



AMERICAN ACADEMY *of* ACTUARIES

Progress Report: C-3 Phase II

**Presented by the American Academy of Actuaries' Life Capital Adequacy
Subcommittee to the National Association of Insurance Commissioners' Life Risk-
Based Capital Working Group**

New York, NY – June 2003

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The following report was prepared by the C-3 Work Group chaired by Bob Brown.

During the NAIC's Life Risk-Based Capital Work Group's (LRBC WG) exposure period for our December 2002 report, 14 letters were received expressing comments, concerns, questions, suggestions, and endorsements. In addition, members of the C-3 Work Group, interested parties, and the new Variable Annuity Reserve Work Group (which is working through the implications of extending our recommended approach to reserves) have surfaced a few issues.

In response to all of this input, our work group has been reviewing the letters and working through the issues raised. For each of these topics we are either explaining the basis of our recommendation, modifying it (if we think that would improve the recommendation), or elaborating on it (if the input suggests that our recommendation was unclear).

Our objective is to address all substantive outstanding issues for our report to the LRBC WG for their fall meeting in September 2003 (although work will continue beyond September along the lines of fleshing out the Appendix, examining Actuarial Standards of Practice for possible revision, etc.).

At this time, we have made the decision to modify a few of the recommendations made in the December report, namely:

- a) We have decided to exclude variable life insurance products from the scope of the requirements. At this stage, inclusion seems to add a great deal of complexity and work effort. In addition, modeling of "typical" variable life insurance products produced no additional capital requirements.
- b) We need to broaden the scope to include guarantees similar to the variable annuity guarantees currently covered, no matter what policy form provides them. For example, group life contracts sold to mutual fund companies providing minimum death benefit guarantees or group annuity contracts with equity fund guarantees. There is no reason that similar guarantees should not have similar capital requirements.
- c) We have also expanded our scope to include variable annuities with no guarantees, and to remove the modest capital charge for these products from the "regular" C-3 factors.
- d) Our December recommendation, as written, effectively failed to reflect Federal Income Tax credit for reserve increases in excess of Cash Surrender Value increases. This will be remedied in the revised recommendation.

Between now and September, we will finalize our recommendation with respect to the eight critical issues still under discussion:

- a) Should year-by-year accumulated deficits be projected using a “working reserve” of modified Cash Surrender Value (see Section 7 of the December report) or against a more accurate approximation to the statutory reserve?
- b) Should the total capital target be defined in terms of Modified CTE (MCTE) or CTE (i.e., in integrating the tail of the loss distribution, is each scenario floored at zero)(see Section 9 of the December 2002 report)?
- c) Equity fund performance calibration standards.
- d) What starting assets should be used for the fund projections? In particular, should the investment of capital held in “old money” be reflected? If the coupon rate on currently held assets differs significantly from that available on newly purchased assets, this distinction may substantially impact capital requirements.
- e) Should some method of dampening the volatility of capital requirements be introduced?
- f) What categories of funds should be required or permitted?
- g) Can we find a way to use a standard mortality table for scenario projections, then modify the result to set total asset goals to conform to a company’s “prudent best estimate”?
- h) Basis for future interest rate assumptions.

In addition to these issues, we will be working to produce a set of 10,000 scenarios that companies can use as an alternative to generating their own and a set of “alternative method” factor tables for companies that prefer not to do stochastic testing. We will also suggest approaches to shifting the primary work effort off of year-end through the use of earlier values, with adjustment for subsequent events. We also plan to address a number of practical implementation and methodology issues in an appendix, some of which will be done by September’s report, some of which will represent ongoing work over the following period.

Attached to this report are two appendices. The first summarizes the many questions and issues raised in the comment letters and our responses to those comments. The second presents the results of the initial work on total asset needs for minimum death benefit guarantees, with sensitivity analyses for key parameters.

We continue to believe the recommended approach is the appropriate basis for capital standards for this broad class of products. We look forward to continued discussion of this with the LRBC WG as we move toward completion of this recommendation.

Comments Resulting from December 2002 Report And *Initial* Work Group Response

As a result of our December 2002 report, a number of comments and questions about this work were received through the NAIC or directly by our work group itself. Over time, the work group reviewed each of these comment letters in detail to identify the issues raised. At the same time, an initial response was developed.

The following pages list each issue raised in those comment letters, along with others generated by the work group along the way. This list also includes the *initial* response of the work group to the issue. Occasionally, the work group felt that additional discussion or work was needed. In some cases that work has been done and, as a result, these comments may not reflect the current position of the work group. Current positions can be found in the brief report to which this appendix is attached.

Administrative Issues

1. **Application to VUL** - While the testing regime proposed will add value in understanding variable annuity risks, there is less benefit to be gained by applying this methodology to variable universal life (VUL) contracts, due to the different risk profile of these products. This lesser benefit does not warrant the cost of implementing this testing for VUL contracts so we recommend that VUL contracts be excluded from the dynamic testing requirement.

WG (work group): The work group needs to think more about this issue. We will look into testing the hypothesis that the testing method proposed will add little in the case of VUL. We are also considering adding tabular values for VUL death benefit guarantees like those for VA death benefit guarantees. [8 – original question number from comment letters]

2. **Treatment of Variable Life** - The part of the scope dealing with Variable Life appears to produce a “catch 22” situation since they would have to be subjected to the calculations (although kept separate) in order to determine if their inclusion “increases the capital requirement.” Is this intended? If so, why treat VL differently than VA? In any event, isn’t a definition of “VL with secondary guarantees” desirable to ensure uniformity in the application of the recommendation?

WG: These are good points. As noted elsewhere, (see question 1) we are still working on VLI and how it relates to the VA calculation. If VLI remains in the scope of this project, we intend to change the definition to include Variable life with any death benefit guarantees, including secondary guarantees. [44]

3. **Treatment of Variable Life** - It is stated that a factor method will be permitted for annuity contracts which only contain GMDB. Is this alternative also intended to apply for VL with secondary guarantees? If not, why?

WG: As noted above, we are still considering the VLI situation. A factor approach is being considered. (See questions 1 and 2.) [45]

4. **Treatment of Variable Life** - Variable life and variable universal life should be excluded from this proposal. Modeling of these products is complex, likely significantly more so than variable annuity products. The limited testing that we are aware of has shown that there is very little risk resulting from the guarantees. Thus the benefit of including variable life products does not seem worth the cost.

WG: We are reconsidering the decision to include variable life and variable universal life in the scope of this project. (See questions 1, 2 and 3.) [62]

5. **Treatment of Variable Life** - New York recommends removing variable universal life from the initial implementation of these requirements. More investigation is needed on the necessity and implication of including this product category under a scenario testing methodology for determining RBC. In addition, inclusion of variable universal life could slow down the implementation process.

WG: The work group will consider removing VLI from the scope of this project. (See Questions 1, 2, 3 and 4.) [86]

6. **Treatment of Variable Life** - The paper encompasses application of the methods proposed to Variable Life products. To the best of our knowledge no analysis has been completed to demonstrate that the proposed methods produce appropriate results. Given the lack of analysis of the effect of this proposal on Variable Life, we suggest that it be removed from consideration until more work is completed.

WG: The work group is reconsidering the application of this proposal to variable life. (See questions 1, 2, 3, 4 and 5.) [97]

7. **Volatility of Results** - The proposed methodology produces substantial RBC requirements for these benefits. These requirements may be volatile. If these results flow logically from sound modeling assumptions, then they are desirable in that they will force regulators and company management to confront the true risks inherent in these products. However, high and/or volatile RBC requirements would be counterproductive if they are primarily the result of inadequately researched modeling assumptions—or if the modeling process/assumptions weren't trusted by the financial community.

WG: We do not believe the volatility is a result of “inadequately researched modeling assumptions.” The reality is that these contracts move into and out of the money and there is a high degree of leverage in the value of long dated options. The RBC requirement simply reflects this. We do acknowledge that the use of a model with mean reversion would somewhat dampen volatility but historical data does not support mean reversion of any strength. [15]

8. **Volatility of Results** - The proposed method might introduce substantial volatility in capital requirements. This could make capital planning very difficult for a company that targets a particular RBC ratio such as 250%.

WG: The proposed method will introduce volatility for unhedged risks but that volatility is a real function of the risks being accepted. We believe it is the right answer. We also note that a similar system seems to work well in Canada. If volatility represents a serious problem, it can be substantially reduced (at a cost) through hedging or reinsurance. [20]

9. **Volatility of Results** - Is it possible that the volatility is coming from the model itself? It just doesn't seem that a 20-year model should be that dependent on the starting point of the model.

WG: In a path and position independent model (i.e., one in which the 20 year wealth ratio distribution is not affected by current market levels or by how we arrived at those levels), if the starting asset values are shifted 10%, the values to which the 20-year probability distributions apply are also shifted 10%. We are unaware of evidence that refutes path and position independence. [21]

10. **Volatility of Results** - Is the work group considering grading the results of the modeling into the calculation?

WG: We are considering that. Our Canadian counterpart is currently looking at methods for dampening period-to-period volatility and the implications of using such techniques in setting a capital standard. We are particularly concerned about the impact of this volatility on the trend test used in evaluating a company's RBC position. It seems that the changes in this number should be excluded from the trend test. [22]

11. **Volatility of Results** - The choppiness of the resulting RBC numbers may make RBC calculations less useful as a measure of capitalization.

WG: Assuming the "choppy" results to be "real", any other RBC standard would seem to have little meaning. It seems safe to assert that if a market loss over the period leads to a sharp increase in RBC, the economic position the company is in if it fully hedges its exposure today is similarly affected. [23]

12. **Volatility of Results** - Under this proposal volatility in the market could result in wide swings in required capital. This volatility may reduce the RBC formula's ability to identify poorly capitalized companies. As a somewhat extreme example, consider a market increase of 15% in the month of December versus the same increase in the month of January. The proposed method could produce very different capital requirements for a particular company under each scenario. But, for the purposes of evaluating capitalization, does the risk position of the company really differ? The work group should consider methods to smooth the results to avoid inappropriate interpretations.

WG: We are considering that. (See question 10.) [61]

13. **Volatility of Results** - The proposed model may be overly sensitive to current market conditions and could result in unwarranted volatility in capital requirements. This, in turn, could make short and long range capital planning difficult for insurance companies.

WG: We agree that the results could be volatile but that is reality for unhedged risks of this type. Hedging can make the results much more stable. (See questions 10 and 12.) [102]

14. **Volatility of Results** - The volatility of this measure could actually impede regulators' efforts to determine whether a company is adequately capitalized.

WG: The proposed method will introduce volatility for unhedged risks but that volatility is a real function of the risks being accepted. We believe it is the right answer. We also note that a similar system seems to work well in Canada. If volatility represents a serious problem, it can be substantially reduced (at a cost) through hedging or reinsurance. (See questions 10, 12, and 13.) [103]

15. **Variable CTE Measure** - Scenario assumptions and methods can change from year to year. With assumptions and methods "unlocked" each year, results can be volatile with dynamics similar to a market value accounting. While most of the volatility is a result of the real economics of the guarantees, some volatility may be overstated because the cyclical nature of equity markets and the economy are ignored. New York recommends investigation of appropriate ways to take into account the cyclical nature of markets on a uniform basis for all companies. One possible approach may be the use of a variable CTE percentage. The percentage would increase to a cap, say 95%, when recent market performance has been favorable (relative to the guarantee) and decrease to a floor, say 90%, when recent market performance has been unfavorable. Under this approach, contracts with right tail risk could be subject to a different CTE than a product with a left tail risk.

WG: This is an intriguing idea. The work group is interested in ways to dampen the volatility of the proposed method and this method would do that by recognizing presumed changes in risk. The target could be based on P/E ratios, recent movements, or P/E ratios compared to interest rates. One concern would be different fund classes that may be on different cycles. Another is that any such adjustment would be arbitrary. The work group will consider this further, along with other smoothing approaches. (See questions 10, 12, 13 and 14.) [80]

16. **Pertinent CTE Measure** - The recommended 90% CTE is less than the 95% CTE required by the Canadian authorities. What is the rationale for this difference? New York recommends a 95% CTE be adopted and/or would support a variable CTE to reflect market cycles.

WG: There are a number of reasons why we believe that 90% CTE is the right number. In all likelihood, 90% CTE is roughly equivalent to the 95th percentile for all other risks and therefore it is consistent with other NAIC RBC measures. We also note that it has some similarities to the weighted average used for Phase I calculations. We like 90% CTE better for this risk for a variety of reasons.

