II standard. The former is a pre-tax calculation and should assist the Variable Annuity Reserve Working Group ("VARWG") in formulating a consistent "alternative method" for statutory reserves.

General

1. The Alternative Method is to be applied on a policy-by-policy basis (i.e., seriatim). If the company adopts a cell-based approach, only materially similar contracts should be grouped together. Specifically, all policies comprising a "cell" must display substantially similar characteristics for those attributes expected to affect risk-based capital (e.g., definition of guaranteed benefits, attained age, policy duration, years-to-maturity, market-to-guaranteed value, asset mix, etc.).

2. The Alternative Method determines the Total Asset Requirement ("TAR") as the sum of the Cash Surrender Value and the following three (3) provisions, collectively referred to as the *Additional Asset Requirement* ("AAR"):

   - Provision for amortization of the outstanding (unamortized) surrender charges;
   - Provision for fixed dollar expenses/costs net of fixed dollar revenue; and
   - Provision for claims (in excess of account value) under the guaranteed benefits net of available spread-based revenue ("margin offset").

   All of these components reflect the impact of income taxes and are explained in more detail later in the document.

3. The total AAR (in excess of cash surrender value) is the sum of the AAR calculations for each policy or cell. The result for any given policy (cell) may be negative, zero or positive.

4. For variable annuities without guarantees, the Alternative Method for capital uses the methodology which applied to all Variable annuities previously. The charge is 11 percent of the difference between fund balance and cash surrender value if the current surrender charge is based on fund balance. If the current surrender charge is based on fund contributions, the charge is 2.4 percent of the difference for those contracts for which the fund balance exceeds the sum of premiums less withdrawals and 11 percent for those for which that is not the case. In all cases, the result is to be multiplied by .65 to adjust for Federal Income Tax.

5. For variable annuities with death benefit guarantees, the AAR for a given policy is equal to: $R \times (CA + FE) + GC$ where:

CA (Charge Amortization)	=	Provision for amortization of the outstanding (unamortized) surrender charges
FE (Fixed Expense)	=	Provision for fixed dollar expenses/costs net of fixed dollar revenue
GC (Guaranteed Cost)	=	Provision for claims (in excess of account value) under the guaranteed benefits net of available spread-based revenue ("margin offset")

The components *CA*, *FE* and *GC* are calculated separately. *CA* and *FE* are defined by deterministic "single-scenario" calculations which account for asset growth, interest, inflation and tax at prescribed rates. Mortality is ignored. However, the actuary determines the appropriate "prudent best estimate" lapses/withdrawal rates for the calculations. The components *CA*, *FE* and *GC* may be positive, zero or negative. $R = h(\circ)$ is a "scaling factor" that depends on certain risk attributes $\tilde{\theta}$ for the policy and the product portfolio.

6. The "Alternative Method" factors and formulas for GMDB risks (component *GC*) have been developed from stochastic testing using the 10,000 "Pre-packaged" scenarios (Version 5). The pre-packaged scenarios have been fully documented under separate cover – see http://www.actuary.org/pdf/life/c3supp_nov03.pdf at the American Academy of Actuaries' website.

7. The model assumptions for the AM Factors (component GC) are documented in the section of this Appendix on Component GC.

8. The table of *GC* factors that has been developed assumes male mortality at 100% of the MGDB 94 ALB table. Companies using the Alternative Method may use these factors, or may use the procedure described in Methodology Note C3-04 to adjust for the actuary's Prudent Best Estimate of mortality. Once a company uses the modified method for a block of business, the option to use the unadjusted table is no longer available for that part of its business. In applying the factors to actual inforce business, a 5-year age setback should be used for female annuitants.

9. There are five (5) major steps in using the *GC* factors to determine the "*GC*" component of the AAR for a given policy/cell:

    a) Classifying the asset exposure;

    b) Determining the risk attributes;

    c) Retrieving the appropriate nodes from the factor grid;

    d) Interpolating the nodal factors, where applicable (optional);

    e) Applying the factors to the policy values.

Categorizing the asset value for the given policy or cell involves mapping the entire exposure to one of the eight (8) prescribed "fund classes". Alternative Method factors are provided for each asset class.

The second step requires the company to determine (or derive) the appropriate attributes for the given policy or cell. These attributes are needed to calculate the required values and access the factor tables:

- Product form ("Guarantee Definition"), P.
- Adjustment to guaranteed value upon partial withdrawal ("GMDB Adjustment"), A.
- Fund class, F.
- Attained age of the annuitant, X.
- Policy duration since issue, D.
- Ratio of account value to guaranteed value, ϕ.
- Total account charges, MER.

Other required policy values include:

- Account value, AV.
- Current guaranteed minimum death benefit, $GMDB$.
- Net deposit value (sum of deposits less sum of withdrawals), $NetDeposits$[16].
- Net spread available to fund guaranteed benefits ("margin offset"), α.

The next steps – retrieving the appropriate nodes from the factor grid and interpolation – are explained in the section of this Appendix on Component GC. Tools are provided to assist the company in these efforts (see Appendix 9), but their use is not mandatory. This documentation is sufficiently detailed to permit the company to write its own lookup and extraction routines. A calculation example to demonstrate the application of the various component factors to sample policy values is shown in the section of this Appendix on Component GC.

[16] Net deposits are required only for certain policy forms (e.g., when the guaranteed benefit is capped as a multiple of net policy contributions).

10. The total account charges should include all amounts assessed against policyholder accounts, expressed as a level spread per year (in basis points). This quantity is called the Management Expense Ratio ("MER") and is defined as the average amount (in dollars) charged against policyholder funds in a given year divided by average account value. Normally, the MER would vary by fund class and be the sum of investment management fees, mortality & expense charges, guarantee fees/risk premiums, etc. The spread available to fund the GMDB costs ("margin offset", denoted by α) should be net of spread-based costs and expenses (e.g., net of maintenance expenses, investment management fees, trail commissions, etc.), but may be increased for Revenue Sharing as can be reflected in modeling (had the Alternative Methodology not been elected) by adhering to the requirements set forth in section 6 of the *Modeling Methodology*. The section of this Appendix on Component GC describes how to determine *MER* and α. 'Time-to-maturity' is uniquely defined in the factor modeling by $T = 95 - X$. (This assumes an assumed maturity age of 95 and a current attained age of X.) Net deposits are used in determining benefit caps under the GMDB Roll-up and Enhanced Death Benefit ("EDB") designs.

11. The GMDB definition for a given policy/cell may not exactly correspond to those provided. In some cases, it may be reasonable to use the factors/formulas for a different product form (e.g., for a "roll-up" GMDB policy near or beyond the maximum reset age or amount, the company should use the "return-of-premium" GMDB factors/formulas, possibly adjusting the guaranteed value to reflect further resets, if any). In other cases, the company might determine the RBC based on two different guarantee definitions and interpolate the results to obtain an appropriate value for the given policy/cell. However, if the policy form (definition of the guaranteed benefit) is sufficiently different from those provided and there is no practical or obvious way to obtain a good result from the prescribed factors/formulas, the company must select one of the following options:

    a) Model the "C3 Phase II RBC" using stochastic projections according to the approved methodology;

    b) Select factors/formulas from the prescribed set such that the values obtained conservatively estimate the required capital; or

    c) Calculate company-specific factors or adjustments to the published factors based on stochastic testing of its actual business. This option is described more fully in the section of this Appendix on Component GC.

12. The actuary must decide if existing reinsurance arrangements can be accommodated by a straight-forward adjustment to the factors and formulas (e.g., quota-share reinsurance without caps, floors or sliding scales would normally be reflected by a simple pro-rata adjustment to the "gross" *GC* results). For more complicated forms of reinsurance, the company will need to justify any adjustments or approximations by stochastic modeling. However, this modeling need not be performed on the whole portfolio, but can be undertaken on an appropriate set of representative policies. See the section of this Appendix on Component GC.

Component *CA*

Component *CA* provides for the amortization of the unamortized surrender charges using the actual surrender charge schedule applicable to the policy. Over time, the surrender charge is reduced and a portion of the charges in the policy are needed to fund the resulting increase in surrender value. This component can be interpreted as the "amount needed to amortize the unamortized surrender charge allowance for the *persisting* policies plus an implied borrowing cost". By definition, the amortization for non-persisting lives in each time period is exactly offset by the collected surrender charge revenue (ignoring timing differences and any waiver upon death). The company must project the unamortized balance to the end of the surrender charge period and discount the year-by-year amortization under the following assumptions. All calculations should reflect the impact of income taxes.

- Net asset return (i.e., after fees) as shown in Table 1 below. These rates roughly equate to an annualized 5th percentile return over a 10-year horizon17. The 10 year horizon was selected as a reasonable compromise between the length of a typical surrender charge period and the longer testing period usually needed to capture all the costs on "more expensive" portfolios (i.e., lower available spread, lower AV/GV ratio, older ages, etc.). Note, however, that it may not be necessary to use these returns if surrender charges are a function of deposits/premiums.

- Income tax and discount rates (after-tax) as defined in Table 9 of this Appendix. .

- The "Dynamic Lapse Multiplier" calculated at the valuation date (a function of Account Value (AV) ÷ Guaranteed Value (GV) ratio) is assumed to apply in each future year. This factor adjusts the lapse rate to reflect the antiselection present when the guarantee is in-the-money. Lapse rates may be lower when the guarantees have more value.

- Surrender charges and free partial withdrawal provisions should be reflected as per the contract specifications.

[17] A 5th percentile return is consistent with the CTE90 risk measure adopted in the C3 Phase II RBC methodology.

- "Prudent best estimate" lapse and withdrawal rates. Rates may vary according to the attributes of the business being valued, including, but not limited to, attained age, policy duration, etc.

- For simplicity, mortality may be ignored in the calculations.

Unlike the GC component, which requires the actuary to map the entire contract exposure to a single "equivalent" asset class, the *CA* calculation separately projects each fund (as mapped to the 8 prescribed categories) using the net asset returns in Table 1.

Table 1: Net Asset Returns for "CA" Component

Asset Class/Fund	**Net Annualized Return**
Fixed Account	Guaranteed Rate
Money Market and Fixed	0%
Balanced	–1%
Diversified Equity	–2%
Diversified International	–3%
Intermediate Risk Equity	–5%
Aggressive or Exotic Equity	–8%

Component *FE*

Component *FE* establishes a provision for fixed dollar costs (i.e., allocated costs, including overhead *and* those expenses defined on a "per policy" basis) less any fixed dollar revenue (e.g., annual administrative charges or policy fees). The company must project fixed expenses net of any "fixed revenue" to the earlier of contract maturity or 30 years, and discount the year-by-year amounts under the following assumptions. All calculations should reflect the impact of income taxes.

- Income tax and discount rates (after-tax) as defined in Table 9 of this Appendix.

- The "Dynamic Lapse Multiplier" calculated at the valuation date (a function of MV÷GV ratio) is assumed to apply in each future year. This factor adjusts the lapse rate to reflect the antiselection present when the guarantee is in-the-money. Lapse rates may be lower when the guarantees have more value.

- Per policy expenses are assumed to grow with inflation starting in the second projection year. The ultimate inflation rate of 3% per annum is reached in the 8th year after the valuation date. The company must grade linearly from the current inflation rate ("CIR") to the ultimate rate. The CIR is the higher of 3% and the inflation rate assumed for expenses in the company's most recent asset adequacy analysis for similar business.

- "Prudent best estimate" for policy termination (i.e., total surrender). Rates may vary according to the attributes of the business being valued, including, but not limited to, attained age, policy duration, etc. Partial withdrawals should be ignored as they do not affect survivorship.

- For simplicity, mortality may be ignored in the calculations.

