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Applied Modeling Concepts

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Summary: Actuaries struggle with developing models to adequately reflect financial risk embedded in insurance products. Emerging theories of risk measurement and hedging techniques require sophisticated modeling techniques that have not been contemplated until recently. Panelists discuss the conceptual and practical issues of modeling to reflect developing areas, including fair-value and embedded-value measurement, embedded guarantees and stochastically determined capital requirements.

MR. DAVID A. RICCI: This is an open forum, and there's a reasonable expectation that at the end of the discussion period by our presenters you will have a small amount of time to add comments or ask for clarifications. There is available expertise out there to help enhance the process, and we're looking forward to that session.

The first presenter is Steve Strommen. He's a senior actuary for the Northwestern Mutual and has been an actuary there for 20 years. He's on the corporate actuarial staff responsible for financial projections. Steve will be talking about modeling as it applies to fair value and embedded value.

MR. STEPHEN J. STROMMEN: There are four general areas I'd like to cover. First, I want to make sure we all understand the terms "fair value" and "embedded value." Then I'll talk about some structural features that need to be included in a

Note: The charts referred to in the text can be found at the end of the manuscript.

dynamic model for a fair value accounting basis. I'll talk about an example model valuation approach, which is sort of a simplified fair value approach, and then I'll talk about some common errors and misconceptions that I've run across.

First, what is fair value and embedded value? They are not the same thing. When we're talking about fair value, we typically are talking about measuring the value of liabilities. The accounting problem, of course, is to divide the right-hand side of the balance sheet between liabilities and net worth. Fair value is a measure of the liabilities. It's usually calculated directly as a present value of policy cash flows. Embedded value, on the other hand, is a value of net worth. It's typically calculated as the present value of distributable earnings. Under a fair value approach, net worth is the remainder. Under embedded value, the value of the liabilities is the remainder.

Some people think that there is an intersection between fair value and embedded value. I'm one of those people. In fact, back in the year 2000, Luke Girard published a paper in the *North American Actuarial Journal* showing that you can calculate a liability value consistent with embedded value by directly discounting the cash flows of the insurance policies if the adjustment for risk that you include in your valuation is calculated in a particular way. The adjustment for risk, in order to get a liability value consistent with embedded value, has to be based on the cost of capital, based on your hurdle rate, based on the amount of capital that you expect to hold in some formulaic basis. Fair value and embedded value do have an intersection. They're both the present value of future cash flows under current assumptions, including current interest rates, and with a provision for risk. If you want a value consistent with embedded value, that provision for risk has to be calculated essentially based on your cost of capital.

Let's assume we want to create a model to project company financial statements under dynamic economic conditions, dynamic conditions for claims and for everything else. A dynamic model has to separate the projection of cash flows for valuation purposes from the projection of the cash flows for the financial statements. That means we have to separate the valuation timeline and its assumptions from the calendar timeline and its assumptions. Chart 1 is a picture of what I mean by that. On this picture, we have calendar time proceeding horizontally across the top and valuation time proceeding from top to bottom vertically. The model calculations proceed along the diagonal. At the end of any accounting period there's a valuation date, and we have a vertical line that proceeds downward from that valuation date in valuation time.

The assumptions that are in place at that point in time have to be used for the projection of cash flows for valuation, but they may be different than the assumptions used in the scenario you're projecting. For example, if there is an assumption in this scenario that interest rates increase dramatically in year five, and you're doing the valuation at the end of year three, you cannot have advance knowledge of that change in interest rates. The model has to be able to make this

distinction between the assumptions used for valuation and those used for projecting the cash flows for the financial statement.

This is facilitated by having a model that loops through calendar time. Within every calendar period, it simulates all the insurance transactions and cash flow, uses that to simulate the investments, and then comes to the end of the period, wherein you do a valuation that involves that independent projection of the cash flows. A loop by calendar period is a necessary piece of a dynamic valuation model or a dynamic model for projecting financial statements under fair value or embedded value. I've included the valuation step at period-end processing. I'm assuming that, whether we're doing embedded value or fair value, it can do that valuation by present valuing the cash flows and including a provision for risk. Again, the provision for risk is the real driver between whether we call it embedded value or fair value.

Sometimes it's useful to have a simplified technique for valuation in a model. I ran across something like this recently when I was participating in a joint research project with the ACLI and the International Actuarial Association (IAA) to illustrate for the International Accounting Standards Board the effect of certain assumptions that were being proposed for valuation under accounting rules. One issue that was being addressed was renewal premiums. Do you get to recognize them for valuation or not? Another issue being addressed was non-guaranteed elements. How do you treat those for valuation?