In addition, we note that the measure used in Canada is different than that used here. The Canadian measure is based solely on cash flows. The proposed method is based on statutory income and this raises the bar. The proposed 90% CTE calculation may be more conservative than the Canadian calculation at 95% CTE. [85]

17. **Variation in Results by Company** - Won't the lack of consistency in the models and generators make it difficult for regulators to take action against a company that is weakly capitalized?

WG: This is an NAIC issue. [28]

18. **Scope** - The scope section contains certain requirements in addition to the contracts/benefits that are intended to fall under the recommended method. Would it be clearer to edit the requirements out of the scope section and put them elsewhere in the recommendation (if they were not there already)?

WG: The work group will consider this editorial comment when it assembles its next report. [39]

19. **Scope** - It appears that the intent of the scope section's language is to include the entire contract if it contains one or more of the ancillary benefits mentioned. However, this is not specifically stated. Also, the benefits mentioned do not match to what's defined in the glossary, which in turn may not be complete (see below). Either definition may not include all ancillary benefits which could generate material risks, either those now in existence (e.g., an enhanced death benefit equal to some portion of account value in excess of considerations) or any which might be developed in the future. Would a conceptual definition which covers what's intended, followed by a list of all currently extant benefits which are intended to trigger inclusion of a given contract, be worth considering as an alternative?

WG: It is our intent to include the entire contract if any of the benefits included in the list are present. We will revisit the language to make sure this is clearly stated.

The idea of a conceptual definition is interesting and we will consider it. [40]

20. **Scope** - Is it intended that benefits which increase with increasing market movements (e.g., enhanced death benefits) are also to be included or excluded in the scope? This needs clarification.

WG: All guarantees are included (including these) [43]

21. **VAs without Guarantees** - Some companies have existing VAs with no guarantees. The current RBC structure has an RBC requirement for these policies but bringing them into the Phase II RBC model may lower the overall requirement. Will companies be allowed to bring these contracts into the model?

WG: Bringing VAs that have no guarantees into the model does make sense. As a result, the proposal will allow it but it does not require it. In other words, the factor approach will still be acceptable even if the company models other VAs. We note there isn't much of this on the books and it isn't likely to have a material effect for most companies. Note that once a company models this business, it will not be allowed to go back to factors. [67]

22. **Effective Date** - This approach should not be adopted to be effective with the RBC calculation as of 12/31/03. The proposal is not yet complete since final factors for death benefits on variable annuities have not been published. More importantly, no analysis has been put forth that evaluates the effect of this proposal on individual company or industry capital. While the proposed approach appears to have a sound theoretical basis, the practical effects need much more study before full implementation should occur.

WG: This is an NAIC Issue. [60]

23. **Effective Date** – The comment period for the proposal coincided with the year-end financial reporting period during which company actuaries – the individuals responsible for commenting on the proposal – were busy with reporting obligations. This timing precluded in-depth analysis and comment on the recommendations. In addition, some companies were unaware of the impending deadline for comments until receiving notice from the Society of Actuaries on February 5.

As a result, most companies have not had sufficient time to analyze the Academy's model and test it against their own products under a wide variety of economic scenarios. As you know, the variable product market consists of numerous carriers and even more numerous product designs. Different companies and products will be affected differently by the proposal. It is therefore essential to obtain input from as many carriers as possible. We respectfully request that the NAIC extend the comment period to June 1, 2003 in order to provide the industry with the time it needs to effectively review and comment on the proposal. [101]

WG: This is an NAIC issue (See question 22.)

24. **Effective Date** - The paper was exposed at a time when valuation actuaries, who are most able to effectively review and respond to this proposal, are extremely busy with year-end asset adequacy testing and financial reporting. Additionally, due to the nature of the proposal informed comment requires time-consuming analysis of the effect of the proposed methods. The combination of timing and the effort required have limited industry's ability to effectively respond to the proposal. We believe full implementation of C3 – Phase II effective December 31, 2003 is unrealistic.

WG: Timing of implementation is a regulatory issue. (See questions 22 and 23.) [95]

25. **Phase-In of New System** – Because this is new and different, a phase-in period might be appropriate. New York would recommend the following:

For year-end 2003: Change the instructions to include unitized separate account products with guaranteed death benefits with VAGLBS.

For year-ends after 2003: The necessary worksheet changes would be made to phase in the modeling as follows:

<u>Year</u>	<u>% 2003 Factors</u>	<u>% Modeled Result less Reserves</u>
2004	75%	25%
2005	50%	50%
2006	25%	75%
2007+	0%	100%

WG: We believe that the focus of the work group should be on the resulting RBC system and not on how we get there. As a result, we see the concept of phase-in as a regulatory issue. In addition, the American Council of Life Insurers (ACLI) may be interested. However, we do have a few comments.

First, we note that phase-in of this type is typical in changes where the impact is a little unknown and could be significant. The Phase I project involved a phase-in (by limiting the impact in the first years – this might work for Phase II as well). Phase-in allows the regulators to see the impact of the new standard before making it permanent, while limiting the impact of the change.

Second, using VAGLB factors for GMDBs seems harsh. VAGLB factors are likely to be higher. As an alternative, perhaps the GMDB factors developed as part of our project could be used. [83]

26. **Exposure Period** - We note the proposal is incomplete. Default factors for Minimum Death Benefit risks were to be provided for companies choosing not to do the modeling. Those factors are still under development by the Academy. Companies have no way to react to underlying assumptions and resulting factors that have not yet been published. We feel the exposure period should end no sooner than 90 days after the proposal from the Academy is completed with the release of assumptions and factors promised in the paper. ACLI will strongly encourage member companies to conduct analysis as soon as possible and submit comment during the extended comment period.

WG: The next report will be complete and should provide plenty of time for review. Note, however, that exposure periods are set by the NAIC. [96]

27. **Testing of Proposal** - No testing of the aggregate effect of this proposal on any individual company has been completed by the work group or the Academy. Testing has been exclusively on a product level. The effect of aggregation of risk has not been reviewed for its effect on total industry required capital. We are concerned that this proposal will not have enough lead-time for companies and regulators to have worked through many of the practical implications.

WG: Testing the effect of this proposal for industry effect is problematic. The proposal uses a complex process that relies on aggregation and individual company experience. As a result it is very dependent on individual company characteristics such as the model, the book of business, the scenario generator, and product assumptions. The Academy is not in a position to ask for or use these characteristics. We would be interested in alternatives that may allow industry testing, however. [98]

28. **Reporting Format** – Despite the potential variability in the value of identical items, New York believes the proposed approach is superior to a formulaic approach. A formulaic approach would need to be extremely complicated to align the asset requirements to the specifics of product design, in-force characteristics and the investment management strategy. The tradeoff for moving away from formula simplicity will be a more complex regulatory review.

Codification was a major effort to ensure identical items were recorded at similar values. Consistent with that effort, this approach will require regulatory oversight commensurate with the potential variability of results that could be reported on identical items. Regulatory tools (e.g., standardized reporting formats for assumptions and results, norms or safe harbors for assumptions when company data is not credible, a reviewer’s handbook, etc.) should be developed to monitor the range of assumptions and results. When and where appropriate, the Life and Health Actuarial Task Force (LHATF) and the Life Risk-Based Capital (LRBC) Working Group should take steps to limit variation (e.g., an actuarial guideline on assumptions and or methods).

WG: While we believe this is primarily an NAIC issue, we will give it further consideration. [81]

29. **Electronic Documentation** – The report notes that the equity scenarios used must be available in electronic format. New York recommends that all assumptions and results should be available (preferably in electronic format) or reproducible. This requirement would not allow the use of random number generators where the seed is unknown unless all the information needed to reproduce a scenario is saved at the time the scenario is run.

WG: This is a regulatory issue [91]

30. **Regulatory Management** – An article by Allen Brender, Ph.D., FSA, in the April 2002 North American Actuarial Journal, “The Use of Internal Models for Determining Liabilities and Capital Requirements”, provides background pertinent to the proposed approach. This article motivated the following comments:

- Should model and model changes be explicitly approved by regulators? Should standards be set for models and the modeling process to ensure basic regulator questions can be answered (e.g., should all models be required to run with a quarterly or shorter frequency?) The proposed approach provides some guidance on modeling and assumptions, but over time more definitive and or more detailed guidance will be needed to facilitate review and or reduce the variability in results.
- There should be requirements for updating data sets used to develop assumptions.

- Results on specific stress test should be required (unfavorable deterministic scenarios).
- Explicit sensitivity test should be required on lapse rates, mortality, election rates, transfers of funds and other assumptions.
- Explicit expectations should be stated for independent or internal auditors for the auditing of models and results.
- Companies crossing some defined threshold should be subject to risk management program requirements.

New York recommends a subcommittee of LRBC Working Group and or LHATF or both address these and similar issues to facilitate regulatory management of the new approach.

WG: In our view, a detailed regulatory review of the actuary's work is not necessary or normally appropriate. Under the proposal, the Actuary is responsible for his/her work and should make sure the system works properly for that company. This requires that the actuary test the groupings, assumptions, model and other characteristics and demonstrate that their system works appropriately.

We can think of a number of ways to address the issue of oversight of the actuary's work. Peer review is one possibility. In this context we are thinking of a review of the computational aspects of the model and not necessarily the assumptions used. Independent actuarial review is another possibility. The cash flow testing approach, with actuarial sign-off is still another approach.

We also believe that disclosure of what is being done is important. A number of points of disclosure are covered in Appendix 1, including disclosure and sensitivity of assumptions. Disclosure of the impact of other changes to the model, including processing and grouping, might also be desirable.

In any arrangement of this type there will be a healthy tension between regulatory actuary and company actuary. While we have views on this issue as noted above, we believe this is a largely a regulatory issue. [82]

31. **Formal Requirements for Models and Hedge Strategies** – If this approach is adopted, New York would like to see LRBC Working Group and/or LHATF adopt more formal requirements for modeling of hedge strategies. Such requirements should include the following:
- A modeled hedge strategy must actually be in place and followed for a period of time.
 - A model component that purchases and or sells derivatives must be back tested to verify it would have produced values similar to actual market values.

- The modeling of hedges is limited to the hedging required by a written Board (or a committee thereof) approved hedging strategy. For example, if the strategy provides management the option to forgo the purchases of hedges if the price of such hedges is deemed to be “rich”, the modeling should always assume hedges would be too expensive to buy when they are needed.

WG: This is an important topic and the comments above are consistent with our recommendations. Still, we note that this is largely a regulatory issue. [89]

Methodology

32. **Timing of Work** - The report suggests that the stochastic testing be done at year-end but this is a very busy time. It would be better if it was done in conjunction with cash flow testing done at the end of the third quarter. It fits better in this time period and Canada allows this option. Is this a possibility?

WG: A third-quarter testing regime could be made workable. Updating the 3Q information for changes that have taken place since year-end would be an issue that would have to be addressed to make this work, however. One possibility is to do sensitivity testing along with the regular testing and adjust for fourth quarter changes in asset values, in-force, and fund mix using that information. The work group will consider the third-quarter option at a later date. [1]

33. **Timing of Work** - The timing of this additional work is bad, in that it comes at a time when valuation actuaries are quite busy with year-end work. It seems that the method for RBC should not be so sensitive that material change can happen quarterly. Are there any ideas to reduce the workflow at year-end?

WG: We have considered a number of ways to spread the workflow but no recommendation has yet emerged. (See question 32) The main idea under consideration is to allow most of the work to be done using 9/30 data. The question then concerns dealing with changes that occur between the time the work is done and year-end. We have considered a number of ways to address this issue:

- Simply comment on any material change between the date of testing and year-end.
- Do sensitivity tests in September along with the basic tests and use the results of those tests to estimate the effect of changes between the testing date and year-end.
- Calculate factors in September and adjust for changes in market levels, volume of business, and distribution by fund. [33]

34. **Timing of Work** - Under Regulatory Communication, the date when the certification and C3 values are required is not mentioned. It appears that what's being proposed will require a great deal of work in addition to what is now done. Among other things, this brings up the issue of the "as of" date of the data to be used in the projections. This ought to be the same as that used to model these benefits for reserve adequacy purposes (similar to Phase I) and this might be worth mentioning.

WG: We are still working on an appropriate schedule for this work. See questions 32 and 33.) [55]

35. **Concurrent Cash Flow Testing Data not Available** - The proposal notes that the mix of assets between separate account and the general account should be consistent with that used for cash flow testing. In some cases these liabilities may not have been cash flow tested, may have been tested with other methodologies, or may have been tested at other times. Therefore, there may not be comparable cash flow testing information. Perhaps a better statement, if one is needed at all, is that the mix of assets between separate and general account should be consistent with the administrative records as of the date of the calculation of RBC.