Component *GC*

The general format for *GC* may be written as: $GC = GV \times f\left(\tilde{\theta}\right) - AV \times \hat{g}\left(\tilde{\theta}\right) \times h\left(\hat{\theta}\right)$ where *GV* = current guaranteed minimum death benefit, *AV* = current account value and $\hat{g}\left(\tilde{\theta}\right) = \frac{\alpha}{\hat{\alpha}} \times g\left(\tilde{\theta}\right)$. The functions $f(\circ), g(\circ)$ and $h(\circ)$ depend on the risk attributes of the policy $\tilde{\theta}$ and product portfolio $\hat{\theta}$. $h(\circ) = R$ was introduced in the "General" section as a "scaling factor". α is the company-determined net spread ("margin offset") available to fund the guaranteed benefits and $\hat{\alpha} = 100$ basis points is the margin offset assumed in the development of the "Base" tabular factors. The functions $f(\circ), g(\circ)$ and $h(\circ)$ are more fully described later in this section.

Rearranging terms for *GC*, we have $GC = f\left(\tilde{\theta}\right) \times \left[GV - AV \times z\left(\tilde{\theta}\right)\right]$. Admittedly, $z\left(\tilde{\theta}\right)$ is a complicated function that depends on the risk attribute sets $\tilde{\theta}$ and $\hat{\theta}$, but conceptually we can view $AV \times z\left(\tilde{\theta}\right)$ as a shock to the current account value (in anticipation of the adverse investment return scenarios that typically comprise the CTE90 risk measure for the AAR) so that the term in the square brackets is a "modified net amount at risk". Accordingly, $f\left(\tilde{\theta}\right)$ can be loosely interpreted as a factor that adjusts for interest (i.e., discounting) and mortality (i.e., the probability of the annuitant dying).

In practice, $f(\circ), g(\circ)$ and $h(\circ)$ are not functions in the typical sense, but values interpolated from the factor grid. The factor grid is a large pre-computed table developed from stochastic modeling for a wide array of combinations of the risk attribute set. The risk attribute set is defined by those policy and/or product portfolio characteristics that affect the risk profile (exposure) of the business: attained age, policy duration, AV/GV ratio, fund class, etc.

Fund Categorization

The following criteria should be used to select the appropriate factors, parameters and formulas for the exposure represented by a specified guaranteed benefit. When available, the volatility of the long-term annualized total return for the fund(s) – or an appropriate benchmark – should conform to the limits presented. This calculation should be made over a reasonably long period, such as 25 to 30 years.

Where data for the fund or benchmark are too sparse or unreliable, the fund exposure should be moved to the next higher volatility class than otherwise indicated. In reviewing the asset classifications, care should be taken to reflect any additional volatility of returns added by the presence of currency risk, liquidity (bid-ask) effects, short selling and speculative positions.

All exposures/funds must be categorized into one of the following eight (8) asset classes:

1. Fixed Account
2. Money Market
3. Fixed Income
4. Balanced
5. Diversified Equity
6. Diversified International Equity
7. Intermediate Risk Equity
8. Aggressive or Exotic Equity

Fixed Account. The fund is credited interest at guaranteed rates for a specified term or according to a 'portfolio rate' or 'benchmark' index. The funds offer a minimum positive guaranteed rate that is periodically adjusted according to company policy and market conditions.

Money Market/Short-Term. The fund is invested in money market instruments with an average remaining term-to-maturity of less than 365 days.

Fixed Income. The fund is invested primarily in investment grade fixed income securities. Up to 25% of the fund within this class may be invested in diversified equities or high-yield bonds. The expected volatility of the fund returns will be lower than the Balanced fund class.

Balanced. This class is a combination of fixed income securities with a larger equity component. The fixed income component should exceed 25% of the portfolio and may include high yield bonds as long as the total long-term volatility of the fund does not exceed the limits noted below. Additionally, any aggressive or 'specialized' equity component should not exceed one-third (33.3%) of the total equities held. Should the fund violate either of these constraints, it should be categorized as an equity fund. These funds usually have a long-term volatility in the range of 8% – 13%.

Diversified Equity. The fund is invested in a broad based mix of U.S. and foreign equities. The foreign equity component (maximum 25% of total holdings) must be comprised of liquid securities in well-developed markets. Funds in this category would exhibit long-term volatility comparable to that of the S&P500. These funds should usually have a long-term volatility in the range of 13% – 18%.

Diversified International Equity. The fund is similar to the Diversified Equity class, except that the majority of fund holdings are in foreign securities. These funds should usually have a long-term volatility in the range of 14% – 19%.

Intermediate Risk Equity. The fund has a mix of characteristics from both the Diversified and Aggressive Equity Classes. These funds have a long-term volatility in the range of 19% – 25%.

Aggressive or Exotic Equity. This class comprises more volatile funds where risk can arise from: (a) underdeveloped markets, (b) uncertain markets, (c) high volatility of returns, (d) narrow focus (e.g., specific market sector), etc. The fund (or market benchmark) either does not have sufficient history to allow for the calculation of a long-term expected volatility, or the volatility is very high. This class would be used whenever the long-term expected annualized volatility is indeterminable or exceeds 25%.

Selecting Appropriate Investment Classes. The selection of an appropriate investment type should be done at the level for which the guarantee applies. For guarantees applying on a deposit-by-deposit basis, the fund selection is straightforward. However, where the guarantee applies across deposits or for an entire contract, the approach can be more complicated. In such instances, the approach is to identify for each policy where the "grouped fund holdings" fit within the categories listed and to classify the associated assets on this basis.

A seriatim process is used to identify the "grouped fund holdings", to assess the risk profile of the current fund holdings (possibly calculating the expected long-term volatility of the funds held with reference to the indicated market proxies), and to classify the entire "asset exposure" into one of the specified choices. Here, "asset exposure" refers to the underlying assets (separate and/or general account investment options) on which the guarantee will be determined. For example, if the guarantee applies separately for each deposit year within the contract, then the classification process would be applied separately for the exposure of each deposit year.

In summary, mapping the benefit exposure (i.e., the asset exposure that applies to the calculation of the guaranteed minimum death benefits) to one of the prescribed asset classes is a multi-step process:

1. Map each separate and/or general account investment option to one of the prescribed asset classes. For some funds, this mapping will be obvious, but for others it will involve a review of the fund's investment policy, performance benchmarks, composition and expected long-term volatility.

2. Combine the mapped exposure to determine the expected long-term "volatility of current fund holdings". This will require a calculation based on the expected long-term volatilities for each fund and the correlations between the prescribed asset classes as given in Table 2.

3. Evaluate the asset composition and expected volatility (as calculated in step 2) of current holdings to determine the single asset class that best represents the exposure, with due consideration to the constraints and guidelines presented earlier in this section.

In step 1., the company should use the fund's actual experience (i.e., historical performance, inclusive of reinvestment) only as a guide in determining the expected long-term volatility. Due to limited data and changes in investment objectives, style and/or management (e.g., fund mergers, revised investment policy, different fund managers, etc.), the company may need to give more weight to the expected long-term volatility of the fund's benchmarks. In general, the company should exercise caution and not be overly optimistic in assuming that future returns will consistently be less volatile than the underlying markets.

In step 2., the company should calculate the "volatility of current fund holdings" (σ for the exposure being categorized) by the following formula using the volatilities and correlations in Table 2.

$$\sigma = \sqrt{\sum_{i=1}^{n}\sum_{j=1}^{n} w_i w_j \rho_{ij} \sigma_i \sigma_j}$$

where $w_i = \dfrac{AV_i}{\sum_k AV_k}$ is the relative value of fund *i* expressed as a proportion of total contract value, ρ_{ij} is the correlation between asset classes *i* and *j* and σ_i is the volatility of asset class *i* (see Table 2). An example is provided at the end of this section.

Table 2: Volatilities and Correlations for Prescribed Asset Classes

ANNUAL VOLATILITY		FIXED ACCOUNT	MONEY MARKET	FIXED INCOME	BALANCED	DIVERSE EQUITY	INTL EQUITY	INTERM EQUITY	AGGR EQUITY
1.0%	FIXED ACCOUNT	**1**	0.50	0.15	0	0	0	0	0
1.5%	MONEY MARKET	0.50	**1**	0.20	0	0	0	0	0
5.0%	FIXED INCOME	0.15	0.20	**1**	0.30	0.10	0.10	0.10	0.05
10.0%	BALANCED	0	0	0.30	**1**	0.95	0.60	0.75	0.60
15.5%	DIVERSE EQUITY	0	0	0.10	0.95	**1**	0.60	0.80	0.70
17.5%	INTL EQUITY	0	0	0.10	0.60	0.60	**1**	0.50	0.60
21.5%	INTERM EQUITY	0	0	0.10	0.75	0.80	0.50	**1**	0.70
26.0%	AGGR EQUITY	0	0	0.05	0.60	0.70	0.60	0.70	**1**

As an example, suppose three funds (Fixed Income, diversified U.S. Equity and Aggressive Equity) are offered to clients on a product with a contract level guarantee (i.e., across all funds held within the policy). The current fund holdings (in dollars) for five sample contracts are shown in Table 3.

Table 3: Fund Categorization Example

	1	**2**	**3**	**4**	**5**
MV Fund X (Fixed Income):	5,000	4,000	8,000	-	5,000
MV Fund Y (Diversified Equity):	9,000	7,000	2,000	5,000	-
MV Fund Z (Aggressive Equity):	1,000	4,000	-	5,000	5,000
Total Market Value:	15,000	15,000	10,000	10,000	10,000
Total Equity Market Value:	10,000	11,000	2,000	10,000	5,000
Fixed Income % (*A*):	33%	27%	80%	0%	50%
Fixed Income Test (*A*>75%):	No	No	Yes	No	No
Aggressive % of Equity (B):	10%	36%	n/a	50%	100%
Balanced Test (*A*>25% & *B*<33.3%):	Yes	No	n/a	No	No
Volatility of Current Fund Holdings:	10.9%	13.2%	5.3%	19.2%	13.4%
Fund Classification:	**Balanced**	**Diversified ***	**Fixed Income**	**Intermediate**	**Diversified**

* Although the volatility suggests "Balanced Fund", the Balanced Fund criteria were not met. Therefore, this 'exposure' is moved "up" to Diversified Equity. For those funds classified as Diversified Equity, additional analysis would be required to assess whether they should be instead designated as "Diversified International Equity".

As an example, the "Volatility of Current Fund Holdings" for policy #1 is calculated as $\sqrt{A+B}$ where:

$$A = \left(\frac{5}{15}\times 0.05\right)^2 + \left(\frac{9}{15}\times 0.155\right)^2 + \left(\frac{1}{15}\times 0.26\right)^2$$

$$B = 2\cdot\left(\frac{5}{15}\cdot\frac{9}{15}\right)(0.1\times 0.05\times 0.155) + 2\cdot\left(\frac{5}{15}\cdot\frac{1}{15}\right)(0.05\times 0.05\times 0.26) + 2\cdot\left(\frac{9}{15}\cdot\frac{1}{15}\right)(0.7\times 0.155\times 0.26)$$

So the volatility for contract #1 = $\sqrt{0.0092+0.0026}$ = 0.109 or 10.9%.

Derivation of Total Equivalent Account Charges (MER) and Margin Offset (α)

The total equivalent account charge ("MER") is meant to capture *all* amounts that are deducted from policyholder funds, not only those that are commonly expressed as spread-based fees. The MER, expressed as an equivalent annual basis point charge against account value, should include (but not be limited to) the following: investment management fees, mortality & expense charges, administrative loads, policy fees and risk premiums. In light of the foregoing, it may be necessary to estimate the "equivalent MER" if there are fees withdrawn from policyholder accounts that are not expressed as basis point charges against account value.