We had to develop a dynamic model that would project financial statements through time on a fair value basis using some of the different proposed rules. We discovered in doing this that the liability value depends mainly on the assumed spread between the discount rate and the credited rate, the assumed level of renewal premiums and, of course, the value of the interest rate guarantee. We noted that the first two of those don't necessarily have to be stochastically determined. The valuation of the interest rate guarantee does. We came up with a valuation technique for this model used for this research project. The valuation technique involves a single scenario valuation of a universal life contract without the interest guarantee, wherein we estimate the future credited rates with no change to the current market, we estimate the future renewal premiums on a best-estimate basis, we project all the future cash flows and we use the current discount rate. We do a single scenario projection of the contract without the guarantee and then add the value of the guarantee.

In this case, it's just an interest rate guarantee. The interest rate guarantee is analogous to an interest rate floor, but it's a particular kind of interest rate floor. This one has a notional amount that's equal to the projected account value and a strike rate that's equal to the guaranteed interest rate plus the required spread. The payment under this interest rate floor is equal to the strike rate less the earned rate, if that difference is greater than zero. The earned rate requires us to have a stochastic model for the earned rate. In our example, we were investing all the money in seven-year corporate bonds, so we decided that a seven-year average of

stochastically generated seven-year bond rates would be a reasonable representation of the earned rate. We used that to create a stochastic model for the earned rate and then priced the interest rate floor on an evaluation date.

I can see a lot of gears turning out there saying, "Boy, you left a lot out of this kind of valuation approach." There are a number of weaknesses. Certainly a single scenario ignores a lot of dependencies on the scenario. It ignores renewal premium that may be responsive to the level of interest rates. It ignores the projected account value, lapse rates and all kinds of policy-owner behavior that may depend on the scenario. Our simple model for the future earned rate certainly is simple. Some people might think it's unrealistic.

Nevertheless, the single scenario approach does have a lot of advantages. It avoids the need for a full stochastic valuation of universal life at every valuation date in your model, something that might be very complicated and difficult to do. The stochastic valuation of the interest rate floor, as we described it, is a whole lot simpler, and it still captures all the dynamic behavior of the liability value.

There are errors that I've run across in talking about fair value or embedded value with other people. One common error is that you can do a reasonable single scenario valuation of an interest-sensitive product using the current yield curve. The proposal is that you assume a continuation of current conditions, use the full yield curve (that means all of the spot rates in it for discounting), and project interest-sensitive cash flows forward, assuming that the yield curve does not change in the future. Let me explain why that creates a problem. If you just apply that to a money market fund with no expense charges, and you assume that the typical owner of the fund withdraws his or her money three years from now, you would accumulate the fund value at the current short-term rate for three years because money market funds pay the short-term rate. You would then discount at a three-year spot rate, which is higher than a short-term rate, and you'd get a discounted value less than the current value, which is obviously wrong.
There are no margins on this product. You always pay the current rate. So you can see that this technique is wrong for a money market fund. It's not so obvious that it is also wrong for universal life or any other interest-sensitive product, but I assure you that it is. The correction is that you have to project interest-sensitive cash flows assuming the yield curve changes along the path of its forward rates if you want to discount using the entire yield curve. Your accumulation forward has to be consistent with your discounting back. If you're going to use the whole yield curve, you have to use the forward rates in the yield curve. An alternative, of course, is to just use one rate, which makes things a lot simpler.

It's a totally different issue, but there's a common misconception I've run across with regard to fair value for life insurance. Certainly the McCaulley duration of cash flows for life insurance is very long. If you have good persistency, those death benefits are way out in the future, and that implies an extreme fluctuation in fair value any time interest rates change. That's true. However, non-guaranteed

interest credits or dividends change the duration significantly. The actual duration of life insurance cash flows that have these interest-sensitive elements depends on the speed of the change to the credited rate or to the dividend interest rate. When the credited rate is based on the "portfolio rate" under amortized cost accounting, the duration of the liability approximates the duration of the portfolio, so there is an implicit duration matching when you're paying a "portfolio rate" on this kind of a product. I can't count the number of people who have been surprised when I've tried to explain that, and I'll try again if somebody has a question.

MR. RICCI: Before you step down, Steve, could you give particular applications of both fair value and embedded value in your organization?

MR. STROMMEN: In our organization, as a mutual company, right now we are mostly researching these things. I have been a member of the American Academy of Actuaries' group that put together a monograph on the fair valuation of insurance liabilities. Within our organization, however, these things are still being researched. It's hard to define embedded value in a mutual company because it's hard to determine what your hurdle rate ought to be. If your hurdle rate is basically the rate that you price for, you can always adjust your dividends to exactly produce that. It becomes kind of a circular—

MR. RICCI: The definition of distributable earnings for a mutual company is kind of questionable.