WG: We assume that the company would use the same data for both RBC work and cash flow testing. When cash flow testing is not done, the company should use assumptions that are appropriate if cash flow testing had been done. When there is no cash flow testing on the appropriate date, values should be adjusted to reflect any material changes that occurred between the two dates including changes in market value, business volume, fund allocations, and reinsurance arrangements. Perhaps a Phase I approach (estimate now, change after the fact if there is a material change) would be appropriate. (See questions 32, 33 and 34).

It should be noted that a final schedule for testing has not yet been developed. When the details have been worked out we will add better language that may be a bit less specific. [73]

36. **Factor Approach for Living Benefits** - Couldn't there be an option for a tabular amount for insignificant amounts of living benefits guarantees as there is for all death benefit guarantees.

WG: The work group is investigating this possibility. The factors developed will likely be conservative but if the block is immaterial that conservatism should not be an issue. The definition of immaterial should be left to the actuary. [2]

37. **Factor Approach for GMDB** - Guaranteed minimum death benefits seem simpler in variety. Couldn't a factor approach be used for them?

WG: When all factors are considered, they may not be simpler but it is the work group's intention to allow factors for VA death benefit guarantees. We are also considering the same for VLI. [35]

38. **Factor Based Approach for GMDBs** - We do not see the factor based approach for GMDBs as a practical alternative. Our analysis of our own companies' products shows that there is considerable variation in features and expectation of future experience. It will be a daunting challenge to develop and maintain an appropriate set of factors.

WG: We believe that the number of dimensions of GMDBs is small enough that we will be able to develop a matrix of reasonable factors based on product provisions, in-the-moneyness and duration. If a company does write guarantees that just don't fit the actuary will have to consider using the closest set of factors or doing the modeling. The fact that not all guarantees will fit does not invalidate the concept of providing factors for those that do fit.

Even though the work group will provide these factors, we do encourage modeling. We note that the factor system will not provide any benefit of aggregating and that this will encourage companies to model. [29]

39. **Gaming the Sample Size** - What is to prevent a company from generating a set of equity scenarios (and/or interest scenarios), determining the 90% CTE for RBC, and regenerating the scenarios because the results required too high capital requirements? The process seems to be subjective and easy to manipulate.

WG: By definition, the sample size that the actuary selects should be large enough that re-running the simulation should not produce significantly different results. In addition, it is the opinion of the work group that the actuary should use all information available. If a second run is done for any reason, the RBC requirement should be based on the results of both runs. "Gaming the system" should be clearly identified as a violation of standards of practice, as well. [4]

40. **Funds That Don't Map Well** - How should an actuary that wants to use the given scenarios deal with funds that don't map well?

WG: It is up to the actuary to determine appropriate projections for all funds. In the case cited, this may mean that the actuary will not be able to use the given scenarios. It is our impression that these funds represent a small proportion of total holdings, in which case simply saying "map them to the aggressive fund category" may suffice. [13]

41. **Starting Assets** - We understand the logic of starting the projection with a level of assets that produces zero initial surplus, given the way the RBC amount is to be determined. But this methodology may cause confusion in situations where the assets (including hedges) that a company customarily earmarks to support a product exceed that product's statutory liabilities. Guidance should be provided for how to adjust starting assets down to starting liabilities. Possibilities include
- Fictitious loans
 - Negative assets of the type and duration typically purchased by the company's general account.
 - Negative short-term investments.

Allocate a negative share of assets currently backing free surplus.

(One way to avoid the need for negative, non-existent, starting assets would be to determine the RBC by simply solving for the starting assets that would result in the average of the worst 10% of ending surpluses being zero.)

WG: Starting assets in excess of starting liabilities can be an issue. In addition to the ways to address the issue given above, we also note that the calculation could be set up to solve for the amount of assets needed in addition to those held at the start of the simulation. The work group needs to consider this issue further. [19]

42. **Starting Assets** - The proposed modeling approach starts with assets equal to the cash surrender value. This ignores the additional CARVM, AG 34 and AG 39 reserves required. We think the assets supporting those guarantees should be directly taken into account in the modeling and the resulting RBC factor.

WG: The work group agrees that the assets backing these reserves could make a difference in the RBC need. The earnings on these amounts would help pay benefits. These earnings are tax efficient, compared to earnings on surplus. The work group needs to think more about this. (See question 41.) [31]

43. **Level of Reserves Used in Model** - The language of Item 7 can be read to mean that the starting reserve would equal cash value (especially if the benefits on the contract were out of the money). Reserves held will frequently exceed cash values due to amounts for general account guarantees. How will these extra amounts be handled? Of even more concern is the level of reserves used in the model after it starts. We will need a surrogate for the "formula" reserve which would exist at future times during the projection, thus, avoiding the formidable computational task of making stochastic projections (e.g., those required under MMMM) at each point along each projection.

WG: We intend to allow earnings on additional reserves to be considered in calculating RBC. However, the intent is that future reserves will be equal to the account value. The work group still needs to finalize how this is to be handled. (See questions 41 and 42) [49]

44. **Reserves Used in Model** - The formula reserve for GMIB along a given scenario is not well defined. Guideline MMMM requires the greater of cumulative GMIB fees supplemented by additional reserves if a cash-flow testing approach reveals the former to be inadequate. The threshold for adequacy is not specified in MMMM. It is not clear whether the path-wise formula reserve is the accumulated fees, or whether some estimate must be made of how much this would need to be strengthened in different equity/interest environments. The latter can't be know at the level of the cell being tested, since adequacy would be determined across all cells.

Also, the AG34 formula reserve for MGDB requires testing of immediate drop and subsequent recovery of fund balances by various groupings. In order to correctly calculate the path-wise MGDB reserve, there may be need for consistency between fund groupings for AG34 purposes and capital purposes. The projection of the MGDB reserve is an extremely complex undertaking, since at each point the immediate drop and recovery and the interaction with future ratchet or compounding provisions must be estimated.

WG: It is not our intent to calculate these reserves in the model. [74]

45. **Modeled Reserves** - What reserve is included in the modeling? Are reserves for guarantees considered?

WG: Our current thinking is that the amount of reserve tested should include any initial reserve held for benefit guarantees in addition to the accumulation value. In working the model, after the waiting period, the minimum reserve is the greater if the accumulation value and the value of any other surrender benefit, such as a GMIB or GMWB. No additional risk reserves (such as AG34) are to be modeled. Funds currently invested supporting such reserves are reflected at their current earnings rate. (See question 44.) [70]

46. **Interim Reserves** - If the recommended method is used to calculate reserves, the approach leads to circularity, in that the projection of statutory surplus requires a projection of reserves. A simpler and easier alternative is to use the distribution of the present value of revenues minus the present value of benefits and expenses for both reserves and capital. The CTE threshold could be set at two separate levels and both reserves and capital would react appropriately to changes in the economic environment. Looking at the greatest PV of future surplus demands some estimation of future reserves; however reserves only change the incidence of loss not the ultimate level of loss.

WG: The recommendation sets year-to-year reserves equal to the cash surrender value (or, for years after the waiting period, an amount based on any GMIB, if greater). The proposal above would set no floor for year-to-year reserves. We would agree that the proposal may produce an appropriate value over the lifetime of the contract but would worry about the ability of the company to weather extremes of performance during that lifetime. We set the floor as we did to acknowledge these concerns. (See questions 44 and 45.) [79]

47. **RBC Time Horizon** - The proposed 20-year horizon doesn't seem consistent with that for other RBC factors which typically run five to ten years. This is a critical consideration because our modeling indicates that the longer projection periods dramatically increase the RBC requirements.

WG: The intent in calculating all RBC factors is to cover a complete cycle. For example, credit risk is covered over the complete market cycle, which is assumed to be four years. Other risks use a five to ten year cycle to cover the entire risk. With this risk, we noted that the worst results tended to occur in the 15 to 20 year range. That is why we have the longer cycle. [24]

48. **RBC Time Horizon** - Consideration of cycles in other RBC calculations makes them less subject to the starting point but the proposed values are still quite dependent on the start point. Why are they different?

WG: Hedged options don't behave this way. The movement of a contract option into and out of the money coupled with the associated leverage for unhedged contracts makes this risk different. Still, some feel the longer time horizon should smooth the numbers. The work group is considering the implications of smoothing results on the modeling process. (See question 47.) [26]

49. **Treatment of Fixed Pocket** - The report states that the result of this testing should be included with $C1_{CS}$ in the covariance calculation. Given that some of the assets on these contracts will be invested in fixed income investments, this seems inappropriate.

WG: As things stand now, the fixed bucket of a VA is considered (in the O&I) as part of c3 Phase I, in spite of a recommendation that it not be included and no contrary decision by the NAIC. We do not believe it is appropriate to bifurcate contracts to accommodate the fixed bucket. On the other hand, it is not theoretically correct to have the fixed risk in the equity covariance bucket. This issue needs further consideration that may involve the placement of the fixed bucket in Phase I as well.

In addition, we believe that we need to work on the definition of variable annuities sold as fixed. This term is meant to apply to contracts that were mostly fixed at issue and are still mostly fixed at valuation. This definition was originally used assure that companies couldn't get around the Phase I requirements for fixed annuities by using a variable chassis. [30]

50. **Splitting Fixed and Variable Funds** - Some products have both fixed (a guaranteed fund) and variable guarantees. Should these products be bifurcated so that phase I can be used for the fixed amount and Phase II for the equity portion?

WG: Products should be included on a Product-by-Product basis, not benefit by benefit within product. If a product is a variable annuity that is sold other than as a fixed annuity it should go to Phase II. (See question 49.) [65]

51. **Splitting Fixed and Variable Funds** - Shouldn't the option of including the fixed account in Phase I or Phase II be the choice of the company?

WG: Policies shouldn't be bifurcated. If policy is sold as fixed, it is Phase I. If not, it is Phase II. We note that the testing of interest rate risk in Phase II is not as rigorous as that of Phase I but the equity risk is the dominant risk. We encourage interest rate testing in Phase II but don't require it. (See questions 49 and 50.) [69]

52. **Fixed to Variable Transfers** - None of the numbered items mention transfers between fixed and variable options. However, these can be material (e.g., any tendency to transfer to fixed after a market drop will lock in losses).

WG: At this time we do not intend to require companies to model this contingency because of difficulties in doing so. (It is sensitive to assumptions and assumptions are difficult to set). If a company can do it, we would encourage them to do so. If the actuary believes it adds material risk, it should be considered.

The work group needs to think more about this. If money has moved in response to market drops, locking in losses, the conservative approach is to assume no moves. On the other hand, for policies not in-the-money, assuming movement due to future drops would be conservative not ignoring the effect just anticipating it. [54]

53. **Use of Phase II Method for Phase I** - Badly matched "Fixed Only" products can also create distributions of results that have severe "tails." Is any thought being given to put the products addressed by "Phase I" under the methodology being suggested here?

WG: We feel that Phase I adequately addressed the C3 needs for fixed products. There are no plans to develop a Phase II approach for fixed products. [37]

54. **Aggregation with Phase I** - The methodology is inconsistent with that in place under “Phase I” in several ways. In particular, because of the differences in the method of scenario generation and the statistical basis used to set the RBC, it does not appear possible to aggregate results prior to setting the RBC.

WG: There is no intent to allow aggregation of Phase I and Phase II calculations. Aggregation of this type requires that the scenarios in each test be correlated. Phase I has required scenarios but Phase II does not. As a result, Phase I and Phase II cannot be aggregated. However, we note that the Phase II result enters the covariance calculation as part of the common stock component and Phase I enters as part of the $C1_0$ component. As a result there is some consideration of the relationship between these two risks. [36]

55. **Use of Stochastic Interest Rates** - Regarding Item 1, to the extent that material portions of contracts are held under “fixed” options, either in the general account or the separate account (e.g., modified guaranteed annuities), it seems that stochastic interest rates will be needed to model these options properly. The same is probably true for GMIBs and possibly for other ancillary benefits.

WG: We agree that the use of stochastic interest rates would add to the process but it is more than we can realistically require. If companies have consistent interest rates and can use them we encourage them to do so. [46]

56. **Work Volume** - The recommended protocol involves a lot of work. Aren’t there any alternatives?