The margin offset, α, represents the total amount available to fund the guaranteed benefit claims and amortization of the unamortized surrender charge allowance after considering most other policy expenses (including overhead). The margin offset, expressed as an equivalent annual basis point charge against account value, may include the effect of Revenue Sharing in the same manner as would be done for modeling as described in section 6 of the Modeling Methodology, except as may be thereby permitted, should be deemed "permanently available" in all future scenarios. However, the margin offset should not include per policy charges (e.g., annual policy fees) since these are included in *FE*. It is often helpful to interpret the margin offset as $\alpha = MER - X$ + R, where *X* is the sum of:

- Investment management expenses and advisory fees;
- Commissions, bonuses (dividends) and overrides;
- Maintenance expenses, other than those included in *FE*; and
- Unamortized acquisition costs not reflected in *CA*.

And R is the Revenue Sharing to the extent permitted as described above.

Product Attributes and Factor Tables

The tabular approach for the *GC* component creates a multi-dimensional grid (array) by testing a very large number of combinations for the policy attributes. The results are expressed as factors. Given the seven (7) attributes for a policy (i.e., *P*, *A*, *F*, *X*, *D*, ϕ, *MER*), two factors are returned for $f(\circ)$ and $g(\circ)$. The factors are determined by looking up (based on a "key") into the large, pre-computed multi-dimensional tables and using multi-dimensional linear interpolation.

The policy attributes for constructing the test cases and the lookup keys are given in Table 4.

As can be seen, there are 6 × 2 × 8 × 8 × 5 × 7 × 3 = 80,640 "nodes" in the factor grid. Interpolation is only permitted across the last four (4) dimensions: Attained Age (*X*), Policy Duration (*D*), AV÷GV Ratio (ϕ) and MER. The "MER Delta" is calculated based on the difference between the actual MER and that assumed in the factor testing (see Table 10), subject to a cap (floor) of 100 bps (–100 bps).

Functions are available to assist the company in applying the Alternative Method for GMDB risks. These functions perform the factor table lookups and associated multi-dimensional linear interpolations. Their use is not mandatory. Based on the information in this document, the company should be able to write its own lookup and retrieval routines. Interpolation in the factor tables is described further later in this section.

Table 4: Nodes of the Factor Grid

Policy Attribute	Key : Possible Values & Description
Product Definition, *P*.	0 : 0 Return-of-premium. 1 : 1 Roll-up (3% per annum). 2 : 2 Roll-up (5% per annum). 3 : 3 Maximum Anniversary Value (MAV). 4 : 4 High of MAV and 5% Roll-up. 5 : 5 Enhanced Death Benefit (excl. GMDB)
GV Adjustment Upon Partial Withdrawal, *A*.	0 : 0 Pro-rata by market value. 1 : 1 Dollar-for-dollar.
Fund Class, *F*.	0 : 0 Fixed Account. 1 : 1 Money Market. 2 : 2 Fixed Income (Bond). 3 : 3 Balanced Asset Allocation. 4 : 4 Diversified Equity. 5 : 5 International Equity. 6 : 6 Intermediate Risk Equity. 7 : 7 Aggressive / Exotic Equity.
Attained Age (Last Birthday), *X*.	0 : 35 4 : 65 1 : 45 5 : 70 2 : 55 6 : 75 3 : 60 7 : 80
Policy Duration (years-since-issue), *D*.	0 : 0.5 1 : 3.5 2 : 6.5 3 : 9.5 4 : 12.5
Account Value-to-Guaranteed Value Ratio, ϕ.	0 : 0.25 4 : 1.25 1 : 0.50 5 : 1.50 2 : 0.75 6 : 2.00 3 : 1.00
Annualized Account Charge Differential from Table 10 Assumptions (“MER Delta”)	0 : –100 bps 1 : +0 2 : +100

A test case (i.e., a node on the multi-dimensional matrix of factors) can be uniquely identified by its key, which is the concatenation of the individual 'policy attribute' keys, prefixed by a leading '1'. For example, the key '12034121' indicates the factor for a 5% roll-up GMDB, where the GV is adjusted pro-rata upon partial withdrawal, balanced asset allocation, attained age 65, policy duration 3.5, 75% AV/GV ratio and "equivalent" annualized fund based charges equal to the 'base' assumption (i.e., 250 bps p.a.).

The factors are contained in the file "C3 II GMDB Factors (2004-03-11) 65%.csv", a comma-separated value text file. Each "row" represents the factors/parameters for a test policy as identified by the lookup keys shown in Table 4. Rows are terminated by new line and line feed characters.

Each row consists of 5 entries, described further below.

1	2	3	4	5
Test Case Identifier (Key)	Base GMDB Cost Factor	Base Margin Offset Factor	Scaling Adjustment (Intercept)	Scaling Adjustment (Slope)

<u>GMDB Cost Factor</u>. This is the term $f(\tilde{\theta})$ in the formula for *GC*. The parameter set $\tilde{\theta}$ is defined by $(P, A, F, X, D, \phi, MER)$. Here, ϕ is the AV/GV ratio for the benefit exposure (e.g., policy) under consideration. The values in the factor grid represent CTE90 of the sample distribution[18] for the present value of guaranteed benefit cash flows (in excess of account value) in all future years (i.e., to the earlier of contract maturity and 30 years), normalized by guaranteed value.

<u>Base Margin Offset Factor</u>. This is the term $g(\tilde{\theta})$ in the formula for *GC*. The parameter set $\tilde{\theta}$ is defined by $(P, A, F, X, D, \phi, MER)$. Here, ϕ is the AV/GV ratio for the benefit exposure (e.g., policy) under consideration. The values in the factor grid represent CTE90 of the sample distribution for the present value of margin offset cash flows in all future years (i.e., to the earlier of contract maturity and 30 years), normalized by account value. Note that the Base Margin Offset Factors assume $\hat{\alpha} = 100$ basis points of "margin offset" (net spread available to fund the guaranteed benefits).

[18] Technically, the sample distribution for "present value of net cost" = PV[GMDB claims] – PV[Margin Offset] was used to determine the scenario results that comprise the CTE90 risk measure. Hence, the "GMDB Cost Factors" and "Base Margin Offset Factors" are calculated from the same scenarios.

All else being equal, the margin offset α has a profound effect on the resulting AAR. In comparing the Alternative Method against models for a variety of GMDB portfolios, it became clear that some adjustment factor would be required to "scale" the results to account for the diversification effects[19] of attained age, policy duration and AV/GV ratio. The testing examined $W_1 = \frac{\alpha}{MER} = 0.20$ and $W_2 = \frac{\alpha}{MER} = 0.60$, where α = available margin offset and *MER* = total "equivalent" account based charges, in order to understand the interaction between the margin ratio ("*W*") and AAR.

Based on this analysis, the *Scaling Factor* is defined as:

$$h\left(\hat{\theta}\right) = R = \beta_0 + \beta_1 \times W$$

β_0 and β_1 are respectively the intercept and slope for the linear relationship, defined by the parameter set $\hat{\theta}$ = $\left(P, F, \hat{\phi}\right)$. Here, $\hat{\phi}$ is 90% of the aggregate AV/GV for the *product form* (i.e., not for the individual policy or cell) under consideration. In calculating the *Scaling Factor* directly from this linear function, the margin ratio "*W*" must be constrained[20] to the range $\left[0.2, 0.6\right]$.

It is important to remember that $\hat{\phi} = 0.90 \times \frac{\sum AV}{\sum GV}$ for the product form being evaluated (e.g., all 5% Roll-up policies). The 90% factor is meant to reflect the fact that the cost (payoff structure) for a basket of otherwise identical put options (e.g., GMDB) with varying degrees of in-the-moneyness (i.e., AV/GV ratios) is more left-skewed than the cost for a single put option at the "weighted average" asset-to-strike ratio.

To appreciate the foregoing comment, consider a basket of two 10-year European put options as shown in Table 5. These options are otherwise identical except for their "market-to-strike price" ratios. The option values are calculated assuming a 5% continuous risk-free rate and 16% annualized volatility. The combined option value of the portfolio is \$9.00, equivalent to a single put option with *S* = \$180.92 and *X* = \$200. The market-to-strike (i.e., *AV*/*GV*) ratio is 0.905, which is less than the average *AV*/*GV* = $1 = \frac{\$75+\$125}{\$100+\$100}$.

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[19] By design, the Alternative Methodology does not directly capture the diversification benefits due to a varied asset profile and product mix. This is not a flaw of the methodology, but a consequence of the structure. Specific assumptions would be required to capture such diversification effects. Unfortunately, such assumptions might not be applicable to a given company and could grossly over-estimate the ensuing reduction in required capital.

[20] The scaling factors were developed by testing "margin ratios" $W_1 = 0.2$ and $W_2 = 0.6$. Using values outside this range could give anomalous results.

Table 5: Equivalent Single European Put Option

	Equivalent Single Put Option	Put Option A ("in-the-money")	Put Option B ("out-of-the-money")
Market value (*AV*)	$180.92	$75	$125
Strike price (*GV*)	$200.00	$100	$100
Option Value	$9.00	$7.52	$1.48

<u>Scaling Adjustment (Intercept)</u>. The scaling factor $h\left(\hat{\theta}\right) = R$ is a linear function of *W*, the ratio of margin offset to MER. This is the intercept β_0 that defines the line.

<u>Scaling Adjustment (Slope)</u>. The scaling factor $h\left(\hat{\theta}\right) = R$ is a linear function of *W*, the ratio of margin offset to MER. This is the slope β_1 that defines the line.

Table 6 shows the "Base Cost" and "Base Margin Offset" values from the factor grid for some sample policies. As mentioned earlier, the Base Margin Offset factors assume 100 basis points of "available spread". The "Margin Factors" are therefore scaled by the ratio $\frac{\alpha}{100}$, where α = the actual margin offset (in basis points per annum) for the policy being valued. Hence, the margin factor for the 7th sample policy is exactly half the factor for node 12044121 (the 4th sample policy in Table 6). That is, 0.02715 = 0.5 × 0.05430.

Table 6: Sample Nodes on the Factor Grid

KEY	GMDB TYPE	GV ADJUST	FUND CLASS	AGE	POLICY DUR	AV/GV	MER (bps)	OFFSET	COST FACTOR	MARGIN FACTOR
10132031	ROP	$-for-$	Balanced Allocation	55	0.5	1.00	250	100	0.00570	0.04645
10133031	ROP	$-for-$	Balanced Allocation	60	0.5	1.00	250	100	0.00901	0.04365
10134031	ROP	$-for-$	Balanced Allocation	65	0.5	1.00	250	100	0.01338	0.03995
12044121	5% Rollup	Pro-rata	Diverse Equity	65	3.5	0.75	250	100	0.14596	0.04863
12044131	5% Rollup	Pro-rata	Diverse Equity	65	3.5	1.00	250	100	0.09147	0.04397
12044141	5% Rollup	Pro-rata	Diverse Equity	65	3.5	1.25	250	100	0.05725	0.04133
12044121	5% Rollup	Pro-rata	Diverse Equity	65	3.5	0.75	250	50	0.14596	0.02431

Interpolation in the Factor Tables

Interpolation is only permitted across the last four (4) dimensions of the risk parameter set $\tilde{\theta}$: Attained Age (X), Policy Duration (D), AV÷GV Ratio (ϕ) and MER. The "MER Delta" is calculated based on the difference between the actual MER and that assumed in the factor testing (see Table 10), subject to a cap (floor) of 100 bps (–100 bps). In general, the calculation for a single policy will require *three* applications of multi-dimensional linear interpolation between the $16 = 2^4$ factors/values in the grid:

(1) To obtain the *Base Factors* $f(\tilde{\theta})$ and $g(\tilde{\theta})$.

(2) To obtain the *Scaling Factor* $h(\hat{\theta}) = R.$.

Based on the input parameters, the supplied functions (see Appendix 9) will automatically perform the required lookups, interpolations and calculations for $h(\hat{\theta}) = R$, including the constraints imposed on the margin ratio *W*. Use of the tools noted in Appendix 9 is not mandatory.