MR. STROMMEN: Nothing gets distributed.

MR. RICCI: Of course, embedded value was brought up seven or eight years ago as being an excellent way to pay bonuses and that kind of thing.

MR. STROMMEN: I believe embedded value is being used for that purpose in quite a few places, particularly outside the United States, but I can't say that I have experience doing that.

MR. RICCI: Would you say the people at Northwestern feel that fair value is going to come into increasing importance, particularly with the International Accounting Standards and that kind of thing?

MR. STROMMEN: Fair value is probably going to do that. The issues that we are struggling with have to do mostly with the same thing that came up this morning under the life and annuity valuation issues session. If all of the assumptions are up to the actuary, there needs to be some discipline on how those assumptions are set. There's a concern that if fair value is put in place without that kind of disciplinary framework, fair value can be whatever the actuary wants it to be. All of us have done valuation calculations and played with the assumptions; you can change them a little bit and have a dramatic effect on fair value. That's a major issue.

MR. RICCI: Thanks very much. Our next presenter is Vincent Tsang. He is senior manager of Ernst & Young's Chicago office. He is going to speak about the application of the stochastic process in accounting for statutory and GAAP. He's going to be talking specifically about variable annuity (VA) commissioners annuity reserve valuation method (CARVM).

MR. VINCENT Y. TSANG: David, in order to answer your question a little more about the fair value and the embedded value, the European has published something called European Embedded Value Principles that teach the European companies how to calculate the embedded value. For more information, please go to the Web site www.cfoforum.nl. Over there, they talk about an approach that is very similar to an actuarial appraisal according to Actuarial Standard of Practice (ASOP) 19, but there are some particular differences between the two. There is a paper coming out in the November issue of the *Financial Reporter* that talks about these embedded value principles. For more information, please look at that article.

First of all, I would like to talk about the embedded guarantees of the insurance products. Embedded guarantees are not necessarily what we call embedded derivatives; you have to make a distinction between the two. For one of them, you go with the normal Standard of Practice (SOP), and for the other one, you go with the FAS 133. Also, I would like to talk about when you're using your stochastic processes, there's a difference between whether you're doing a valuation or whether you are doing a risk management project. These two are very similar, but they have their fundamental differences, so please don't mix the two together.

Then the next thing I would like to talk about is how the stochastic processes have been applying to the statutory and the GAAP accounting issues. Later on, when we have to face the ultimate choice, what do you do when you have a large number of policies? Do you go with seriatim policy valuation and projection, or shall we use some kind of actuarial model? Lastly, I will talk about the current proposed actuarial guideline VA CARVM with a numerical example that illustrates its main points. The VA CARVM is a long and detailed comprehensive description of the method. It can drive people crazy reading it, because they kind of go around and around. Before you read that, I think it would be very helpful if you have an example to show you the main focus of this VA CARVM so that you can focus your energy more effectively.

First of all, when we talk about the embedded guarantees, we are not always talking about the separate account guarantee. Sometimes we are also talking about the fixed account guarantee. For example, some of the interest-related book guarantee on the general account liability can be the death benefit equals the account value. For example, when you defer an annuity saying that if you surrender, we give you the cash surrender value, and if the policyholder dies, then we give you the account value. This is actually one of the guarantees.

Also for two-tier annuities, you'll have two funds. One is for cash surrender, and one is for your death benefits or nursing home and so forth. A third one is the guaranteed interest rate, and that is the reason we are doing cash-flow testing in the first place. It's because there is a contract guarantee. In light of the currently low interest rate environment, this guaranteed interest rate is causing a lot of companies a lot of headaches.

With respect to the equity-indexed products, then we are talking about options. For this one then, we are going to have the Actuarial Guideline (AG) 35 as well as the FAS 133 to take care of this kind of embedded guarantee on a valuation basis. Lastly, on the equity-related guarantee, there will be the guaranteed minimum death benefit (GMDB) as well as the variable annuity guaranteed living benefit (VAGLB). Don't have all your focus only on the equity-related guarantee. There are some other things that you should have to worry about. Currently, the VA CARVM only talks about the variable annuities or any contract they're offering, something similar to a GMDB or VAGLB. Equity-indexed annuities (EIAs) and equity-indexed universal life (EIUL) are explicitly excluded. That doesn't mean that in the future it would not somehow creep back into this. Even though currently the EIA and EIUL are excluded, don't think that you are forever exempt from it. It will be coming soon.