WG: We agree that it is a lot of work. It is the intent of the workgroup to allow approximate methods and to allow practice to develop, with appropriate validation, in an attempt to reduce the workload. The work group is considering alternatives to manage the effort:

- Allowing analysis could be done “ahead of time” – maybe once a year – to develop factors.
- The use of representative scenarios is another possibility. The use of a small number of representative cash-flow scenarios, with corresponding probabilities determined from the distribution of the underlying risk parameters, can provide accurate results, even in the tail of the distribution. Perhaps this is a method that companies could use to reduce the number on runs down to, say, 50 or so.

There are methodologies proposed for use in interest rate risk analysis that might work here as well. In particular see:

- Longley-Cook 1996. "Probabilities of Required 7 Scenarios (and a Few More)", The Financial Reporter, July
<http://www.soa.org/library/sectionnews/finrptng/FRN9607.pdf>
- Christiansen. 1998. "Representative Interest Rate Scenarios", NAAJ, July
http://www.soa.org/library/naaj/1997-09/naaj9807_3.pdf
- Cheuh, 2002. "Efficient Stochastic Modeling for Large and Consolidated Insurance Business: Interest Rate Sampling Algorithms", NAAJ, July
http://www.soa.org/bookstore/naaj02_07.html#naaj0203_8 (abstract only)

- However, the work group is concerned that it may be difficult to choose representative scenarios as was done for C3 Phase I. While the asset-side for these contracts is simple the asset models needed may be more difficult to work with. In addition, these products are different enough that risks are different, which means different products would need different scenarios.

No doubt there are other approaches. The work group will continue to investigate. In addition, the work group will consider developing an appendix highlighting some alternatives. [32]

57. **A Simpler Alternative** - The need for something like 1000 scenarios to determine the 90% CTE, plus however many more will be needed to produce any required sensitivity tests, implies a great deal of work needs to be accomplished during the same period that all of the other financial statement work has to be done. This made us step back and see if any simpler alternatives were possible. Assuming that the objective of RBC is to distinguish weakly capitalized companies and that the desire is to do this in a way that provides an early warning of about a year, we'd like to outline an alternative two step process. (The questioner then outlined a simplified process.)

WG: We will review it. [59]

58. **Including Phase II with $C1_{cs}$** - The cost and risk of some GMDBs ("resets" and "ratchets") also may increase due to upward movements in equity markets. Is it clear that it is appropriate to combine the amount produced here with $C1_{cs}$?

WG: We recognize that including it in $C1_{cs}$ isn't perfect but it is approximate and handy. The dominant market risk is down. We don't feel the proposed treatment distorts the calculation materially. [38]

59. **Contributions after the Test Date** - Some deferred annuities allow the contractholder to make additional contributions after the first. Should future contributions on these contracts be included in the testing? Or should the testing only be concerned with existing account values?

WG: Future contributions should be assumed. However, assumptions about the level of future contributions should reflect historical and anticipated experience. (In some cases these assumptions may indicate that no future contributions will be made.) We note that this may be inconsistent with cash flow models but we feel that including these contributions is appropriate for RBC work. [66]

60. **Recognition of New Business** - On many occasions in the past, companies that have gotten into trouble have had a growth surge, caused to a large extent by writings of whatever product(s) ultimately caused the problem. This suggests that recognizing new business would enhance any early warning capabilities that the proposed RBC methodology would create. Has any consideration been given to installing this kind of process, at least for the benefits covered here?

WG: It is appropriate for a company to think about new business in doing its testing. However, it will not be considered in the basic RBC calculation since that calculation is only intended to cover existing business. It may be considered in the RBC sensitivity tests. [51]

61. **Discount Rate** - The use of “post tax one year Treasury Rates” is mentioned here (on page 9) as a seeming alternative to swap rates but not in the body of the report. Offhand, it seems that these two alternatives may produce quite different results.

WG: This discussion concerns the appropriate discount rate when dynamic interest rates are used. We allow use of the forward swap rates as a simple alternative to a dynamic interest model. In this situation the same rates will be used for discounting purposes. When dynamic interest rates are used the situation is less obvious. In Phase I, where volatile rates are the norm for the required scenarios, the 1-year Treasury rates are used for discounting (so as to not have to model an investment strategy for capital, then have capital gains and losses as bonds are liquidated). The current version of Phase II follows this approach.

The work group needs to give additional consideration to the appropriate way to discount back to time 0 if dynamic interest rates are being modeled. [57]

62. **Interest Rate Models** - There are three areas where stochastic interest rate work would help the process: evaluating purchase rate margins on GMIB, evaluating floor guarantees on fixed options, and evaluating the disintermediation cost associated with fixed options (when money moves out due to market changes). Are there any plans to require this?

WG: The adjustment for these issues may not be as large as one might imagine. The adjustment to assumed GMIB margins does approximately reflect the impact of stochastic simulation. The floor guarantee impact should seldom be material with or without stochastic simulation (although it would have value today). The so-called disintermediation impact would only show value in conjunction with dynamic reallocation of funds between fixed and equity, which we don't require. Still, we recognize that the simulation in interest rates can have value in these situations and we encourage companies to bring this into their models. However, the recommendation does not require it. [71]

63. **Interest Rate Models** - How is interest rate risk on fixed options to be handled? Would a factor approach for the fixed fund be appropriate?

WG: If a company is capable of it, we would encourage them to simulate interest rates in doing their modeling. (See question 62.) However, when modeling is not available, the company should use the forward rates based on the yield curve as of the testing date. The mix of assets between separate account and general account assets should be consistent with that used for cash flow testing. [72]

64. **Use of Forward Rates** – The future rates implied by the forward rate curve may not be “real world” expected rates, much as the Q probabilities of equity returns are not “real world”. In general, the normally upward sloping yield curve reflects expectations plus a liquidity adjustment less a convexity adjustment. For shorter-term rates the liquidity adjustment may more than offsets the convexity adjustment so that future rates based on this portion of the yield curve will exceed “real world expectations”. In the long end of the normal yield curve, the value of convexity may overtake the liquidity premium (e.g., the curve may slope down from durations 20 to 30) and future rates based on this end of the curve may be less than “real world” expectations.

This may not be material for discount rates as surplus may be invested in longer-term assets (i.e., the current curve can be realized). However, GMIB purchase rate margins based on the forward rate curve may not be realistic. Some alternate standard may be more appropriate. For more background on this see Antti Ilmanen. 1995. "A Framework for Analyzing Yield Curve Trades, Understanding the Yield Curve: Part 6." Portfolio Strategies, U.S. Fixed Income Research. Salomon Brothers. As of 3/14/03 this was available at <http://www.aimr.com/publications/specialization/fi-online.html>

WG: We don't think these distortions will materially affect results but there are differences of opinion. We will give this situation additional thought. [93]

65. **Use of 1-Year Forward Rates** – The proposal uses 1-year forward rates for discounting instead of longer term rates that might be more consistent with how surplus funds are invested.

WG: The effect of using 1-year forward rates chained together is consistent with using longer rates – it's not same as assuming very conservative short investments. We need to clarify this in our in report. [94]

66. **Pre-Tax or After-Tax** – It seems that RBC should be based on an after-tax calculation but reserves are more likely pre-tax. It would be desirable to use the same model for both? How do you intend to address this issue?

WG: The work group needs to consider this further. [99]

67. **Tax Calculations in the Model** - It is common actuarial practice to assume losses are tax deductible in the period they occur. In the extreme tail events, which 90% CTE captures, consideration needs to be given whether or not such losses can in fact be taken for tax purposes. The company would need taxable gain from other sources in order to offset the losses. It is impossible to predict the entire company's tax position on the basis of the testing required by this recommendation. Given that, and since there may be no tax offset in most tail events, I would favor looking at pre-tax results, with perhaps a lower testing threshold, such as 75% CTE to compensate.

WG: We note that the hits associated with either death or living benefits won't be concentrated in a single calendar year. Second, losses due to these product guarantees are unlikely to overwhelm other source of gain. We don't feel that tax adjustment distorts the calculations. Also, there is a sensitivity test requiring a pre-tax calculation. [68]

68. **Hedge Risks** - There should be a fuller discussion of adjustments required for basis, gap and price risk presented by hedges. With respect to basis risk, it is the imperfect mapping of funds to indices which creates the basis risk, since the hedge instrument would normally be available to match the given index. In this case, an appropriate way to reflect this risk may be to increase the volatility of the proxy fund relative to the index or indices it is intended to match, assuming the hedge instrument is modeled with the volatility of the index itself. For static hedging using derivatives, price risk may be handled through economic scenarios that reflect volatility stochastically. For gap risk, the modeling may need to reflect the frequency of re-balancing the hedge position.

WG: These are good suggestions and we will consider them in the next version of the report. We also would note that the gap risk we are most concerned about is that created when trading is suspended. [78]

69. **Self-Hedging** – On occasion, a company may have products that provide a natural hedge. How will this proposal handle this if only one of the products is in the scope of this project?

WG: The work group needs to consider this further. [100]

70. **Accuracy Requirements** – Results could vary considerably based on the seed number chosen and the number of scenarios run; however, no numerical requirements are set for accuracy. New York recommends that for 2004 numerical requirements be placed on the required accuracy. To do this information is needed on the approximate number of scenarios various levels of accuracy would require (e.g., how many scenarios would be required to be 95% confident the correct number is within 1% of the calculated number). The requirement for accuracy could be dependent on the significance of this business for a company.

WG: While we appreciate the need for accuracy, we note that it is impossible to make any assurance about the degree of accuracy of the model. There are many sources of error, including granularity of assumption data, model risk, and others, most of which are unquantifiable.

If the concern is solely about sampling error, our modeling effort may help in quantifying the error. Our report noted that it is up to the actuary to run enough scenarios to get appropriate results. If we were to be more specific we might specify that companies should run the “equivalent” of 1000 scenarios. Alternatively, we could state the level of accuracy needed in terms of sampling error. As an aside, we note that requiring 95% confidence on being within 1% will require an immense number of simulations.

The work group needs to discuss this further. [92]

71. **Level of RBC Requirement** – The proposed model, particularly the 90% MCTE criteria, could result in Risk-Based Capital requirements so onerous that some carriers could experience a significant decrease in Risk-Based Capital ratios on existing business or find it impractical to offer guaranteed benefits on new contracts. Put in a broader context, the concern here is that requiring additional conservatism in assumptions and setting reserves and Risk-Based Capital based on tail risk appears excessive, and could result in significant, adverse consequences for both new and existing blocks of business.

WG: The proposal does not double up in conservatism by requiring conservative RBC on top of conservative reserves. The proposal determines the total amount of assets needed. RBC is that amount less whatever reserve is held. We also note that the proposal was not intended to add conservatism to the assumptions used. The concern about the size of the potential requirement is real but it represents the real risk. Unhedged guarantees will have high requirements. We note, however, that appropriate hedging can reduce the RBC to near zero. [104]

Scenario Generators

72. **Use of Standard Scenarios** - Not all companies will have the time to develop scenarios meeting the requirements in Appendix 2. We need information on calibration points, mean, standard deviation, and background data for the other 5 asset classes. We need more information to generate scenarios "consistent with the calibration points in Table 3" (page 18).

WG: The task force intends to provide internally consistent scenarios for all six asset classes, along with interest rates. This information could be provided in the form of an excel spreadsheet – the final format has not yet been decided. [3]

73. **Use of Standard Scenarios** - The Academy has provided sets of standard scenarios, but for a certifying actuary to competently decide whether to use these scenarios may require almost the same learning curve and research as would the selection of generator parameters?

WG: It is the work group's intent that the 10,000 linked scenarios provided be a safe harbor; that an actuary should feel free to use them without further testing. In this case the actuary would only be required to certify that the funds of the company are properly mapped to the given fund classes. [12]

74. **Use of Standard Scenarios** - If standard scenarios were to be mandated for all companies, the onus would be lifted from the certifying actuary's shoulders, but the choice of parameters (for the standard scenarios) would become especially critical. Developing a consensus on the parameters would involve a lengthy debate.

WG: The Academy will provide a set of standard scenarios based on the work group's assessment of the situation. However we agree with the questioner that there may be differences of opinion regarding those scenarios. That is one reason why we allow the company to use their own models, with certain constraints. [14]

75. **Use of Standard Scenarios** - Asking each company to develop their own equity and interest rate scenarios will waste a lot of time on the part of the companies generating and calibrating the scenarios. It will also waste time on the part of regulators determining whether variations among companies in the results obtained are due to the underlying business economics or are due to the particular scenarios chosen. We recommend that either specific scenarios be provided or that a scenario generator be provided and that the use on one or the other should be required.

WG: It is the work group's intent to provide a set of 10,000 linked scenarios for each asset class and for interest rates. These scenarios would be available for use but would not be required.