Multi-dimensional interpolation is an iterative extension of the familiar two-dimensional linear interpolation for a discrete function $V(x)$:

$$\tilde{V}(x_k + \delta) = (1 - \xi) \times V(x_k) + \xi \times V(x_{k+1})$$

and

$$\xi = \frac{\delta}{x_{k+1} - x_x}$$

In the above formulation, $\tilde{V}(x)$ is assumed continuous and x_k and x_{k+1} are defined values ("nodes") for $V(x)$. By definition, $x_k \le (x_k + \delta) \le x_{k+1}$ so that $0 \le \xi \le 1$. In effect, multi-dimensional interpolation repeatedly applies simple linear interpolation one dimension at a time until a single value is obtained.

Multi-dimensional interpolation across all four dimensions is not required. However, simple linear interpolation for *AV*÷*GV* Ratio (ϕ) is mandatory. In this case, the company must choose nodes for the other three (3) dimensions according to the following rules:

Risk Attribute (Dimension)	**Node Determination**
Attained Age	Use next higher attained age.
Policy Duration	Use nearest.
MER Delta	Use nearest (capped at +100 & floored at –100 bps.

For example, if the actual policy/cell is attained age 62, policy duration 4.25 and MER Delta = +55 bps, the company should use the nodes defined by attained age 65, policy duration 3.5 and MER Delta = +100.

Table 7 provides an example of the fully interpolated results for a 5% Roll-up "Pro Rata" policy mapped to the Diversified Equity class (first row). While Table 7 does not demonstrate how to perform the multi-dimensional interpolation, it does show the required 16 nodes from the *Base Factors*. The margin offset is assumed to be 100 basis points.

Table 7: Base Factors for a 5% Rollup GMDB Policy, Diversified Equity

Key	Age	Policy Dur	Policy Av/Gv	Mer (Bps)	Base Cost Factor	Base Margin Factor
INTERPOLATED	62	4.25	0.80	265	0.114646	0.050918
12043121	60	3.5	0.75	250	0.110688	0.055028
12043122	60	3.5	0.75	350	0.126751	0.051686
12043131	60	3.5	1.00	250	0.069200	0.049403
12043132	60	3.5	1.00	350	0.084225	0.046705
12043221	60	6.5	0.75	250	0.096893	0.054733
12043222	60	6.5	0.75	350	0.111307	0.051411
12043231	60	6.5	1.00	250	0.059561	0.049202
12043232	60	6.5	1.00	350	0.072471	0.046497
12044121	65	3.5	0.75	250	0.145960	0.048629
12044122	65	3.5	0.75	350	0.164008	0.045956
12044131	65	3.5	1.00	250	0.091474	0.043968
12044132	65	3.5	1.00	350	0.109137	0.041837
12044221	65	6.5	0.75	250	0.132030	0.048435
12044222	65	6.5	0.75	350	0.148705	0.045771
12044231	65	6.5	1.00	250	0.081563	0.043807
12044232	65	6.5	1.00	350	0.097257	0.041709

The interpolations required to compute the *Scaling Factor* are slightly different from those needed for the *Base Factors*. Specifically, the user should *not* interpolate the intercept and slope terms for each surrounding node, but rather interpolate the *Scaling Factors* applicable to each of the nodes.

Table 8 provides an example of the *Scaling Factor* for the sample policy given earlier in Table 7 (i.e., a 5% Roll-up "Pro Rata" policy mapped to the Diversified Equity class) as well as the nodes used in the interpolation. The aggregate AV/GV for the product portfolio (i.e., all 5% Roll-up policies combined) is 0.75; hence, 90% of this value is 0.675 as shown under "Adjusted Product AV/GV". As before, the margin offset is 100 basis points per annum.

Table 8: Interpolated Scaling Factors for a 5% Rollup GMDB Policy, Diversified Equity

Key	Age	Policy Dur	Adjusted Product Av/Gv	Mer (Bps)	Intercept	Slope	Scaling Factor
INTERPOLATED	62	4.25	0.675	265	n/a	n/a	0.871996
12043111	60	3.5	0.50	250	0.855724	0.092887	0.892879
12043112	60	3.5	0.50	350	0.855724	0.092887	0.882263
12043121	60	3.5	0.75	250	0.834207	0.078812	0.865732
12043122	60	3.5	0.75	350	0.834207	0.078812	0.856725
12043211	60	6.5	0.50	250	0.855724	0.092887	0.892879
12043212	60	6.5	0.50	350	0.855724	0.092887	0.882263
12043221	60	6.5	0.75	250	0.834207	0.078812	0.865732
12043222	60	6.5	0.75	350	0.834207	0.078812	0.856725
12044111	65	3.5	0.50	250	0.855724	0.092887	0.892879
12044112	65	3.5	0.50	350	0.855724	0.092887	0.882263
12044121	65	3.5	0.75	250	0.834207	0.078812	0.865732
12044122	65	3.5	0.75	350	0.834207	0.078812	0.856725
12044211	65	6.5	0.50	250	0.855724	0.092887	0.892879
12044212	65	6.5	0.50	350	0.855724	0.092887	0.882263
12044221	65	6.5	0.75	250	0.834207	0.078812	0.865732
12044222	65	6.5	0.75	350	0.834207	0.078812	0.856725

Adjustments to GC for Product Variations & Risk Mitigation/Transfer

In some cases, it may be necessary for the company to make adjustments to the published factors due to:

1. A variation in product form wherein the definition of the guaranteed benefit is materially different from those for which factors are available (see Table 9); and/or

2. A risk mitigation / management strategy that cannot be accommodated through a straight-forward and direct adjustment to the published values.

Any adjustments to the published factors must be fully documented and supported through stochastic analysis. Such analysis may require stochastic simulations, but would not ordinarily be based on full inforce projections. Instead, a representative "model office" should be sufficient. In the absence of material changes to the product design, risk management program and Alternative Method (including the published factors), the company would not be expected to redo this analysis each year.

Note that minor variations in product design do not necessarily require additional effort. In some cases, it may be reasonable to use the factors/formulas for a different product form (e.g., for a "roll-up" GMDB policy near or beyond the maximum reset age or amount, the company should use the "return-of-premium" GMDB factors/formulas, possibly adjusting the guaranteed value to reflect further resets, if any). In other cases, the company might determine the RBC based on two different guarantee definitions and interpolate the results to obtain an appropriate value for the given policy/cell. Likewise, it may be possible to adjust the Alternative Method results for certain risk transfer arrangements without significant additional work (e.g., quota-share reinsurance without caps, floors or sliding scales would normally be reflected by a simple pro-rata adjustment to the "gross" *GC* results).

However, if the policy design is sufficiently different from those provided and/or the risk mitigation strategy is non-linear in its impact on the AAR, and there is no practical or obvious way to obtain a good result from the prescribed factors/formulas, the company must justify any adjustments or approximations by stochastic modeling. Notably this modeling need not be performed on the whole portfolio, but can be undertaken on an appropriate set of representative policies.

The remainder of this section suggests a process for adjusting the published "Cost" and "Margin Offset" factors due to a variation in product design (e.g., a "step-up" option at every 7th anniversary whereby the guaranteed value is reset to the account value, if higher). Note that the "Scaling Factors" (as determined by the slope and intercept terms in the factor table) would not be adjusted.

The steps for adjusting the published *Cost* and *Margin Offset* factors for product design variations are:

1. Select a policy design in the published tables that is similar to the product being valued. Execute cashflow projections using the documented assumptions (see Tables 9 and 10) and the pre-packaged scenarios for a set of representative cells (combinations of attained age, policy duration, asset class, AV/GV ratio and MER). These cells should correspond to nodes in the factor grid. Rank (order) the sample distribution of results for the present value of net cost[21]. Determine those scenarios which comprise CTE90.

[21] Present value of net cost = PV[guaranteed benefit claims in excess of account value] – PV[margin offset]. The discounting includes cashflows in all future years (i.e., to the earlier of contract maturity and the end of the horizon).

2. Using the results from step 1., average the present value of cost for the CTE90 scenarios and divide by the current guaranteed value. For a the Jth cell, denote this value by F_J. Similarly, average the present value of margin offset revenue for the same subset of scenarios and divide by account value. For the Jth cell, denote this value by G_J.

3. Extract the corresponding factors from the published grid. For each cell, calibrate to the published tables by defining a "model adjustment factor" (denoted by asterisk) separately for the "cost" and "margin offset" components:

$$F_J^* = \frac{f(\tilde{\theta})}{F_J} \text{ and } G_J^* = \frac{\hat{g}(\tilde{\theta})}{G_J}$$

4. Execute "product specific" cashflow projections using the documented assumptions and pre-packaged scenarios for the same set of representative cells. Here, the company should model the actual product design. Rank (order) the sample distribution of results for the present value of net cost. Determine those scenarios which comprise CTE90.

5. Using the results from step 4., average the present value of cost for the CTE90 scenarios and divide by the current guaranteed value. For a the Jth cell, denote this value by $\overline{F}_J$. Similarly, average the present value of margin offset revenue for the same subset of scenarios and divide by account value. For a the Jth cell, denote this value by $\overline{G}_J$.

6. To calculate the AAR for the specific product in question, the company should implement the Alternative Method as documented, but use $\overline{F}_J \times F_J^*$ in place of $f(\tilde{\theta})$ and $\overline{G}_J \times G_J^*$ instead of $\hat{g}(\tilde{\theta})$. The company must use the "Scaling Factors" for the product evaluated in step 1. (i.e., the product used to calibrate the company's cashflow model).

Assumptions for the Alternative Method Published GMDB Factors

This subsection reviews the model assumptions used to develop the Alternative Method factors. Each node in the factor grid is effectively the modeled result for a given "cell".

Table 9: Model Assumptions & Product Characteristics

Account Charges (MER)	Vary by fund class. See Table 10 later in this section.
Base Margin Offset	100 basis points per annum
GMDB Description	1. ROP = return of premium ROP. 2. ROLL = 5% roll-up, capped at 2.5 × premium, frozen at age 80. 3. MAV = annual ratchet (maximum anniversary value), frozen at age 80. 4. HIGH = Higher of 5% roll-up and annual ratchet frozen at age 80. 5. EDB = ROP + 40% Enhanced Death Benefit (capped at 40% of deposit).
Adjustment to GMDB Upon Partial Withdrawal	"Pro-Rata by Market Value" and "Dollar-for-Dollar" are tested separately.
Surrender Charges	Ignored (i.e., zero). Reflected in the "CA" component of the AAR.
Single Premium / Deposit	$100,000. No future deposits; no intra-policy fund rebalancing.
Base Policy Lapse Rate	• Pro-rata by MV: 10% p.a. at all policy durations (before dynamics) • Dollar-for-dollar: 2% p.a. at all policy durations (no dynamics)
Partial Withdrawals	• Pro-rata by MV: None (i.e., zero) • Dollar-for-dollar: Flat 8% p.a. at all policy durations (as a % of AV). No dynamics or anti-selective behavior.
Mortality	100% of MGDB 94 ALB.
Gender /Age Distribution	100% male. Methodology accommodates different attained ages and policy durations. A 5-year age setback will be used for female annuitants.
Max. Annuitization Age	All policies terminate at age 95.
Fixed Expenses, Annual Fees	Ignored (i.e., zero). Reflected in the "FE" component of the AAR.
Income Tax Rate	35%
Discount Rate	3.74% (after-tax) effective = 5.75% pre-tax.
Dynamic Lapse Multiplier (Applies only to policies where GMDB is adjusted "pro-rata by MV" upon withdrawal)	$\lambda = MIN\left[U, MAX\left[L, 1 - M \times \left(\frac{GV}{AV} - D\right)\right]\right]$ U=1, L=0.5, M=1.25, D=1.1 ▪ Applied to the 'Base Policy Lapse Rate' (not withdrawals).