As I mentioned before, there are differences between the valuation and risk management. Valuation is by all means the actuary's province of expertise. All we do is try to come up with an actuarial reserve and say that this is the reserve that is required, together with the future revenues, to fulfill my obligations. It is currently based on some prescribed scenario or a range of scenarios, as required by SOP 03-1. For statutory valuation at least, this is mainly focusing on the solvency and whether your reserve is sufficient, and so in general, you are probably going more than what is needed. That's why you have a margin or provision for this kind of adversity.

But when you are talking about risk management, the question is more or less, how does the volatility of the equity index affect my income statement and my cash flows? There's a more immediate focus rather than a long-term focus. For a valuation, you're talking about the long term. What's the amount I need today together with the *future* revenues to pay for the *future* obligations? But risk management asks, what would happen to my income if the volatility changes or the interest rate changes? The focus is a little different. The kind of asset that you purchase is probably more a short-term asset. It's impossible for someone to buy a 15-year put unless you go into an investment banker and ask for a 15-year put. Even if that is available, the investment banker would ask you, "What is your strike price?" You would have a tough time coming up with that number. I just wanted to mention that. Don't confuse the two.

In addition, whenever you are doing a hedging strategy from a risk management perspective, you are talking about how effective that hedge strategy is and also

about what kind of hedging strategy you are going to follow into the future. For risk management, we are also focusing on outliers and extremes. Of course, no one can design a foolproof hedging strategy such that your company will be protected under all scenarios. You can only go to a reasonable range. For the reserve , if you talk about the VA CARVM, they only talk about the 65 conditional tail expectation (CTE), which is more or less the average of the worst 35 percent. They are not really going out to the extreme. For the risk-based capital (RBC), we go to 90 CTE, which is the average of the worst 10 percent. That goes even further. You have to understand that whenever we talk about valuation, like VA CARVM, we are talking about valuation. When we are talking about risk management, we talk about RBC Phase II. Those two things look very much the same, but they are very different.

There's another thing I want to point out. If you look at risk management, you can do it in two ways. One is called cash-flow hedging. In other words, your future asset cash flow matches your liability cash flow. That will be the ideal case. Then the other one is called fair value hedging. In other words, your changes in your liability are somehow consistent with your changes in your asset, so that your net impact on your surplus is minimized. Let me assure you that when you have a cash-flow hedge then you have a fair value hedge, because if you have two sets of identical cash flow, they better give you the same value. Otherwise, the arbitrage opportunity exists, and then you would probably have to sell it quickly. But when you have two fair value hedging (that means the market value of the asset in here and the market value of the liability in here are kind of close to each other), that doesn't have anything to do with the asset cash flow being matched. So, one is more restrictive than the other. From a risk management perspective, you're probably looking at a fair value hedge rather than a cash flow hedge, because you don't have this 15-year put into the future for you.

The stochastic process has been going on for a long time and has recently hit the GAAP book before it hit the statutory. I'm sure that you all have gone through some pain in implementing the SOP 03-1. They are asking for a reasonable range of scenarios. So the first question people may ask is, is this supposed to be risk-neutral scenarios or should this be an arbitrage-free scenario or should there be any kind of bias scenario involved? The answer is "probably," based on the best estimate. Personally, I would suggest that all company actuaries not do it in a vacuum, but, instead, talk to your investment professional and talk about what kind of scenario he or she uses to price the assets, and use that scenario as a base to form your SOP 03-1 scenarios.

The stochastic only happens in the very beginning, really. Afterward, you would have to roll forward the assessment and subtract the benefit out. It is more like holding some kind of a fund value for you to roll forward. The stochastic processes seem to have stopped after that, but, of course, you have to do unlocking. There are several practices, and I would suggest that you talk to your auditor and see what practices are acceptable. I understand that there are practice notes out in the Academy Web site that talk about SOP 03-1. I have also heard a lot of auditors

saying that some of the prohibitions in there are not acceptable. Do not use that Standard of Practice and call it a Bible and then use it. You may be surprised at year-end. Talk to your auditor.

As far as the statutory, we have been doing some kind of stochastic modeling all along, even if we don't know it. For example, when we do the AG 34, we are talking about in the very beginning it was a one-third drop, followed by recovery, and then later on AG 34 redefined what it is. Also, the AG 33 requires you to run a lot of policyholder behavior scenarios. You either use cash surrender, or you partial withdraw and then surrender, and so forth. In a way, we are already doing something similar to that; the only thing we are missing is the stochastic equity scenarios. All we have are deterministic scenarios.