Variability in company results due to model or generator differences is a concern but we are not sure how big a problem it might be. We expect it will be immaterial. Part of the work group is already testing what impact different models will have on results. We may also ask them to look at the impact of different scenario generators.

The work group is reluctant to require the use of standardized scenarios for two main reasons. First, many companies have their own generators and some have spent considerable effort developing them. We feel they should be allowed to use them, if they are properly calibrated. Second, we are concerned that requiring a specific model or set of scenarios would stifle technological development. We expect that there will be many new advances in the area of equity modeling and a rigid structure would not allow them to be put into use readily. [27]

76. **Regime Changes** - Given that a regime change occurs with the same frequency as one's model, the probability factors in table 1 would have to change if the frequency of my model were anything other than monthly - please confirm.

WG: The time step in our equity returns model is monthly, as is that in most regime switching models. Individual models could use a longer time step by aggregating monthly results over that longer time step. As a result, the cash flow time step could be monthly, annual or any other period and the equity model would still be appropriate. [5]

77. **Random Number Generation** - Are the two regimes perfectly correlated? Can I use the same random numbers for each ILN or must I have another set that is uncorrelated?

WG: The two regimes are not correlated since they never exist simultaneously. However, one cannot use the same random numbers for both. The generation of the normals is unrelated to the calculation of returns but the random numbers should not be reused. [6]

78. **Dependence on History** - The results of the proposed methodology are very dependent on the historical period used to calibrate the parameters used in the equity yield generator. Does this make this approach inappropriate?

WG: The proposed process does create some uncomfortable situations. As noted, there is not enough data to create a stable model. However, the alternative is to make the model dependent on someone's market view. We prefer calibrating to the limited history (over 47 years).

We also note that modeling is not an exact science and that there are many assumptions. We are aware of no better model or we would use it. The RSLN2 model used is consistent with the best academic research that has been done on equity modeling.

In short, the work group is aware of the dependence on history but does not feel that it invalidates the process. There is a need for RBC factors. We acknowledge that the dependence on limited data creates an uncomfortable situation but we are unaware of any alternatives. [9]

79. **RBC Time Horizon** - Can the key statistics be validated over this long of a time period?

WG: It is difficult to calibrate the wealth ratios over 20 years due to limited historical data. This is uncomfortable but we see no alternative. [25]

80. **Mean Reversion** - Does the equity yield generator incorporate mean reversion? If so, what are the settings for the reversion parameters?

WG: The equity model is not mean reverting. [10]

81. **Use of State Dependent Models** - The report indicates state dependent models are not prohibited. New York recommends prohibiting such models. A model that implicitly assumes initial equity values are undervalued (overvalued) should not be used to measure left tail (right tail) risk. This concern is somewhat mitigated by the need to meet the calibration criteria, but such criteria are only explicit for an S&P 500 index fund. Any assumptions on cyclical market behavior should be applied uniformly to all companies (e.g., by using a variable CTE).

WG: We are in general agreement. We note that attempts to demonstrate states dependencies generally run out of data before they demonstrate it to a reasonable statistical significance. On the other hand, they don't disprove state dependency either.

We also believe that the suggested method for handling state dependency, moving the CTE might be effective. The work group needs to further consider the calibration issue.

We also note that the work group needs to rethink use of the terms “state dependent”, “Position dependent”, “Path dependent”, “Equilibrium model”, and “Mean reversion” to make sure our report properly uses the terms. (See questions 15 and 80.) [90]

82. **Generator Issues** - Does the equity model incorporate some sort of second-order random process to the basic random parameters—e.g. jump diffusion or regime switching? If so, what are the parameters?

WG: The model used by the task force is regime switching but the use of this model is not required. Parameters for the model are included in the report. [11]

83. **Model Calibration** - In the section on Scenario Requirements, the proposal requires calibration only in the tails that matter. This is an important point that should be expanded on. Some benefits, such as the estate preservation benefit will only have a cost in one tail or the other. For others, including benefits with significant ratchet or maximum anniversary features, both tails will be important. It also is noteworthy that hedging will tend to hurt results in positive scenarios, and over-hedging could be even more harmful than being under-hedged if the need for hedging were determined based scenarios that did not adequately reflect the right tail risk. My suspicion is that most companies, through either ratchet features or hedging, will need to be mindful of both tails.

WG: The work group will consider expanding this point. [76]

84. **Model Calibration** - Perhaps there should be three sets of calibration points for the scenario model. The first would fit the left tail best, as the given calibration points do. The second would fit the combination of left and right tail, and be used in situations where both tails are equally important. The third set would fit the right tail best, perhaps by calibrating a five-parameter RSLN2 as I discuss above. The actuary would need to justify which set of calibration points were most appropriate for the mix of risks being tested.

WG: We don't see how separate calibration sets would help the process. We stand by our existing proposal. [77]

85. **Model Calibration** – The mean return underlying the S&P calibration points is over 13%. This is high. New York would like to see calibration points based on a lower mean (e.g., 8% to 9%). The historic period used as the basis for the calibration points had a net increase in the multiple of price to earnings. Because this source of returns was not backed out of the historic data, the increase in the price to earnings ratio in the historic data is implicitly imbedded in the calibration points (i.e., implicitly P/E ratios rise forever). For more background on this point, see William Reichenstein, Ph.D., CFA, “What Do Past Stock Market Returns Tell Us About the Future?” *Journal of Financial Planning*, July 2002. As of 3/14/03 this was available at: http://www.fpanet.org/journal/articles/2002_Issues/jfp0702-art8.cfm

As of 3/14/03, stock market returns from January 1871 through September 2001 were available at <http://aida.econ.yale.edu/~shiller/data.htm>. Robert J. Schiller, Stanley B. Resor Professor of Economics at Yale University, developed the data. From this data, a table of “Wealth Ratios” was developed comparing the highest and lowest historic returns from this data to the 0.5% and 99.5% calibration points in the Academy proposal.

Wealth Ratios

	One Year	Five Year	Ten Year
Month/Year of Historic	6/31 to 5/32	9/29 to 8/34	8/28 to 7/39
Lowest Historic	38%	39%	67%
0.5% Calibration Points	65%	58%	67%
Month/Year of Historic	7/32 to 6/33	9/24 to 8/29	6/49 to 5/59
Highest Historic	240%	426%	681%
99.5% Calibration Points	160%	410%	1048%

At 65% and 58% respectively, the one-year and five-year .5% calibration points look high. A lower mean return assumption would lower these calibration points. The .5% calibration point at 10 years is 67%, which looks okay. It is identical to the lowest 10-year historic return. The regime switching lognormal model underlying the calibration points assumes that the probability of a market downturn ending is independent of the length and severity of the decline already experienced. This may make the probability of a bear market continuing too high in later years. This would tend to offset the affects of a high mean return. The 99.5% 10-year calibration point at 1048% is too conservative. In the right tail (i.e., at high returns), the model's implicit assumption of a constant probability of a bull market continuing independent of the prior market advance works with the high mean to significantly overstate the right tail.

New York recommends a continuing effort to refine and improve the calibration points. When will the calibration points be updated? More specific guidance may be needed in applying the implied severity of the calibration points to other funds. What are the implied calibration points for the six funds in the 10,000 pre-packaged scenarios? LRBC and or LHATF should revisit calibration points for year-end 2004.

WG: The work group needs to consider these points further and will do so as part of a larger discussion on calibration, scope, and reliance on empirical fitting of experience. [84]

86. **Inconsistent Results** - I have created a regime switching model that produces the same negative skewness (-0.46) and kurtosis (-1.45) values stated on pg.12; however, I produce lower values (see table below based on 10000 scenarios of monthly returns) than the ones in Table 2 and 3. Please help me understand how this can happen.

WG: This question will be handled on a one-on-one basis. [7]

87. **Equity Model Alternative** - The correlation between increased volatility in bear markets exists, but is weak. It is implicitly incorporated into the RSLN2 model upon which the S&P 500 equity calibration points are based.

The RSLN2 postulates two regimes, each with its own drift and volatility parameter, and transition probabilities between the two regimes, requiring six parameters in total. We have examined an alternate formulation of a RSLN2 model with only five parameters, allowing for separate volatility but common drift in the two regimes. We have found that this model is slightly more statistically significant over the period originally studied by Mary Hardy (NAAJ pp. 1-53) than the six parameter model. Further, we have tested the t-scores for individual parameters in the six-parameter model and found the drift in regime 2 to not be statistically significant.

An interesting result is that the five-parameter RSLN2 model exhibits fatter right tails. We think it may fit the data better.

WG: We recognize that better models will be developed over time and better assumptions will also be developed. Changes to the calibration will result over time. For now, we are confident in our current model. However, we will test the suggested model. Note that companies will be permitted to use their own models if they meet the calibration points. [75]

Assumptions

88. **Prudent Best Estimate Assumptions** - We don't agree that the assumptions used in modeling should "...be set at the conservative end of the actuary's confidence interval..." as stated in the section "Prudent Best Estimate" of the AAA C-3 Phase II Report (Agenda Item 2f). The 90% CTE benchmark is already conservative; we should use best estimates in setting assumptions to get there. Otherwise, we'll end up with a double-dose of conservatism.

WG: We agree that a double dose of conservatism is not appropriate. Our intent was that the actuary should use his or her best estimate for all assumptions. We are not expecting the actuary to use "loaded" assumptions. However, when the actuary's knowledge of a particular item is limited, we believe prudent actuarial practice would dictate that the actuary err on the side of conservatism. We will consider rewriting this section to better reflect this concept. [16]

89. **Prudent Best Estimate Assumptions** - We are concerned by the definition of “prudent best estimate” as presented in the Academy paper. First, given that the ending result relies on near-worst-case economic scenarios, any conservatism in the assumptions leads to a lower probability of insolvency than is implied by the scenario probabilities and may be lower than that targeted in other RBC factors. We believe best-estimate assumptions should be used in all cases. Second, the wording in the definition is ambiguous. Some have read it to require the addition of an explicit provision for adverse deviation to every assumption. Others believe a less explicit approach is required, with an implicit recognition of “the conservative side.” We suggest that the wording be clarified to avoid multiple interpretations. In line with our comment about conservatism, we believe that explicit provision for adverse deviation should not be required.

WG: We agree that a double dose of conservatism is not appropriate. Our intent was that the actuary use best estimate assumptions. However, when the actuary’s knowledge of a particular item is limited, we believe prudent actuarial practice would dictate that the actuary err on the side of conservatism. (See question 88.)

In addition, we note that the use of the 90% MCTE is only conservative for the variables that are simulated. Margin is needed for other variables unless they are specifically picked up in other areas (like C2).

We will consider rewriting this section to better reflect this concept. [63]

90. **Prudent Best Estimate Assumptions** - The formula recommendations should have sufficient adversity in lapse, mortality, the use of volatile investments, etc., so that the results are adequate for most companies and probably very conservative for the "average" company. The formula amounts should not reflect any investment strategies that may be used to mitigate risk. New York expects formula requirements to be high enough that most companies with a material amount of this business will choose to do the modeling.

WG: We are in general agreement with this point. Assumptions will be chosen to be conservative. In addition, the factors will be conservative because they don’t reflect aggregation. (See questions 88 and 89.) [87]

91. **Prudent Best Estimate Assumptions** - It is not clear that the target CTE percentile is meant to cover all product risk (market, mortality, lapse, anti-selection) or just market risk. The target CTE should apply to all the risk in these contracts so that no additional RBC calculation is required. Thus for example, if the mortality is to be held constant throughout all the market scenarios it should be loaded adequately with recognition for the lack of correlation with market risk so that the resulting requirement is suitable at the target CTE for all sources of risk.

WG: The work group needs to discuss this further. (See questions 88, 89 and 90.) [88]

92. **Sensitivity Tests** - The text of the “bullet” at the top of page 7 implies that some sensitivity tests may also be put in place. The last sentence sets forth three such tests. This will quadruple the actual computational burden. Is all that work necessary?

WG: We believe that sensitivity tests are important but it is not our intent to require a complete model run for each test. Perhaps running some of the worst scenarios with modified assumptions would suffice. The work group needs to think about how this needs to be done. [52]

93. **Degree of Judgment** - If these numbers could be used to put a Company out of business isn't precision more important than accuracy? The system seems to rely heavily on judgment.