Notes on GMDB Factor Development

- The roll-up is continuous (not simple interest, not stepped at each anniversary) and is applied to the previous roll-up guaranteed value (i.e., not the contract guaranteed value under HIGH).

- The Enhanced Death Benefit ("EDB") is floored at zero. It pays out 40% of the gain in the policy upon death at time *t*:

  $B_t = MIN\left[0.40 \times Deposit, 0.40 \times MAX\left(0, AV_t - Deposit\right)\right]$. The test policy also has a 100% return-of-premium GMDB, but the EDB Alternative Factors will be net of the GMDB component. That is, the EDB factors are 'stand-alone' and applied *in addition to* the GMDB factors.

- The "Base Policy Lapse Rate" is the rate of policy termination (total surrenders). Policy terminations (surrenders) are assumed to occur throughout the policy year (not only on anniversaries).

- Partial withdrawals (if applicable) are assumed to occur at the end of each time period (quarterly).

- Account charges ("MER") represent the total amount (annualized, in basis points) assessed against policyholder funds (e.g., sum of investment management fees, mortality and expense charges, risk premiums, policy/administrative fees, etc.). They are assumed to occur throughout the policy year (not only on anniversaries).

Table 10: Account-Based Fund Charges (bps per annum)

Asset Class / Fund	**Account Value Charges (MER)**
Fixed Account	0
Money Market	110
Fixed Income (Bond)	200
Balanced	250
Diversified Equity	250
Diversified International Equity	250
Intermediate Risk Equity	265
Aggressive or Exotic Equity	275

Calculation Example

Continuing the previous example (see Tables 7 and 8) for a 5% Roll-up GMDB policy mapped to Diversified Equity, suppose we have the policy/product parameters as specified in Table 11.

Table 11: Sample Policy Results for 5% Roll-up GMDB, Diversified Equity

Parameter	Value	Description
Deposit Value	$100.00	Total deposits adjusted for partial withdrawals.
Account Value	$98.43	Total account value at valuation date, in dollars.
GMDB	$123.04	Current guaranteed minimum death benefit, in dollars.
Attained Age	62	Attained age at the valuation date (in years).
Policy Duration	4.25	Policy duration at the valuation date (in years).
GV Adjustment	Pro-Rata	GMDB adjusted pro-rata by MV upon partial withdrawal.
Fund Class	Diversified Equity	Contract exposure mapped to Diversified Equity as per the Fund Categorization instructions in the section of this Appendix on Component GC.
MER	265	Total charge against policyholder funds (bps).
ProductCode	2	Product Definition code as per lookup key in Table 4.
GVAdjust	0	GV Adjustment Upon Partial Withdrawal as per key in Table 4.
FundCode	4	Fund Class code as per lookup key in Table 4.
PolicyMVGV	0.800	Contract account value divided by GMDB.
AdjProductMVGV	0.675	90% of the aggregate AV/GV for the Product portfolio.
RC	150	Margin offset (basis points per annum).

Using the usual notation, $GC = GV \times f\left(\tilde{\theta}\right) - AV \times \hat{g}\left(\tilde{\theta}\right) \times h\left(\hat{\theta}\right)$.

$f\left(\tilde{\theta}\right)$ = 0.114646 = GetCostFactor(2, 0, 4, 62, 4.25, 0.8, 265)

$\hat{g}\left(\tilde{\theta}\right)$ = 0.076377 = GetMarginFactor(2, 0, 4, 62, 4.25, 0.8, 265, 150)

$h\left(\hat{\theta}\right)$ = 0.887663 = GetScalingFactor(2, 0, 4, 62, 4.25, 0.675, 265, 150)

Hence, GC = $7.43 = (123.04 × 0.114646) – (98.43 × 0.076377 × 0.887663). As a normalized value, this quantity is 7.55% of account value, 6.04% of guaranteed value and 30.2% of the current net amount at risk (Net amount at risk = GV – AV).

Note that $\hat{g}\left(\tilde{\theta}\right) = \frac{\alpha}{\hat{\alpha}} \times g\left(\tilde{\theta}\right) = \frac{150}{100} \times 0.050918$ where $g\left(\tilde{\theta}\right)$ is "per 100 basis points" of available margin offset.

$g\left(\tilde{\theta}\right)$ = 0.050918 = GetMarginFactor(2, 0, 4, 62, 4.25, 0.8, 265, 100)

Appendix 9 – Supplied Functions for the Alternative Method

Special functions have been supplied in the file GMDBFactorCalc.dll (C++ dynamic linked library) to retrieve the "cost", "margin offset" and "scaling" factors from the factor file *and* perform the multi-dimensional linear interpolation based on the input parameters. Cover functions in the Microsoft® Visual Basic "Add-In" are provided in the file GMDBFactorCalc(2004-03-11).xla so that the C++ routines are callable from Microsoft Excel. The VBA[22] and C++ functions are identically named and are described in Table 1. Installation instructions are given later in this section. A call to an Excel function (built-in or VBA) must be preceded by a "+" or "=" character (e.g., =GetCostFactor(...)).

Using the notation given earlier, $GC = GV \times f\left(\tilde{\theta}\right) - AV \times \hat{g}\left(\tilde{\theta}\right) \times h\left(\hat{\theta}\right)$.

GetCostFactor(ProductCode, GVAdjust, FundCode, AttAge, PolicyDur, PolicyMVGV, MER)

- Returns the "*Cost Factor*" $f\left(\tilde{\theta}\right)$, interpolating between nodes where necessary.

GetMarginFactor(ProductCode, GVAdjust, FundCode, AttAge, PolicyDur, PolicyMVGV, MER, RC)

- Returns the "*Margin Offset Factor*" $\hat{g}\left(\tilde{\theta}\right)$, interpolating between nodes where necessary and scaling for the actual margin offset ("RC").

GetScalingFactor(ProductCode, GVAdjust, FundCode, AttAge, PolicyDur, AdjProductMVGV, MER, RC)

- Returns the "*Scaling Factor*" $h\left(\hat{\theta}\right) = R$, interpolating between nodes where necessary.

[22] Visual Basic for Applications.

Table 1: Input Parameters (Arguments) to Supplied Lookup Functions

Input Parameter	Variable Type	Description
ProductCode	Long Integer	Product Definition code as per lookup key in Table 4 of Appendix 8.
GVAdjust	Long Integer	GV Adjustment Upon Partial Withdrawal as per key in Table 4of Appendix 8.
FundCode	Long Integer	Fund Class code as per lookup key in Table 4 of Appendix 8.
AttAge	Floating Point Double	Attained Age of annuitant (in years).
PolicyDur	Floating Point Double	Policy Duration (in years).
PolicyMVGV	Floating Point Double	Account Value to GMDB ratio (AV/GV) for the policy.
MER	Floating Point Double	Total Equivalent Account Charges (annualized, in bps).
RC	Floating Point Double	Margin Offset (annualized, in basis points).
AdjProductMVGV	Floating Point Double	90% of the aggregate AV/GV for the Product portfolio.

Note that the calling syntax for the function GetScalingFactor requires input parameters for GVAdjust, AttAge, PolicyDur and MER even though the result does not vary by these attributes. However, this structure maintains consistency with the other functions and permits future refinements to the factor tables.

Installing and Using the GMDB Factor Calculation Routines

The files shown in Table 2 comprise the "GMDB Factor Calculation" tools, supplied by the AAA to assist the company in calculating the AAR under the Alternative Method for GMDB risks.

Table 2: GMDB Factor Calculation Tools – Required Files

File Name	Description
RegisterFactorCalc.bat	Batch file to register the C++ "GMDBFactorCalc.dll" in the Windows system registry. This allows the C++ routines to be called from other applications (such as Microsoft Excel via the Visual Basic Add-In).
GMDBFactorCalc(2004-03-11).xla	Microsoft® Excel Visual Basic Add-In. This functionality 'wraps' the C++ routines, allowing them to be called directly from Microsoft Excel workbooks (i.e., can be invoked the same way as built-in Excel functions).
GMDBFactorCalc.dll	The C++ dynamic linked library that contains the lookup and interpolation functions as described in this section.
C3 II GMDB Factors (2004-03-11) 100%.csv	Comma separated value files. These are flat text files containing the factors and parameters described in Appendix 8. Each "row" in the file corresponds to a test policy as identified by the lookup keys shown in Table 4 of Appendix 8. Each row consists of 5 entries and is terminated by new line and line feed characters. The "100%" file refers to the percentage applied to the MGDB 94 ALB mortality table in developing the GC factors.

To install and use the GMDB factor calculation routines, unzip all the files to a common folder (e.g., C:\Documents and Settings\User1\My Documents\AAA C3 Phase II\Factor Tables\ ). In particular, the Microsoft Excel Add-In "GMDBFactorCalc(2004-03-11).xla" and the GMDB factor files must reside in the same location.

The functionality cannot be accessed until the C++ routines are registered in the Window® program registry. This can be accomplished by executing the batch file "RegisterFactorCalc.bat". The DLL only needs to be registered once. Note: post-February 2004 releases of the factor tables include an installation routine (for Windows) that will automatically unzip (decompress) all required files and register the C++ DLL. In this case, the user does not to execute (run) the batch file.

"RegisterFactorCalc.bat" contains the following instructions:

```
REM ***  WinNT version ***

if exist %windir%\system32\regsvr32.exe %windir%\system32\regsvr32.exe GMDBFactorCalc.dll

REM ***  Win95 version ***

if exist %windir%\system\regsvr32.exe %windir%\system\regsvr32.exe GMDBFactorCalc.dll
```

A line prefaced with "REM" denotes a comment and does get executed. The other two statements simply run the program "regsvr32.exe" to register "GMDBFactorCalc.dll". Which statement is executed depends on the installed version of the Window operating system. The first statement is executed for Windows NT, Windows 2000 and Windows XP.

When the C++ DLL is successfully registered after running "RegisterFactorCalc.bat", you should receive a message such as the following:

```
DllRegisterServer in GMDBFactorCalc.dll succeeded
```

Next, the Microsoft Add-In must be loaded (into Excel) before the VBA functions can be called. Remember that the factor file and the Microsoft Excel Add-In (*.xla) should reside in the same folder. Simply open "GMDBFactorCalc(2004-03-11).xla" from Microsoft Excel. To view the VBA program, press [Alt-F11].

Under the VBAProject (GMDBFactorCalc(2004-03-11).xla) there are two important items. First, there is a module named "FactorCalc". This module contains the VBA cover functions for calling the C++ factor engine and some initialization parameters. The only line of code that may need editing is:

```
Public Const FactorFile As String = "C3 II GMDB Factors (2004-03-11) 100%.csv"
```

This statement defines the variable FactorFile as a character vector (string) and assigns the name of the factor file (without the directory). If the factor file is renamed, the user must edit the string (encased in double quotes), provided the correct name and save the .xla. Do not remove or change the .csv extension.

Second, there is a Microsoft Excel Object entitled “This Workbook”. This is a special object that exists in all Excel workbooks. The VBA code in this object initializes the factor calculation engine and loads the factor file into memory for faster execution by the statement:

```
Call m_FactorEngine.LoadFactorFile(ThisWorkbook.Path + "\" + FactorFile)
```

Here we clearly see that the factor file is assumed to reside in the same folder (“path”) as “ThisWorkbook” (i.e., GMDBFactorCalc(2004-03-11).xla).

Appendix 10 – Modeling of Hedges

Initial Considerations

The appropriate costs and benefits of hedging instruments that are currently held by the company in support of the contracts subject to these requirements shall be included in the projections. If the company is following a Clearly Defined Hedging Strategy ("hedging strategy") in accordance with an investment policy adopted by the Board of Directors or a committee of Board members, the company is eligible to reduce the amount of Total Asset Requirement ("TAR") otherwise calculated using the modeling methodology. The investment policy must clearly articulate the company's hedging objectives, including the metrics that drive rebalancing/trading. This specification could include maximum tolerable values for investment losses, earnings, volatility, exposure, etc. in either absolute or relative terms over one or more investment horizons vis-à-vis the chance of occurrence. Company management is responsible for developing, documenting, executing and evaluating the investment strategy, including the hedging strategy, used to implement policy.