WG: While precision is important, we believe judgment should be allowed as it is for a number of other processes. It is commonplace is setting health and PC liabilities. Judgment is also used on the asset side to address write-downs and other valuation issues. In any case regulators will review detail of RBC calculations if the company is in trouble. [34]

94. **Date for Swap Curve** - In Item 6 it appears that the swap curve mentioned is that in existence on the projection date but it might be worthwhile to be more specific.

WG: The swap curve to be used is that from the projection date. We will make this more specific in the report. [48]

95. **Expenses to Model** - Which expenses are to be included? It is especially important to be clear whether or not an allocated portion of corporate overhead should be reflected. Please be more explicit in this regard.

WG: It is our intent that a company be allowed to use the same assumptions as those used in cash flow testing. We would expect these to be fully allocated expenses. [64]

Miscellaneous

96. **Commercial Software** - Many companies are dependent on commercial modeling software. Vendors of this software will need time to build in the necessary processing.

WG: We agree. We also note that the timing of the implementation of this proposal is an NAIC issue. [17]

97. **Gaining Expertise** - Even with commercial software available, companies will still need substantial time to acquire expertise and to gather necessary data.

WG: We agree. We also note that the timing of the implementation of this proposal is an NAIC issue. [18]

98. **New Reserve Method** - The language in Item 10 seems to imply that AG 34 and AG 39 may eventually be replaced by something based on stochastic projections (presumably at some CTE less than 90%). Is it the intent of the Academy group and/or the NAIC to pursue this at some future time?

WG: The Academy's Variable Annuity Reserve Work Group is already in the process of investigating this possibility with NAIC support. This work is not a part of this project. [53]

Written Report

99. **Glossary** – Since Variable Life and Variable Annuity contracts are referred to in the scope, would it be worthwhile to define these terms in the “glossary?”

WG: We do not believe this is necessary. These are common terms that are well understood by most people. [41]

100. **Define VAs sold as Fixed** - To avoid the potential for misinterpretation, “Variable Annuities sold as fixed annuities,” (which are excluded by the scope section) needs to be defined.

WG: We agree. Note that these contracts are included in Phase I. [42]

101. **Reinsurance** - Right after Item 5, it may be worthwhile to have a similar discussion of “the other hedge,” reinsurance.

WG: This is a good idea. We intend that reinsurance be considered just like hedges and this is noted in the Appendix. However, we will consider bringing it into main text. [47]

102. **Formula for Minimum Surplus** - In Item 8, I believe you mean the minimum present value of surplus, which occurs during the scenario, multiplied by minus one.

WG: We'll take a look at the wording to make sure it's correct and clear. [50]

103. **Expansion of Appendix 1** - Given the many nuances of actually performing the calculations needed to do justice to the recommendation, it might be good to expand Appendix 1 a bit. It appears that many parts of the body of the text could be duplicated or moved here if for no other reason than to have them in one place.

WG: We will consider making these changes. [56]

104. **Applicable ASOPs** - The first paragraph (on page 10) states that ASOP 7 “applies to determination of capital adequacy.” Actually, it applies to cash flow analysis. While this can be used in determining capital adequacy (among the other things listed in Section 1.2) we are NOT doing this here (as the third bullet on Page 2 of the recommendation points out) and should avoid giving any impression that we are. Instead, we are determining an amount of RBC attributable to certain benefits which is to be utilized in setting the RBC of the company in question, a far more limited objective.

WG: The work group will look into the distinction noted. In addition we note the need to consider the desirability of additional ASOP’s. [58]

Index to Respondents

Respondent	Company	Letter	Issues
Matthew Dolliver	Kansas City Life	2/10/03	32
Joann Wilson	Farmers New World	2/11/03	36, 39, 72
Steve Schultz	Mass Mutual	2/13/03	7, 40, 41, 73, 74, 78, 80, 82, 88, 96, 97
Mike Akers	AIG	2/14/03	8, 9, 10, 11, 17, 38, 42, 47, 48, 49, 75, 79
Jenny Bowen	Jefferson Pilot	2/13/03	1
Mike Sakoulas	AXA Re	2/12/03	76, 77, 86
Bob Meilander	Northwestern Mutual	2/18/03	33, 37, 56, 93
Tom Campbell	Hartford	2/12/03	
Steve Sedlak	Nationwide	(no date)	2, 3, 18, 19, 20, 34, 43, 52, 53, 54, 55, 57, 58, 60, 61, 92, 94, 98, 99, 100, 101, 102, 103, 104
Mike Smith	Lincoln	2/17/03	4, 12, 22, 89
Andrew Rallis	Met Life	2/15/03	21, 35, 44, 45, 46, 50, 51, 59, 62, 63, 67, 68, 83, 84, 87, 95
Bill Schreiner	ACLI	2/27/03	6, 24, 26, 27
Dennis Lauzon	NY Ins. Dept.	3/14/03	5, 15, 16, 25, 28, 29, 30, 31, 64, 65, 70, 81, 85, 90, 91
Mark Mackey	NAVA	2/28/03	13, 14, 23, 71

The attached spreadsheets are the result of the modeling work to date for MGDB products.

The factors shown are the "total provision" (the sum of the excess of reserves and RBC above cash surrender value).

The sensitivities shown are, in part, for our further work, in part to show which assumptions drive the result, and in part to show how wide the variation might be from company to company due to different pricing, experience, and product and duration mix.

Variable Annuity GMDB/GMIB Modeling – Capital Factors RBC C-3 Phase II

Objectives

The Academy C-3 Work Group modeling has six objectives:

1. Provide the industry with some reasonable estimates for the magnitude and trend of the capital factors under the current proposal for some common GMDB and GMIB product options.
2. Understand the variability in results due to different models (i.e., what ‘range’ can be expected in practice when companies use internal models to value capital?)
3. Offer companies a ‘hands on’ opportunity to interact professionally with their peers in the implementation of stochastic models for capital in respect of guarantees on variable annuities. This will allow companies to understand better the draft proposal, improve/develop their models and learn from the shared collective experiences of the modeling group.
4. Emphasize the important features of the methodology and, if necessary, refine the proposal.
5. Develop the knowledge base required to construct a factor-based methodology (the ‘alternative method’) for broad implementation by the industry.
6. Highlight some alternatives for setting statutory liabilities consistent with the work and objectives of the Variable Annuity Reserve Working Group (VARWG).

It is important to note that the modeling is designed to produce capital/reserve reserve factors and test the proposed framework. The purpose is not to investigate the diversity of investment return models or to document the calibration of such models/scenarios.

Although intended to be broadly representative, the results of this modeling exercise should not be interpreted as definitive. The methodology may be refined and the ‘alternative method’ will need further development. Furthermore, VAGLBs (e.g., GMIB) will require companies to calibrate and run models suitable to the risks assumed in their liabilities and adopt assumptions and methods that are appropriate to their circumstances. All test cases and assumptions used in the modeling are for illustrative purposes only and may not be applicable to a given company.

Modeling Plan

The modeling plan has several stages. Tentative timelines are attached to each stage.

1. Define test cases and set underlying modeling assumptions (**March 31**).
2. Submit GMDB results for a U.S. Equity (S&P500TR) fund – static lapses (**April 30**).
3. Compile GMDB results (static lapses) and investigate/explain inconsistencies (**May 8**).
4. Submit GMDB (dynamic lapses) and GMIB results (base elections) for a U.S. Equity fund (**May 16**).
5. Compile GMDB (dynamic lapses) and GMIB results and investigate/explain inconsistencies (**May 24**).

At this stage, all modelers should be well positioned to take on more testing with little additional effort. There are several possibilities for continued analysis:

- Develop broader array of GMDB factors (e.g., different attained ages, other fund classes, fixed versus variable account mix, etc.)
- Test the sensitivity of results to different actuarial and/or product assumptions (e.g., fees, partial withdrawals, lapses/lapse dynamics, mortality table).
- Produce factors for guaranteed benefit combinations (e.g., GMDB & GMIB).
- Generate factors for a representative portfolio (12–24) policies.

Assumptions – Round 2

To facilitate the comparability of results, all modelers will use the same ‘calibrated’ investment return scenarios. These scenarios were provided by Geoffrey Hancock (Telephone: +1 416 858 2509; Email: Geoff.Hancock@mercer.com).

Participants are encouraged to provide a brief description their models (e.g., cashflow frequency, application of decrements, timing re: collection of fees & payment of claims).

Annual Fee and Waiver	None	
Free Partial Amount	10% of account value, non-cumulative	
Fund Management Fees	100 bps of fund balance per annum	
GMDB Description	<ol style="list-style-type: none"> 1. ROP = return of premium ROP 2. ROLL = 5% roll-up, capped at $2.5 \times$ 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. 5. EDB = ROP + 40% Enhanced Death Benefit (capped at 40% of deposit). 	
GMDB Fees (Insurance Charges) per annum	<ol style="list-style-type: none"> 1. ROP, 5 bps. 2. ROLL, 20 bps. 3. MAV, 15 bps. 4. HIGH, 25 bps. 5. EDB, 20 bps. 	
GMIB Description	<ol style="list-style-type: none"> 1. HIGH = Higher of 5% roll-up and maximum anniversary value. Ratchet and roll-up stop at age 75. Guaranteed death benefit is return of premium. 2. ROLL = 5% roll-up, capped at $2.5 \times$ premium, frozen at age 80. Guaranteed death benefit is 5% roll-up, capped at $2.5 \times$ premium, frozen at age 80. <ul style="list-style-type: none"> ▪ Waiting period is later of attained age 60 and 7 years after issue or reset. ▪ GMIB cannot be elected after age 85. 	

Appendix 2

	<ul style="list-style-type: none"> ▪ GMIB can only be elected within a 30-day window after each policy anniversary. ▪ Guaranteed interest rate is 3% effective. ▪ Guaranteed mortality basis is IAM83a projected at scale G for 30 years. ▪ Purchase interest rate is 7 year U.S. Treasury + 35 bps. ▪ Purchase mortality is IAM83a projected to date of annuitization.
GMIB Base Election Rates (annualized election rate)	0% if outside benefit period or if 'GMIB/AV' < 1 (see below under 'Annuitization Rates' for definition), otherwise 5% per annum.
GMIB Fees (Insurance Charge) per annum	<ol style="list-style-type: none"> 1. HIGH, 45 bps. 2. ROLL, 35 bps.
M&E Charge	150 bps per annum
Surrender Charge Schedule	<p>Base: 7, 6, 5, 4, 3, 2, 1, 0%</p> <ul style="list-style-type: none"> ▪ Currently, "% of deposit". Need to test "% of AV" later. ▪ Free partial withdrawal amount does not attract surrender charges.
Single Premium / Deposit	\$100,000
Base Lapses	1.5, 4, 4, 4, 6, 8, 10, 40, 30, 15%
Mortality	65% of MGDB 94 ALB (for reference, $1000 \times q_x$ rates at ages 65 and 70 for 100% of MGDB94 ALB Male are 18.191 and 29.363 respectively).
Fund Allocation	100% S&P 500TR
Partial Withdrawals	None
Sex /Age Distribution	100% male, attained age 65 <i>at the calculation date</i> .
Max. Annuitization Age	All policies terminate at age 95.
Statutory Reserve	Cash Surrender Value With Recognition of PV GMIB payments once past waiting period
Revenue Sharing	25 bps per annum
Maintenance Expense	85\$ per policy, inflated at 3% p.a. starting in second year. 5 bps of account value p.a.
Discount Rate for PV of Worst Surplus	3.75% (after-tax) effective
Earned Rate on Surplus	3.75% (after-tax) effective
Interest Rate for GMIB Haircut	Implied forward rates minus 30 bps
Borrowing Rate on CARVM Allowance	6% pre-tax

Income Tax Rate	35%
Dynamic Lapse Multiplier	$\lambda = \text{MIN} \left[U, \text{MAX} \left[L, 1 - M \times \left(\frac{GV}{AV} - D \right) \right] \right]$ <p>$U=1, L=0.5, M=1.25, D=1.1$</p>
GMIB Annuitization Rate (annualized election rate)	$\psi = \text{MIN} \left[U, \text{MAX} \left[L, A + M \times \left(\frac{GMIB}{AV} - D \right) \right] \right]$ <p>where 'GMIB/AV' = $\left(\frac{\text{IncomeBase}}{aG} \right) \div \left(\frac{AV}{aP} \right)$</p> <p>$aG$ = annuity factor (15-year certain) on guaranteed basis aP = annuity factor (15-year certain) on purchase basis</p> <p>$U=0.40, L=0, M=0.8, D=1.1, A=0.$</p> <ul style="list-style-type: none"> ▪ If possible, calculate annuity factors as life w/ 10-year certain period. ▪ If possible, calculate aP dynamically according to Purchase basis (see Notes section below).