For this purpose, the investment assets refer to all the assets including derivatives supporting covered products and guarantees. This is also referred to as the investment portfolio. The investment strategy is the set of all asset holdings at all points in time in all scenarios. The hedging portfolio, which is also referred to as the hedging assets, is a subset of the investment assets. The hedging strategy refers to the hedging assets holdings at all points in time in all scenarios. The distinction of what is the hedging portfolio and what is the investment portfolio is something that is not attempted to be made in this document. Nor is the distinction between investment strategy and hedging strategy formally made here. Where necessary to give effect to the intent of the document, the requirements applicable to the hedging portfolio or the hedging strategy are to apply to the overall investment portfolio and investment strategy.

This particularly applies to restrictions on the reasonableness or acceptability of the models that make up the stochastic cash flow model used to perform the projections, since these restrictions are inherently restrictions on the joint modeling of the hedging and non-hedging portfolio. To give effect to these requirements, they must apply to the overall investment strategy and investment portfolio.

The cost and benefits of hedging instruments that are currently held by the company in support of the contracts falling under the scope of these Recommendations shall be included in the stochastic cash flow model (the "model") used to calculate the risk based capital amount. Provided the company is following a Clearly Defined Hedging Strategy, the model shall take into account the cost and benefits of hedge positions expected to be held by the company in the future based on the operation of the hedging strategy.

Before either a new or revised hedging strategy can be used to reduce the amount of risk based capital otherwise calculated, the hedging strategy should be in place (i.e., effectively implemented by the company) for at least three months. The company may meet the time requirement by having evaluated the effective implementation of the hedging strategy for at least three months without actually having executed the trades indicated by the hedging strategy (e.g., mock testing or by having effectively implemented the strategy with similar annuity products for at least three months).

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

Background

The analysis of the impact of the hedging strategy on cash flows is typically performed using either of two methods as described below. Although a hedging strategy would normally be expected to reduce risk provisions, the nature of the hedging strategy and the costs to implement the strategy may result in an increase in the amount of the TAR otherwise calculated.

The fundamental characteristic of the first method is that all hedging positions, both the currently held positions and those expected to be held in the future, are included in the stochastic cash flow model used to determine the greatest present value of the accumulated deficiencies for each scenario.

The fundamental characteristic of the second method is that the effectiveness of the current hedging strategy (including currently held hedge positions) on future cash flows is evaluated, in part or in whole, outside of the stochastic RBC cash flow model.

Regardless of the methodology used by the company, the ultimate effect of the current hedging strategy (currently held hedge positions) on the TAR amount needs to recognize all risks, associated costs, imperfections in the hedges and hedging mismatch tolerances associated with the hedging strategy. The risks include, but are not limited to: basis, gap, price, parameter estimation, and variation in assumptions (mortality, persistency, withdrawal, annuitization, etc). Costs include, but are not limited to: transaction, margin (opportunity costs associated with margin requirements) and administration. In addition, the reduction to the TAR attributable to the hedging strategy may need to be limited due to the uncertainty associated with the company's ability to implement the hedging strategy in a timely and effective manner. The level of operational uncertainty generally varies inversely with the amount of time that the new or revised strategy has been in effect or mock tested.

No hedging strategy is perfect. A given hedging strategy may eliminate or reduce some but not all risks, transform some risks into others, introduce new risks or have other imperfections. For example, a delta-only hedging strategy does not adequately hedge the risks measured by the "Greeks" other than delta. Another example is that financial indices underlying typical hedging instruments typically do not perform exactly like the separate account funds, and hence the use of hedging instruments has the potential for introducing basis risk.

Calculation of TAR (reported)

The company should begin by calculating "TAR (best efforts)" – the results obtained when the TAR is based on the actuary's best efforts to fully incorporate the hedging strategy (including currently held hedge positions) into the stochastic cash flow model, including all of the factors and assumptions needed to execute the hedging strategy (e.g., stochastic implied volatility) and to measure the projected impact of hedge positions.

Because most models will include at least some approximations or idealistic assumptions, TAR (best efforts) may overstate the impact of the hedging strategy. To compensate for potential overstatement of the impact of the hedging strategy, the company must recalculate the TAR reflecting the impact of risks not completely reduced, eliminated or contemplated by the hedging strategy, all of the costs associated with the hedging strategy, the imperfections in the hedging strategy, and any uncertainty over the effectiveness of the hedging strategy. The result so obtained is called "TAR (adjusted)". In some situations the determination of TAR (adjusted) may include both direct and indirect techniques.

Finally, the reported value for the TAR is given by:

$$\text{TAR (reported)} = \text{TAR (best efforts)} + E \times \text{MAX}[0, \text{TAR(adjusted)} - \text{TAR(best efforts)}].$$

The value for *E* (an "error factor") reflects the actuary's view as to the level of sophistication of the stochastic cash flow model. As the sophistication of the stochastic cash flow model increases, the value for *E* decreases, subject to a minimum of 0.05 (i.e., the greater the ability of the TAR(best efforts) model to capture all risks and uncertainties, the lower the value of *E*). If the actuary's "best efforts" model is "state of art", the value "TAR(adjusted)–TAR(best efforts)" may be nominal. On the other hand, if the actuary's best efforts model is simplistic, the value "TAR(adjusted)-TAR(best efforts)" may be significant.

Specific Considerations and Requirements

As part of the process of choosing a methodology and assumptions for estimating the future effectiveness of the current hedging strategy (including currently held hedge positions) for purposes of reducing risk based capital, the actuary should review actual historical hedging effectiveness.

The actuary must carefully evaluate the appropriateness of the assumptions on future trading, transaction costs, and other elements of the model, the strategy, the mix of business, and other items that could result in materially adverse results. This includes an analysis of model assumptions that, when combined with the reliance on the hedging strategy, may result in adverse results relative to those modeled. The parameters and assumptions must be adjusted (based on testing contingent on the strategy used and other assumptions) to levels that fully reflect the risk based on historical ranges and foreseeable future ranges of the assumptions and parameters. If this is not possible by parameter adjustment, the model must be modified to reflect them at either best estimates or adverse estimates of the parameters.

A discontinuous hedging strategy is a hedging strategy where the relationships between the sensitivities to equity markets and interest rates (commonly referred to as the Greeks) associated with the guaranteed contractholder options embedded in the variable annuities and other in-scope products and these same sensitivities associated with the hedging assets are subject to material discontinuities. This includes, but is not limited to, a hedging strategy where material hedging assets will be obtained when the variable annuity account balances reach a predetermined level in relationship to the guarantees. Any hedging strategy, including a delta hedging strategy, can be a discontinuous hedging strategy if implementation of the strategy permits material discontinuities between the sensitivities to equity markets and interest rates associated with the guaranteed policyholder options embedded in the variable annuities and other in-scope products and these same sensitivities associated with the hedging assets. There may be scenarios that are particularly costly to discontinuous hedging strategies, especially where those result in large discontinuous changes in sensitivities (Greeks) associated with the hedging assets. Where discontinuous hedging strategies contribute materially to a reduction in the Conditional Tail Expectation Amount, the actuary must carefully evaluate the interaction of future trigger definitions and the discontinuous hedging strategy, in addition to the items mentioned in the previous paragraph. This includes an analysis of model assumptions that, when combined with the reliance on the discontinuous hedging strategy, may result in adverse results relative to those modeled.

Implementing a strategy that has a strong dependence on acquiring hedging assets at specific times that depend on specific values of an index or other market indicators may not be implemented as precisely as planned.

The combination of elements of the stochastic cash flow model, including the initial actual market asset prices, prices for trading at future dates, transaction costs, and other assumptions should be analyzed by the actuary as to whether the stochastic cash flow model permits hedging strategies that make money in some scenarios without losing a reasonable amount in some other scenarios. This includes, but is not limited to:

(1) hedging strategies with no initial investment that never lose money in any scenario and in some scenarios make money or

(2) hedging strategies that with a given amount of initial money never make less than accumulation at the one-period risk free rates in any scenario but make more than this in one or more scenarios.

If the stochastic cash flow model allows for such situations, the actuary should be satisfied that the results do not materially rely directly or indirectly on the use of such strategies. In addition, the actuary should disclose the situations and provide supporting documentation as to why the actuary believes the situations are not material for determining TAR. If the results do materially rely directly or indirectly on the use of such strategies, the strategies may not be used for the TAR otherwise calculated.

In addition to the above, the method used to determine prices of financial instruments for trading in scenarios should be compared to actual initial market prices. If there are substantial discrepancies, the actuary should disclose the material discrepancies and provide supporting documentation as to why the model-based prices are appropriate for determining the TAR. In addition to comparisons to initial market prices, there should be testing of the pricing models that are used to determine subsequent prices when scenarios involve trading financial instruments. This testing should consider historical relationships. For example, if a method is used where recent volatility in the scenario is one of the determinants of prices for trading in that scenario, then that model should approximate actual historic prices in similar circumstances in history.

Certification and Documentation

The actuary must provide a certification that the values for "E", TAR(adjusted) and TAR (best efforts) were calculated using the process discussed above and the assumptions used in the calculations were reasonable for the purpose of determining RBC. The actuary must document the method(s) and assumptions (including data) used to determine TAR(adjusted) and TAR(best efforts) and maintain adequate documentation as to the methods, procedures and assumptions used to determine the value of *E*.

The actuary must provide a certification as to whether the Clearly Defined Hedging Strategy is fully incorporated into the stochastic cash flow model and any supplementary analysis of the impact of the hedging strategy on TAR. The actuary must document the extent to which elements of the hedging strategy (e.g., time between portfolio rebalancing) are not fully incorporated into the stochastic cash flow model and any supplementary analysis to determine the impact, if any. In addition, the actuary must provide a certification and maintain documentation to support the certification that the hedging strategy designated as the Clearly Defined Hedging Strategy meets the requirements of a Clearly Defined Hedging Strategy including that the implementation of the hedging strategy in the stochastic cash flow model and any supplementary analysis does not include knowledge of events that occur after any action dictated by the hedging strategy (i.e., the model cannot use information about the future that would not be known in actual practice.).

A financial officer of the company (e.g., Chief Financial Officer, Treasurer, or Chief Investment Officer) or a person designated by them who has direct or indirect supervisory authority over the actual trading of assets and derivatives must certify that the Clearly Defined Hedging Strategy is the hedging strategy being used by the company in its actual day to day risk mitigation efforts.

Appendix 11 - Certification Requirements for C-3 Phase 2

1) General Requirements
   a) Compliance with NAIC RBC Instructions.
   b) Submission of Certification.
   c) Creation of Supporting Memorandum
2) Certification
   a) General Description. The certification shall be provided by a qualified actuary and consist of at least the following:
      i) A paragraph identifying the actuary and his or her qualifications;
      ii) A scope paragraph identifying the statement values of Variable Annuities and Similar Products included in the certification and the methodology used for those statement values (e.g. Alternative Methodology, Cash Flow Testing);
      iii) A reliance paragraph describing those areas, if any, where the certifying actuary has relied on other experts;
         (1) A reliance statement from each of those relied upon should accompany the certification. The reliance statements should note the information being provided and a statement as to the accuracy, completeness or reasonableness, as applicable, of the information.
      iv) A paragraph certifying that required capital was determined in accordance with the principles and requirements of the NAIC RBC Instructions;
      v) A paragraph certifying that the assumptions used for these calculations are not unreasonable for the products, scenarios, and purpose being tested.
      vi) A paragraph disclosing all material changes in the model or assumptions from that used previously and the estimated impact of such changes; and
      vii) A paragraph stating that the qualified actuary is not opining on the adequacy of the company's surplus or its future financial condition.
3) Supporting Memorandum
   a) General Description. A supporting memorandum shall be created to document the methodology and assumptions used to determine required capital. The information shall include:
   b) Alternative Methodology using Published Factors
      i) If a seriatim approach was not used, disclose how contracts were grouped
      ii) Disclosure of assumptions to include
         (1) Component CA
            (a) Mapping to prescribed asset categories
            (b) Lapse and withdrawal rates
         (2) Component FE
            (a) Determination of fixed dollar costs and revenues
            (b) Lapse and withdrawal rates
            (c) Inflation rates
         (3) Component GC
            (a) Disclosure of contract features and how the company mapped the contract form to those forms covered by the Alternative Methodology factors
               (i) Product Definition
                1. If not conservatively assigned to a published factor, company-specific factors or stochastic modeling is required

(ii) Partial Withdrawal Provision

(iii) Fund Class

1. Disclose the process used to determine the single asset class that best represents the exposure for a contract
   a. If individual funds are mapped into prescribed categories, the process used to map the individual funds should be disclosed.