Notes

- 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 EDB is floored at zero. It pays out 40% of the gain in the policy upon death at time t : $B_t = \text{MIN}[0.40 \times \text{Deposit}, 0.40 \times \text{MAX}(0, AV_t - \text{Deposit})]$. This test policy also has a 100% return-of-premium GMDB, so the minimum payout upon the annuitant's death is Deposit . To be clear, the benefit claim (under the contract guarantees) at death is $A_t + B_t$, where B_t is defined above and $A_t = \text{MAX}(0, \text{Deposit} - AV_t)$.
- If possible, scenarios should always be used 'from time zero' (i.e., the first 'time period' in the scenario file is always used in the first period after the calculation date, regardless of policy duration). That is, do not drop leading 'columns' from the investment return matrix.
- The valuation date (i.e., calculation date) is always 'time zero', regardless of policy duration. That is, the policy issue date occurs in the past (or at the valuation date for 'at issue'). However, the annuitant is attained age 65 in each test (i.e., the issue age changes).
- Lapses occur throughout the policy year (not only on anniversaries).
- Annuitizations (exercise of GMIB option) occur only on policy anniversaries during the election period.
- Lapse and mortality rates may be applied discretely or according to a double-decrement model.
- Partial withdrawals (if applicable) occur discretely at end-of-period.
- Account value-based fees and charges occur throughout the policy year (not only on anniversaries).
- The total 'spread based' charge against the fund is $[\text{Fund Management Fee}] + [\text{M\&E Charge}] + [\text{Insurance Charge}]$.
- GMIB fees are calculated as a function of the guaranteed income base. However, the fees are deducted from the contract account value.

- In general, the cost at annuitization for GMIB is:

$$COST_t = \text{Max} \left(0, GV_t \times \frac{a_t^{\text{Purchase}}}{a_t^{\text{Guaranteed}}} - MV_t \right)$$

where GV represents the guaranteed income base (e.g. net deposits accumulated according to the product specifications) and MV the contract market value (account value). GV is multiplied by an “annuity factor ratio”. The annuity factors reflect the attained age of the annuitant and the form of income payment (e.g. payment periodicity, certain period, etc.). The “purchase” annuity factor (numerator) is calculated on the “current” basis of interest and mortality. The “guaranteed” factor (denominator) is calculated on the guaranteed basis as specified.

The ‘cost at annuitization’ is multiplied by an election rate, which can vary by age, duration, and the degree to which the guarantee is “in-the-money”.

For simplicity, we assume that the payout form is a 15-year certain annuity (i.e., without life contingencies).

Test Cases – GMDB

All test cases (product guarantees) should be run under the following combinations of ‘policy duration’ and ‘in-the-moneyness’ (“ITM”) of the guaranteed benefit. Here, $ITM = (GV \div AV) - 1$. Mid-year policy durations have been selected so that the ITM% also apply to the MAV guarantee.

- a) Immediately after issue (duration 0): 0% ITM
- b) Policy duration 3.5: -40%, -20%, 0%, +20%, +40%
- c) Policy duration 6.5: -40%, -20%, 0%, +20%, +40%
- d) Policy duration 9.5: -40%, -20%, 0%, +20%, +40%

To avoid ambiguity, the grid on the following page shows the MV and GV for certain product forms. For ROP, $GV = \$100,000$ at all policy durations (i.e., market value adjusts to give the appropriate ITM%). For example, at +20% and +40% ITM the market values are \$83,333.33 and \$71,428.57 respectively.

For ROLL, the $GV = \$100,000 \times (1+g)^T$, where T = policy duration (in years) and g = roll-up rate. For MAV, we assume the maximum guaranteed value was reached 1.5 years prior to the calculation date with a 10% simple interest return (after fees) to that date. For HIGH, we assume that the MAV governs the current GV (as specified for MAV), but that the roll-up guaranteed value is defined by ROLL. For example, for GMDB – HIGH at duration 6.5, we have $GV = \$150,000$ and $GV\text{-ROLL} = \$137,318.94$.

For the Enhanced Death Benefit (EDB), which also includes a simple return-of-premium GMDB, the ‘Guaranteed Value’ shown is the higher of the EDB and GMDB. For consistency, the EDB test case uses the ‘GV’ for the GMDB (i.e., flat \$100,000) in the lapse rate dynamics.

MV / GV relationships for GMDB Test Cases

Product Form	Policy Duration	Market Value	Guaranteed Value	ITM%
GMDB – MAV GMDB – HIGH	3.5	\$200,000 \$150,000 \$120,000 \$100,000 \$85,714	\$120,000	-40% -20% 0% +20% +40%
GMDB – MAV GMDB – HIGH	6.5	\$250,000 \$187,500 \$150,000 \$125,000 \$107,143	\$150,000	-40% -20% 0% +20% +40%
GMDB – MAV GMDB – HIGH	9.5	\$300,000 \$225,000 \$180,000 \$150,000 \$128,571	\$180,000	-40% -20% 0% +20% +40%
GMDB – EDB	ALL	\$233,333 \$150,000 \$100,000 \$83,333 \$71,429	\$140,000 \$120,000 \$100,000 \$100,000 \$100,000	-40% -20% 0% +20% +40%

Test Cases – GMDB

All test cases (product guarantees) should be run under the following combinations of ‘policy duration’ and ‘in-the-moneyness’ (“ITM”) of the guaranteed benefit. Here, $ITM = (GV \div AV) - 1$. Mid-year policy durations have been selected so that the ITM% also apply to the MAV guarantee.

- e) Immediately after issue (duration 0): 0% ITM
- f) Policy duration 3.5: -40%, -20%, 0%, +20%, +40%
- g) Policy duration 6.5: -40%, -20%, 0%, +20%, +40%
- h) Policy duration 9.5: -40%, -20%, 0%, +20%, +40%

To avoid ambiguity, the grid on the following page shows the MV and GV for certain product forms. For ROP, $GV = \$100,000$ at all policy durations (i.e., market value adjusts to give the appropriate ITM%). For example, at +20% and +40% ITM the market values are \$83,333.33 and \$71,428.57 respectively.

Output

Please submit output to Geoffrey Hancock (by email file attachment) in Microsoft Excel or other compatible spreadsheet software. Results by scenario should be provided as actuarial present values (dollar amounts, at the calculation date) in column format without flooring at zero. The following measures are requested:

- PVSURPLUS = PV[Surplus Deficiency]
- PVCLAIMS = PV[Guaranteed Benefit Payments]
- PVNETCF = PV[Cash Outflow] – PV[Cash Inflow]

where ‘Cash Outflow’ includes [guaranteed benefit claims] + [maintenance expenses] and ‘Cash Inflow’ includes [net fee revenue]. Note, surrender charges are not included in the definition of ‘Cash Inflow’.

Each column represents a ‘test case’ and will contain 1000 entries (no flooring at zero) for a given measure. A test case is defined by (a) product/guarantee type, (b) ITM%, (c) attained age, (d) policy duration and (e) fund class.

Each column should contain 8 header lines (“cells”) to identify the test case, with the following information for identification purposes.

Row 1 = business id:	Currently, ‘Policy’. Later, may include ‘Portfolio X’, ‘Sensitivity 2’, etc.
Row 2 = product/guarantee:	GMDB-ROP, GMDB-ROLL, GMDB-MAV, GMDB-HIGH, GMDB-EDB
Row 3 = ITM%:	–40%, –20%, 0%, +20%, +40% (as number)
Row 4 = attained age:	E.g., 65
Row 5 = policy duration:	E.g., 3.5
Row 6 = fund class:	Currently, ‘SP500’ (no quotes).
Row 7 = risk measure:	PVSURPLUS, PVCLAIMS or PVNETCF
Row 8 = account value:	In dollars.

When we expand the testing, some of the ‘header rows’ will have additional entries (e.g., Row 6 may have ‘Balanced’, for a Portfolio of sample of policies Row 4 would be the average attained age and Row 5 the average policy duration at time zero, etc.)

RBC - C3 Phase 2 - Sensitivities

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Base

See "Modelling Specifications" document. Key assumptions include:

- * Asset earnings rate = 5.75% p.a. Discount rate = 5.75% effective.
- * S&P500 Total Return Fund (RSLN2 model). MER is 275 bps p.a.
- * Mortality at 65% of MGDB94 ALB table. Male attained age 65 at valuation date.
- * Static lapses (ultimate rate is 15% p.a.)
- * CARVM borrowing rate is 25 bps above asset earnings rate.
- * Net profit margin (ignoring amortization of CARVM allowance) approximately 180-200 bps.

Falling Rates

Asset earnings rate grading from 5.75% (pretax) to 3.75% over 4 years. Discount rate unchanged.

Rising Rates

Asset earnings rate grading from 5.75% (pretax) to 7.75% over 4 years. Discount rate unchanged.

Balanced Asset Allocation

Asset mix is 60% S&P500, 40% Bond (mix of government and corporates; average duration is 5 years).

Higher Mortality

Mortality is 90% of MGDB94 ALB table.

Lower Lapses

Static lapses at 50% of Base assumption.

Higher Expenses

Expenses are 25 bps higher per annum.

Dynamic Lapses

Dynamic lapse rates as per formula in specifications (lapse rates fall as AV/GV decreases).

RBC - C3 Phase 2 - Sensitivities

CTE90 of CAPITAL as a % of AV

Jun 12, 2003

Product **GMDB-ROP**
 Duration **0**
 Statistic **CAPITAL**

ITM %	CAPITAL as a % of AV				
	-40%	-20%	0%	20%	40%
Base	-	-	0.62%	-	-
Falling Rates	-	-	0.54%	-	-
Rising Rates	-	-	0.75%	-	-
Balanced Asset Allocation	-	-	0.12%	-	-
Higher Mortality	-	-	0.99%	-	-
Lower Lapses	-	-	0.78%	-	-
Higher Expenses	-	-	1.09%	-	-
Dynamic Lapses	-	-	0.74%	-	-

Product **GMDB-ROP**
 Duration **3.5**
 Statistic **CAPITAL**

	CAPITAL as a % of AV				
	-40%	-20%	0%	20%	40%
Base	0.00%	0.02%	0.23%	1.08%	2.21%
Falling Rates	0.00%	0.02%	0.22%	1.02%	2.08%
Rising Rates	0.00%	0.03%	0.26%	1.19%	2.53%
Balanced Asset Allocation	0.00%	0.00%	0.03%	0.57%	1.58%
Higher Mortality	0.00%	0.05%	0.40%	1.57%	3.02%
Lower Lapses	0.00%	0.04%	0.32%	1.34%	2.75%
Higher Expenses	0.00%	0.05%	0.48%	1.49%	2.68%
Dynamic Lapses	0.00%	0.03%	0.29%	1.30%	2.70%

Product **GMDB-ROP**
 Duration **6.5**
 Statistic **CAPITAL**

	CAPITAL as a % of AV				
	-40%	-20%	0%	20%	40%
Base	0.00%	0.00%	0.02%	0.22%	0.53%
Falling Rates	0.00%	0.00%	0.02%	0.21%	0.51%
Rising Rates	0.00%	0.00%	0.02%	0.23%	0.57%
Balanced Asset Allocation	0.00%	0.00%	0.00%	0.12%	0.36%
Higher Mortality	0.00%	0.00%	0.04%	0.36%	0.84%
Lower Lapses	0.00%	0.01%	0.05%	0.35%	0.87%
Higher Expenses	0.00%	0.00%	0.06%	0.34%	0.69%
Dynamic Lapses	0.00%	0.00%	0.04%	0.32%	0.84%

Product **GMDB-ROP**
 Duration **9.5**
 Statistic **CAPITAL**

	CAPITAL as a % of AV				
	-40%	-20%	0%	20%	40%
Base	0.00%	0.00%	0.01%	0.04%	0.14%
Falling Rates	0.00%	0.00%	0.01%	0.03%	0.13%
Rising Rates	0.00%	0.00%	0.01%	0.04%	0.17%
Balanced Asset Allocation	0.00%	0.00%	0.00%	0.00%	0.01%
Higher Mortality	0.00%	0.01%	0.02%	0.13%	0.45%
Lower Lapses	0.00%	0.00%	0.03%	0.14%	0.45%
Higher Expenses	0.00%	0.00%	0.01%	0.07%	0.23%
Dynamic Lapses	0.00%	0.00%	0.02%	0.13%	0.42%