(iv) Attained Age

(v) Contract Duration

(vi) Ratio of Account Value to Guaranteed Value

(vii) Annualized Account Charge Differential from Base Assumptions

(b) Derivation of Equivalent Account Charges

(c) Derivation of margin offset

(d) Disclosure of interpolation procedures and confirmation of node determination

iii) Disclosure, if applicable, of reinsurance that exists and how it was handled in applying published factors. (For some reinsurance, creation of company-specific factors or stochastic modeling may be required.)

c) Alternative Factors based on Company-Specific Factors

i) Disclosure of requirements consistent with Published Factors (as noted in section 3.b.)

ii) Additional Requirements

(1) Documentation of the basis of the actuary's Prudent Best Estimate of mortality if the GC factors are modified for mortality.

(2) Stochastic analysis supporting adjustments to Published Factors should be fully documented. This requirement does not apply to adjustments to Published Factors resulting from adjustments to the mortality assumption underlying the factors.

(a) This analysis needs to be submitted when initially used and be available upon request in subsequent years.

(b) Adjustments may include:

(i) Policy design

(ii) Risk mitigation strategy (excluding hedging); and

(iii) Reinsurance

d) Stochastic Modeling

i) Assets

(1) Description including type and quality

(2) Investment & disinvestment assumptions

(3) Assets used at the start of the projection

(4) Source of asset data

(5) Asset valuation basis

(6) Documentation of assumptions

(a) Default costs
(b) Prepayment functions
(c) Market value determination
(d) Yield on assets acquired
(e) Mapping and grouping of funds to modeled asset classes

Methodology Note C3-01 – Fund Categorization for Variable Accounts

An appropriate proxy for each variable account must be designed in order to develop the investment return paths. This does not mean that unique scenarios need to be developed for each individual variable fund. In most applications, this would be impractical and therefore, some grouping will be necessary. However, the development of the proxy scenarios is a fundamental step in the modeling and can have a significant impact on results. As such, the actuary must carefully and deliberately map each variable account to an appropriately crafted proxy fund. As noted, this 'mapping' is typically not 'one-to-one', but 'many-to-several'.

It would rarely be appropriate to estimate the stochastic model parameters (for the proxy) directly from actual company data. Rather, the proxy would normally be expressed as a linear combination of recognized market indices (or sub-indices). This approach has several distinct advantages:

- A small number of well-developed data series can be used to model a wide range of funds.
- It promotes consistency in practice.
- Historic data is generally available over long time periods. This enhances the reliability of any model parameters estimated from the empirical data.

The proxy construction process should include an analysis that establishes a firm relationship between the investment return proxy and the specific variable funds. Such an analysis can include, but would not be limited to the following:

- Portfolio objectives
- MorningStar classification
- Asset composition
- Historical returns
- Performance benchmark
- Market beta
- AG 34 classifications

When sufficient fund performance information exists, the analysis should examine the relationship of these data to the market/sector indices. Due to shifts in investment objectives, fund manager changes and tactical allocation (e.g., market timing), this comparison may not be straightforward, but would ideally include a study of serial correlations, tracking error and asset composition.

If credible historical fund data is not available, the proxy should be constructed by combining asset classes and/or employing allocation rules that most closely reflect the expected long-term composition of the specific fund given the investment objectives and management strategy. The relevant historic market data can then be used to estimate parameters. If sufficient historical market (or sub-sector) data does not exist, the return-generating process should reflect the contribution of each component by reference to some 'efficient markets' hypothesis.

However defined, efficient market theory generally posits that higher expected returns can only be attained by assuming greater risk. While the historic market data does not indicate a clearly defined 'risk-return' relationship, it would be imprudent to ignore the concept of market efficiency in establishing the proxy funds and the associated model parameters used to generate the investment return scenarios.

Methodology Note C3-02 – Model Building for In-Force Liabilities

When determining RBC requirements the actuary must comply with ASOP 7 and 23.

For large blocks of business, the actuary may employ grouping methods to in-force seriatim data in order to improve model run times. Care needs to be exercised when aggregating data for RBC purposes. Grouping methods must retain the characteristics needed to model all material risks and options embedded in the liabilities. RBC needs to cover "tail scenarios" and these are impacted by low probability, high impact scenarios. This may require more granularity (i.e., model points) in the grouping of data than what is needed for other purposes. Testing indicates that, typically, if each "cell" is assumed to have parameters equal to its mean or midpoint, the capital requirements are understated. This implies the need for either fine subdivision of the book of business, use of a value other than the mean, or an appropriate error adjustment.

Actuaries may want to consider the following when grouping data;

- Various breakpoints for "in-the-moneyness".
- Grouping funds that have similar risk/return characteristics.
- Product variations (e.g., various types of living and/or death benefit options).
- Annuitant and/or owner age.
- Duration of contract.
- Market
- Distribution channel.
- Other factors which could significantly impact the results.

It is important that adequate testing be done to validate models on both a static and dynamic basis. The model used must fit the purpose. The input data, assumptions, and formulas/calculations should all be validated. Peer review is recommended.

Methodology Note C3-03 - Contractholder Behavior

Contractholder behavior assumptions encompass actions such as lapses, withdrawals, transfers, recurring deposits, benefit utilization, option election, etc. Contractholder behavior is difficult to predict and behavior assumptions can significantly impact the results. In the absence of relevant and fully credible empirical data, the actuary should set behavior assumptions on the conservative end of the plausible spectrum (consistent with the definition of Prudent Best Estimate).

In setting behavior assumptions, the actuary should examine, but not be limited by the following considerations:

1. Behavior can vary by product, market, distribution channel, fund performance, time/product duration, etc…
2. Options embedded in the product may impact behavior.
3. Options may be elective or non-elective in nature. Living benefits are often elective and death benefit options are generally non-elective.
4. In comparison to non-elective options, elective contractholder options may be more driven by economic conditions.
5. As the value of a product option increases, there is an increased likelihood that contractholders will behave in a manner that maximizes their financial interest (e.g., lower lapses, higher benefit utilization, etc.).
6. Behavior formulas may have both rational and irrational components (irrational behavior is defined as situations where some contractholders may not always act in their best financial interest). The rational component should be dynamic, but the concept of rationality need not be interpreted in strict financial terms and might change over time.
7. Options that are ancillary to the primary product features may not be significant drivers of behavior. Whether an option is ancillary to the primary product features depends on many things such as:
   - For what purpose was the product purchased?
   - Is the option elective or non-elective?
   - Is the value of the option well known?

The impact of behavior can vary by product, time period, etc. Sensitivity testing of assumptions is recommended.

Within materiality considerations, the actuary should consider all relevant forms of contractholder behavior and persistency, including but not limited to the following:

- Mortality (additional guidance and requirements regarding mortality is contained in Methodology Note C3-04.)
- Surrenders

- Partial Withdrawals (Systematic and Elective)
- Fund Transfers (Switching/Exchanges)
- Resets/Ratchets of the Guaranteed Amounts (Automatic and Elective)
- Future Deposits

It may be acceptable to ignore certain items that might otherwise be explicitly modeled in an ideal world, particularly if the inclusion of such items reduces the calculated provisions. For example:

- The impact of fund transfers (intra-contract fund "switching") might be ignored, unless required under the terms of the contract (e.g., automatic asset re-allocation/rebalancing, dollar cost averaging accounts, etc.)
- Future deposits might be excluded from the model, unless required by the terms of the contracts under consideration and then only in such cases where future premiums can reasonably be anticipated (e.g., with respect to timing and amount).

However, the actuary should exercise caution in assuming that current behavior will be indefinitely maintained. For example, it might be appropriate to test the impact of a shifting asset mix and/or consider future deposits to the extent they can reasonably be anticipated and increase the calculated amounts.

Normally, the underlying model assumptions would differ according to the attributes of the contract being valued. This would typically mean that contractholder behavior and persistency may be expected to vary according to such characteristics as (this is not an exhaustive list):

- Gender
- Attained age
- Issue age
- Contract duration
- Time to maturity
- Tax status
- Fund value
- Investment option
- Guaranteed benefit amounts
- Surrender charges, transaction fees or other contract charges
- Distribution channel

Unless there is clear evidence to the contrary, behavior should be consistent with past experience and reasonable future expectations. Ideally, contractholder behavior would be modeled dynamically according to the simulated economic environment and/or other conditions. However, it is reasonable to assume a certain level of non-financially motivated behavior. The actuary need not assume that all contractholders act with 100% efficiency in a financially rational manner. Neither should the actuary assume that contractholders will always act irrationally.

Consistent with the concept of Prudent Best Estimate assumptions described earlier, the liability model should incorporate "margins" for uncertainty for all risk factors which are not dynamic (i.e., the non-scenario tested assumptions) and are assumed not to vary according to the financial interest of the contractholder.

The actuary should exercise care in using static assumptions when it would be more natural and reasonable to use a dynamic model or other scenario-dependent formulation for behavior. With due regard to considerations of materiality and practicality, the use of dynamic models is encouraged, but not mandatory. Risk factors which are not scenario tested, but could reasonably be expected to vary according to (a) a stochastic process, or (b) future states of the world (especially in response to economic drivers) may require additional margins and/or signal a need for higher margins for certain other assumptions. Risk factors that are modeled dynamically should encompass the plausible range of behavior consistent with the economic scenarios and other variables in the model, including the non-scenario tested assumptions. The actuary is encouraged to test the sensitivity of results to understand the materiality of making alternate assumptions.

All behaviors (i.e., dynamic, formulaic and non-scenario tested) should be consistent with the scenarios used in the CTE calculations (generally, the top 1/3 of the loss distribution). To maintain such consistency, it is not necessary to iterate (i.e., successive runs of the model) in order to determine exactly which scenario results are included in the CTE measure. Rather, in light of the products being valued, the actuary should be mindful of the general characteristics of those scenarios likely to represent the tail of the loss distribution and consequently use Prudent Best Estimate assumptions for behavior that are reasonable and appropriate in such scenarios. For variable annuities, these "valuation" scenarios would typically display one or more of the following attributes:

- Declining and/or volatile separate account asset values;
- Market index volatility, price gaps and/or liquidity constraints;
- Rapidly changing interest rates.

The behavior assumptions should be logical and consistent both individually and in aggregate, especially in the scenarios that govern the results. In other words, the actuary should not set behavior assumptions in isolation, but give due consideration to other elements of the model. The interdependence of assumptions (particularly those governing customer behaviors) makes this task difficult and by definition requires professional judgment, but it is important that the model risk factors and assumptions:

- Remain logically and internally consistent across the scenarios tested;

- Represent plausible outcomes; and
- Lead to appropriate, but not excessive, asset requirements.

The actuary should remember that the continuum of “plausibility” should not be confined or constrained to the outcomes and events exhibited by historic experience.