RBC - C3 Phase 2 - Sensitivities

Jun 12, 2003

CTE90 of CAPITAL as a % of AV

Product **GMDB-ROLL**
Duration **0**
Statistic **CAPITAL**

ITM %	CAPITAL as a % of AV				
	-40%	-20%	0%	20%	40%
Base	-	-	1.32%	-	-
Falling Rates	-	-	1.11%	-	-
Rising Rates	-	-	1.69%	-	-
Balanced Asset Allocation	-	-	0.39%	-	-
Higher Mortality	-	-	2.38%	-	-
Lower Lapses	-	-	2.68%	-	-
Higher Expenses	-	-	2.03%	-	-
Dynamic Lapses	-	-	2.48%	-	-

Product **GMDB-ROLL**
Duration **3.5**
Statistic **CAPITAL**

	CAPITAL as a % of AV				
	-40%	-20%	0%	20%	40%
Base	0.00%	0.04%	0.27%	1.18%	2.75%
Falling Rates	0.00%	0.03%	0.24%	1.03%	2.37%
Rising Rates	0.00%	0.05%	0.33%	1.44%	3.47%
Balanced Asset Allocation	0.00%	0.00%	0.04%	0.43%	1.89%
Higher Mortality	0.01%	0.10%	0.59%	2.20%	4.33%
Lower Lapses	0.02%	0.24%	1.05%	3.30%	6.57%
Higher Expenses	0.01%	0.07%	0.45%	1.70%	3.37%
Dynamic Lapses	0.01%	0.17%	0.91%	3.03%	6.30%

Product **GMDB-ROLL**
Duration **6.5**
Statistic **CAPITAL**

	CAPITAL as a % of AV				
	-40%	-20%	0%	20%	40%
Base	0.00%	0.01%	0.04%	0.20%	0.70%
Falling Rates	0.00%	0.01%	0.04%	0.19%	0.64%
Rising Rates	0.00%	0.01%	0.05%	0.23%	0.82%
Balanced Asset Allocation	0.00%	0.00%	0.00%	0.04%	0.28%
Higher Mortality	0.00%	0.01%	0.12%	0.56%	1.62%
Lower Lapses	0.00%	0.09%	0.40%	1.32%	3.24%
Higher Expenses	0.00%	0.01%	0.07%	0.34%	1.02%
Dynamic Lapses	0.00%	0.04%	0.28%	1.08%	2.93%

Product **GMDB-ROLL**
Duration **9.5**
Statistic **CAPITAL**

	CAPITAL as a % of AV				
	-40%	-20%	0%	20%	40%
Base	0.00%	0.01%	0.05%	0.19%	0.61%
Falling Rates	0.00%	0.01%	0.04%	0.18%	0.56%
Rising Rates	0.00%	0.01%	0.05%	0.22%	0.71%
Balanced Asset Allocation	0.00%	0.00%	0.00%	0.02%	0.16%
Higher Mortality	0.00%	0.02%	0.15%	0.60%	1.76%
Lower Lapses	0.00%	0.05%	0.29%	0.97%	2.48%
Higher Expenses	0.00%	0.01%	0.07%	0.31%	0.91%
Dynamic Lapses	0.00%	0.03%	0.24%	0.87%	2.34%

RBC - C3 Phase 2 - Sensitivities

Jun 12, 2003

CTE90 of CAPITAL as a % of AV

Product **GMDB-MAV**
Duration **0**
Statistic **CAPITAL**

ITM %	CAPITAL as a % of AV				
	-40%	-20%	0%	20%	40%
Base	-	-	0.58%	-	-
Falling Rates	-	-	0.51%	-	-
Rising Rates	-	-	0.71%	-	-
Balanced Asset Allocation	-	-	0.09%	-	-
Higher Mortality	-	-	1.02%	-	-
Lower Lapses	-	-	0.86%	-	-
Higher Expenses	-	-	1.04%	-	-
Dynamic Lapses	-	-	0.78%	-	-

Product **GMDB-MAV**
Duration **3.5**
Statistic **CAPITAL**

ITM %	CAPITAL as a % of AV				
	-40%	-20%	0%	20%	40%
Base	0.00%	0.01%	0.08%	0.50%	1.45%
Falling Rates	0.00%	0.01%	0.07%	0.46%	1.36%
Rising Rates	0.01%	0.01%	0.09%	0.56%	1.65%
Balanced Asset Allocation	0.00%	0.00%	0.00%	0.11%	0.83%
Higher Mortality	0.02%	0.04%	0.20%	0.94%	2.25%
Lower Lapses	0.03%	0.06%	0.17%	0.71%	1.93%
Higher Expenses	0.01%	0.03%	0.18%	0.85%	1.90%
Dynamic Lapses	0.01%	0.04%	0.14%	0.67%	1.88%

Product **GMDB-MAV**
Duration **6.5**
Statistic **CAPITAL**

ITM %	CAPITAL as a % of AV				
	-40%	-20%	0%	20%	40%
Base	0.00%	0.00%	0.00%	0.03%	0.17%
Falling Rates	0.00%	0.00%	0.00%	0.03%	0.16%
Rising Rates	0.00%	0.00%	0.01%	0.03%	0.19%
Balanced Asset Allocation	0.00%	0.00%	0.00%	0.00%	0.03%
Higher Mortality	0.00%	0.00%	0.01%	0.10%	0.45%
Lower Lapses	0.01%	0.01%	0.03%	0.12%	0.45%
Higher Expenses	0.00%	0.00%	0.01%	0.06%	0.32%
Dynamic Lapses	0.00%	0.00%	0.02%	0.10%	0.42%

Product **GMDB-MAV**
Duration **9.5**
Statistic **CAPITAL**

ITM %	CAPITAL as a % of AV				
	-40%	-20%	0%	20%	40%
Base	0.00%	0.00%	0.01%	0.02%	0.10%
Falling Rates	0.00%	0.00%	0.01%	0.02%	0.09%
Rising Rates	0.00%	0.00%	0.01%	0.02%	0.12%
Balanced Asset Allocation	0.00%	0.00%	0.00%	0.00%	0.01%
Higher Mortality	0.00%	0.00%	0.02%	0.10%	0.35%
Lower Lapses	0.01%	0.01%	0.03%	0.11%	0.35%
Higher Expenses	0.00%	0.00%	0.01%	0.04%	0.16%
Dynamic Lapses	0.00%	0.00%	0.02%	0.10%	0.33%

RBC - C3 Phase 2 - Sensitivities

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CTE90 of CAPITAL as a % of AV

Product **GMDB-HIGH**
Duration **0**
Statistic **CAPITAL**

ITM %	CAPITAL as a % of AV				
	-40%	-20%	0%	20%	40%
Base	-	-	1.25%	-	-
Falling Rates	-	-	1.05%	-	-
Rising Rates	-	-	1.60%	-	-
Balanced Asset Allocation	-	-	0.35%	-	-
Higher Mortality	-	-	2.31%	-	-
Lower Lapses	-	-	2.65%	-	-
Higher Expenses	-	-	1.94%	-	-
Dynamic Lapses	-	-	2.45%	-	-

Product **GMDB-HIGH**
Duration **3.5**
Statistic **CAPITAL**

ITM %	CAPITAL as a % of AV				
	-40%	-20%	0%	20%	40%
Base	0.01%	0.03%	0.23%	1.00%	2.52%
Falling Rates	0.01%	0.03%	0.20%	0.88%	2.17%
Rising Rates	0.01%	0.04%	0.27%	1.23%	3.16%
Balanced Asset Allocation	0.00%	0.00%	0.03%	0.31%	1.64%
Higher Mortality	0.02%	0.10%	0.51%	1.97%	4.06%
Lower Lapses	0.04%	0.23%	0.94%	3.00%	6.16%
Higher Expenses	0.01%	0.07%	0.38%	1.50%	3.12%
Dynamic Lapses	0.02%	0.18%	0.81%	2.74%	5.89%

Product **GMDB-HIGH**
Duration **6.5**
Statistic **CAPITAL**

ITM %	CAPITAL as a % of AV				
	-40%	-20%	0%	20%	40%
Base	0.00%	0.00%	0.01%	0.09%	0.36%
Falling Rates	0.00%	0.00%	0.02%	0.08%	0.33%
Rising Rates	0.00%	0.00%	0.02%	0.11%	0.42%
Balanced Asset Allocation	0.00%	0.00%	0.00%	0.01%	0.09%
Higher Mortality	0.00%	0.01%	0.06%	0.29%	0.96%
Lower Lapses	0.00%	0.04%	0.22%	0.74%	1.98%
Higher Expenses	0.00%	0.00%	0.03%	0.16%	0.59%
Dynamic Lapses	0.00%	0.02%	0.15%	0.59%	1.75%

Product **GMDB-HIGH**
Duration **9.5**
Statistic **CAPITAL**

ITM %	CAPITAL as a % of AV				
	-40%	-20%	0%	20%	40%
Base	0.00%	0.00%	0.01%	0.08%	0.26%
Falling Rates	0.00%	0.00%	0.01%	0.07%	0.24%
Rising Rates	0.00%	0.00%	0.02%	0.09%	0.30%
Balanced Asset Allocation	0.00%	0.00%	0.00%	0.01%	0.04%
Higher Mortality	0.00%	0.01%	0.06%	0.26%	0.79%
Lower Lapses	0.00%	0.02%	0.13%	0.43%	1.18%
Higher Expenses	0.00%	0.00%	0.02%	0.12%	0.40%
Dynamic Lapses	0.00%	0.01%	0.10%	0.38%	1.11%

RBC - C3 Phase 2 - Sensitivities

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CTE90 of CAPITAL as a % of AV

Product **GMDB-EDB**
Duration **0**
Statistic **CAPITAL**

ITM %	CAPITAL as a % of AV				
	-40%	-20%	0%	20%	40%
Base	-	-	0.43%	-	-
Falling Rates	-	-	0.37%	-	-
Rising Rates	-	-	0.53%	-	-
Balanced Asset Allocation	-	-	0.06%	-	-
Higher Mortality	-	-	0.73%	-	-
Lower Lapses	-	-	0.56%	-	-
Higher Expenses	-	-	0.72%	-	-
Dynamic Lapses	-	-	0.54%	-	-

Product **GMDB-EDB**
Duration **3.5**
Statistic **CAPITAL**

ITM %	CAPITAL as a % of AV				
	-40%	-20%	0%	20%	40%
Base	0.00%	0.00%	0.13%	0.79%	1.88%
Falling Rates	0.00%	0.00%	0.12%	0.75%	1.76%
Rising Rates	0.00%	0.00%	0.15%	0.89%	2.15%
Balanced Asset Allocation	0.00%	0.00%	0.01%	0.31%	1.24%
Higher Mortality	0.00%	0.01%	0.27%	1.26%	2.68%
Lower Lapses	0.00%	0.00%	0.20%	1.02%	2.36%
Higher Expenses	0.00%	0.01%	0.28%	1.18%	2.33%
Dynamic Lapses	0.00%	0.00%	0.18%	0.98%	2.33%

Product **GMDB-EDB**
Duration **6.5**
Statistic **CAPITAL**

ITM %	CAPITAL as a % of AV				
	-40%	-20%	0%	20%	40%
Base	0.00%	0.00%	0.01%	0.13%	0.43%
Falling Rates	0.00%	0.00%	0.01%	0.12%	0.41%
Rising Rates	0.00%	0.00%	0.01%	0.13%	0.46%
Balanced Asset Allocation	0.00%	0.00%	0.00%	0.04%	0.28%
Higher Mortality	0.00%	0.00%	0.02%	0.26%	0.71%
Lower Lapses	0.00%	0.00%	0.03%	0.24%	0.72%
Higher Expenses	0.00%	0.00%	0.02%	0.24%	0.57%
Dynamic Lapses	0.00%	0.00%	0.02%	0.22%	0.69%

Product **GMDB-EDB**
Duration **9.5**
Statistic **CAPITAL**

ITM %	CAPITAL as a % of AV				
	-40%	-20%	0%	20%	40%
Base	0.00%	0.00%	0.01%	0.02%	0.10%
Falling Rates	0.00%	0.00%	0.01%	0.02%	0.09%
Rising Rates	0.00%	0.00%	0.01%	0.03%	0.12%
Balanced Asset Allocation	0.00%	0.00%	0.00%	0.00%	0.01%
Higher Mortality	0.00%	0.00%	0.02%	0.10%	0.35%
Lower Lapses	0.00%	0.00%	0.02%	0.11%	0.36%
Higher Expenses	0.00%	0.00%	0.01%	0.04%	0.16%
Dynamic Lapses	0.00%	0.00%	0.02%	0.10%	0.34%