Companies should attempt to track experience for all assumptions that materially affect its risk profile by collecting and maintaining the data required to conduct credible and meaningful studies of contractholder behavior.

Methodology Note C3-04– Specific Guidance and Requirements for Setting Prudent Best Estimate Mortality Assumptions

The guidance and requirements in this Methodology Note apply for setting Prudent Best Estimate mortality assumptions when determining the TAR (whether using projections or the Alternative Methodology). The intent is for Prudent Best Estimate mortality assumptions to be based on facts, circumstances and appropriate actuarial practice (best practice if known) with only a limited role for unsupported actuarial judgment.

Prudent Best Estimate mortality assumptions are determined by first developing expected mortality curves based on either available experience or published tables. Where necessary, margins are applied to the experience to reflect data uncertainty. The expected mortality curves are then adjusted based on the credibility of the experience used to determine the expected mortality curve. The sections below address guidance and requirements for determining expected mortality curves and guidance and requirements for adjusting the expected mortality curves to determine Prudent Best Estimate mortality.

Finally, the credibility-adjusted tables shall be adjusted for mortality improvement (where such adjustment is permitted or required) using the guidance and requirements shown below.

For purposes of setting Prudent Best Estimate mortality assumptions, the products falling under the scope of these requirements shall be grouped into business segments with different mortality assumptions. The grouping should generally follow the pricing, marketing, management and/or reinsurance programs of the company. Where less refined segments are used for setting the mortality assumption than is used in business management the documentation should address the impact, if material, of the less refined segmentation on the resulting reserves.

The expected mortality curves may need to include a margin for data uncertainty. The margin could be in the form of an increase or a decrease in mortality, depending on the business segment under consideration. The margin shall be applied in a direction (i.e., increase or decrease in mortality) that results in a higher Total Asset Requirement. A sensitivity test may be needed to determine the appropriate direction of the provision for uncertainty to mortality. The test could be a prior year mortality sensitivity analysis of the business segment or an examination of current representative cells of the segment.

For purposes of this Methodology Note, if mortality must be increased (decreased) to provide for uncertainty the business segment is referred to as a plus (minus) segment.

It may be necessary, because of a change in the mortality risk profile of the segment, to reclassify a business segment from a plus (minus) segment to a minus (plus) segment to the extent compliance with this subsection requires a such a reclassification.

Determination of Expected Mortality Curves

In determining expected mortality curves the company shall use actual experience data directly applicable to the business segment (i.e., direct data) if it is available. In the absence of direct data, the company should then look to use data from a segment that is similar to the business segment (i.e., other than direct experience). See below for additional considerations. Finally, if there is no data, the company shall use the applicable table, as required below.

If expected mortality curves for a segment are being determined using data from a similar business segment (whether or not directly written by the company), the actuary shall document any similarities or differences between the two business segments (e.g., type of underwriting, marketing channel, average policy size, etc.). The actuary shall also document the data quality of the mortality experience of the similar business. Margins shall be applied to the expected mortality curves to reflect any data uncertainty and/or differences between the business segments.

To the extent the mortality of a business segment is reinsured, any mortality charges that are consistent with the company's own pricing and applicable to a substantial portion of the mortality risk may also be a reasonable starting point for the determination of the company's expected mortality curves. The actuary shall document the application of such reinsurance charges and how they were used to set the company's expected mortality curves for the segment.

When little or no experience or information is available on a business segment, the company shall use expected mortality curves that would produce expected deaths no less than using 100% of the 1994 Variable Annuity MGDB mortality table for a plus segment and expected deaths no greater than 100% of the Annuity 2000 table for a minus segment. If mortality experience on the business segment is expected to be a-typical (e.g., demographics of target markets are known to have higher (lower) mortality than typical), these "no data" mortality requirements may not be adequate.

The following considerations shall apply to mortality data specific to the business segment for which assumptions are being determined (i.e., direct data or other than direct data discussed above):

1) **Under-reporting of deaths.** Mortality data shall be examined for possible under-reporting of deaths. Adjustments shall be made to the data if there is any evidence of under-reporting. Alternatively, exposure by lives or amounts on contracts for which death benefits were in the money may be used to determine expected mortality curves. Under-reporting on such exposures should be minimal; however, this reduced subset of data will have less credibility.

2) **Experience by contract duration.** Experience of a plus segment shall be examined to determine if mortality by contract duration increases materially due to selection at issue. In the absence of information, the actuary shall assume that expected mortality will increase by contract duration for an appropriate select period. As an alternative, if the actuary determines that mortality is impacted by selection, the actuary could apply margins to the expected mortality in such a way that the actual mortality modeled does not depend on contract duration.

3) **Modification and Relevance of data.** Even for a large company the quantity of life exposures and deaths are such that a significant amount of smoothing may be required to determine expected mortality curves from mortality experience. Expected mortality curves, when applied to recent historic exposures (e.g. the prior 3 to 7 years), should not result in an estimate of aggregate deaths less (greater) than actual deaths during the exposure period for plus (minus) segments. If this condition is not satisfied, the actuary must document the rationale in support of using expected mortality curves that differ from recent mortality experience.

   In determining expected mortality curves (and the credibility of the underlying data), older data may no longer be relevant. The "age" of the experience data used to determine expected mortality curves should be documented. There should be commentary in the documentation on the relevance of the data (e.g., any actual and expected changes in markets, products and economic conditions over the historic and projected experience).

4) **Other considerations.** In determining expected mortality curves, considerations should be given to factors that include, but are not limited to, trends in mortality experience, trends in exposure, volatility in year to year A/E mortality ratios, mortality by lives relative to mortality by amounts, changes in the mix of business and product features that could lead to mortality selection.

Adjustment for Credibility to Determine for Prudent Best Estimate Mortality

A. Adjustment for Credibility. Expected mortality curves determined according to Section II above shall be adjusted based on the credibility of the experience used to determine the curves in order to arrive at Prudent Best Estimate mortality. The adjustment for credibility shall result in blending the expected mortality curves with a mortality table consistent with a statutory valuation mortality table. For a plus segment, the table shall be consistent with 100% of the 1994 Variable Annuity MGDB table (or a more recent mortality table adopted by the NAIC to replace this table). For a minus segment, the table shall be consistent with 100% of the 2000 Annuity table (or a more recent mortality table adopted by the NAIC to replace that table). The approach used to adjust the curves shall suitably account for credibility[23].

[23] For example, when credibility is zero, an appropriate approach should result in a mortality assumption consistent with 100% of the statutory valuation mortality table used in the blending.

B. Adjustment of Statutory Valuation Mortality for Improvement. For purposes of the adjustment for credibility, the statutory valuation mortality table for a plus segment may be, and the statutory valuation mortality table for a minus segment must be adjusted for mortality improvement. Such adjustment shall reflect applicable published industrywide experience from the effective date of the respective statutory valuation mortality table to the experience weighted average date underlying the data used to develop the expected mortality curves.

C. Credibility Procedure. The credibility procedure used shall:

a. produce results that are reasonable in the professional judgment of the actuary,
b. not tend to bias the results in any material way,
c. be practical to implement,
d. give consideration to the need to balance responsiveness and stability,
e. take into account not only the level of aggregate claims but the shape of the mortality curve, and
f. contain criteria for full credibility and partial credibility that have a sound statistical basis and be appropriayely applied..

Documentation of the credibility procedure used shall include a description of the procedure, the statistical basis for the specific elements of the credibility procedure, and any material changes from prior credibility procedures.

The items identified above were developed from material contained in Actuarial Standard of Practice No. 25, "Credibility Procedures Applicable to Accident and Health, Group Term Life and Property/Casualty Coverages".

D. Further Adjustment of the Credibility–Adjusted Table for Mortality ImprovementThe credibility-adjusted table used for plus segments may be, and the credibility adjusted date used for minus segments must be adjusted for applicable published industrywide experience from the experience weighted average date underlying the company experience used in the credibility process to the valuation date.

Any adjustment for mortality improvement beyond the valuation date is discussed below.

Future Mortality Improvement

The mortality assumption resulting from these requirements shall be adjusted for mortality improvements beyond the valuation date if such an adjustment would serve to increase the resulting Total Asset Requirement. If such an adjustment would reduce the Total Asset Requirement, such assumptions are permitted, but not required. In either case, the assumption must be based on current relevant data with a margin for error (increasing assumed rates of improvement if that results in a higher TAR, reducing them otherwise).

Documentation Requirements

5) **All Segments.**

The documentation should include any material considerations necessary to understand the development of mortality assumptions for the statutory RBC calculation even if such considerations are not explicitly mentioned in this section. The documentation should be explicit when material judgments were required and such judgments had to be made without supporting historic experience.

The documentation shall:

(a) Explain the rationale for the grouping of contracts into different segments for the determination of mortality assumptions and characterize the type and quantity of business that constitute each segment.

(b) Describe how each segment was determined to be a plus or minus segment.

(c) Summarize any mortality studies used to support mortality assumptions, quantify the exposures and corresponding deaths, describe the important characteristics of the exposures and comment on unusual data points or trends.

(d) Document the age of the experience data used to determine expected mortality curves and comment on the relevance of the data.

(e) Document the mathematics used to adjust mortality based on credibility and summarize the result of applying credibility to the mortality segments.

(f) Discuss any assumptions made on mortality improvements, the support for such assumptions and how such assumptions adjusted the modeled mortality.

(g) Describe how the expected mortality curves compares to recent historic experience and comment on any differences.

(h) Discuss how the mortality assumptions used are consistent with the goal of achieving 90 CTE over the joint distribution of all future outcomes, in keeping with Priniciple #3 and Methodology Note C3-03.

If the study was done on a similar business segment, identify the differences in the business segment on which the data was gathered and the business segment on which the data was used to determine mortality assumptions for the statutory RBC calculation. Describe how these differences were reflected in the mortality used in modeling.

If mortality assumptions for the statutory RBC calculation were based in part on reinsurance rates, document how the rates were used to set expected mortality (e.g., assumptions made on loadings in the rates and or whether the assuming company provided their expected mortality and the rationale for their assumptions).

6) **Plus Segments.** For a plus segment, the documentation shall also discuss the examination of the mortality data for the underreporting of deaths and experience by duration, and describe any adjustments that were made as a result of the examination.

7) **Minus Segments.** For a minus segment the documentation shall also discuss how the mortality deviations on minus segments compare to those on any plus segments. To the extent the overall margin is reduced, the documentation should include support for this assumption.

Methodology Note C3-05 Reflecting Prudent Best Estimate Mortality Using the Alternative Method

The factors published for use in the Alternative Method are based on 100% of the MGDB 94 ALB mortality table. Companies using the Alternative Method may use these factors directly or may reflect the actuary's Prudent Best Estimate of mortality expectations in calculating TAR. When using the actuary's Prudent Best Estimate of mortality the steps to be used are as follows:

1. The company will need to develop a set of mortality assumptions for use in making the modifications. In setting the expectations for expected mortality, the company should be guided by the definition of Prudent Best Estimate and the principles discussed in Methodology Notes C3-03 and C3-04.

2. The company then will calculate net single premia at each issue age to be valued using both 100% of the MGDB 94 ALB table (using a 5 year age setback for females) and the table based on the actuary's Prudent Best Estimate of mortality. In making these calculations the company should assume 3.75% interest and a flat lapse rate of 7% per year.

3. The cost factor ($f\left(\tilde{\theta}\right)$ in Appendix 8) is then multiplied by the ratio of the NSP calculated using the Prudent Best Estimate of mortality to the NSP calculated using the MGDB 94 ALB table (using a 5-year age setback for females) for the specific age being valued.

4. The TAR is then calculated using the modified cost factor. All other factors are calculated as they would have been without this adjustment.

Note that once a company had used the modified method, the option to use 100% of the table is no longer available.