In light of all of this, the working group of the American Academy of Actuaries decided that every time there is a new guarantee put on the book, we come with an AG. When you have GMDB, we do AG 34. When we have VAGLB, we do AG 39. When does this stop? We are better off if we do a complete overhaul of the process so that the risks of these guarantees are being factored into directly. That's why they proposed the Actuarial Guideline VA CARVM. As an outside parameter, they also do the RBC Phase II. But you have to understand that the regulators are very used to this kind of standard scenario. It's like a deterministic scenario. That's why they have to put in a standard scenario as a floor.

You may argue, then why on earth are we doing these stochastic processes and getting a result overwritten by a standard deterministic scenario? It doesn't make any sense. Personally, that doesn't make any sense to me. But you have to understand that the regulators have to get hold of what they have, and then eventually, by the time we have proven to them that the stochastic processes actually give them a more reasonable number, maybe the standard scenario will disappear.

Some big companies, for example Met Life or Lincoln or Hartford, have over a million VA contracts. What are you going to do with it? If I have to ask you to run 10,000 scenarios times 1 million, I'm sure that you know the math. It will take a long time before you get the results. So a lot of people are talking about using actuarial modeling. In this case, you have to group the policies with similar risk profiles together. This is easier said than done because you may have a contract that is in the money. Some of them will be out of the money. Depending on how the GMDB and the VAGLB sit, even though you are doing the modeling, you may still end up with a large number of lines in your model. The second thing is that you have to update your model periodically because you will have policy lapses and you will have new policies added in. It's going to be an ongoing process. You will probably have a full-time job just doing that.

This modeling has the advantage of giving you a big picture. Rather than looking at every single policy, you look at your risk profile of your entire block of business.

Then it's more efficient, you can run it faster and you can respond more quickly to your senior management. There are a lot of advantages to modeling.

The seriatim probably makes sense for a small company with less than 100,000 policies. You can directly use the policy-level data, put it into your projection system and do the projection. It's probably the most accurate, because you have every single contract being accounted for. Unfortunately, it takes a very long runtime. I understand that there is something called distributed processing that is being used by a lot of insurance companies. There's a big computer in the back room that you can push, run it overnight or over the weekend and get a number, but if you continue to sell more business, then the runtime gets longer and longer. The next thing I'd ask you would be, when is your close time? Do you have a week, or do you have half a month, or do you have to close on the 20th so that you do the quarter-end reporting? There are a lot of considerations.

There's another common argument about the modeling. Let's say I have a block of business. You and I are actuaries. You model this block of business in your model called Model A. I model this business, and I have a new model called Model B. By running through these 10,000 scenarios, we most likely would come up with two different answers. Which one is right? Is it possible that how you group, or how you skew a grouping or a modeling should become part of your reserve requirement? I think not. I think reserves should only be based on a risk profile of the policies. They should not be based on how skillful someone is in modeling the liability. A lot of documentation, a model validation, would be required in the future. In light of Sarbanes-Oxley breathing down all of our necks, we better have a better documentation to justify our model.

There is a proposed AG VA CARVM. The latest one is in the September 2004 report. I suggest that all of you to go to the Web site www.actuary.org and try to download that report. The scope covers the general account and the separate account business of variable annuities and all the other annuities that contain GMDB and VAGLB. They are trying to stop companies from selling a mutual fund and selling something on the side so that there is not really a VA, so to speak. Anything that resembles a VA with a book guarantee will be included.

There are 10,000 stochastic equity and interest rate scenarios already in the Web site for you to download. These are just the 10,000 scenarios that are recommended; it's not that you *must* use them. There is a tool for you to pick a sample of scenarios out of these 10,000 scenarios to use for your VA CARVM, but after you pick them, you still have to do some kind of calibration. It is not as simple as just going out and picking 10; it's more than that. These 10,000 scenarios are based on the regime switching with two regimes. I think this is a much better model than the linear lognormal model to which we have been accustomed.

I want to point out that in this regime switching with two regimes, the parameters are based on historical data. They are not risk-neutral scenarios. Make sure that

you understand this. There was talk about how you do that for year-end reporting, because you may need more lead time to run these 10,000 scenarios. They allow you to use the September number to come up with the year-end number. All the details are in the VA CARVM report. They also talk about these 10,000 scenarios versus the one deterministic standard scenario that you have to encounter. For the standard scenario, you have to do it on a seriatim basis. Don't throw away your existing valuation system yet. You still have to do it one deterministic, policy by policy. You can throw it away next year, maybe, but not this year. There is a minimum floor, and that is the standard scenario. Also, the other ultimate floor is the cash surrender value.

In this proposed actuarial guideline, the VA CARVM is no longer based on present value of future benefits. Instead, it's based on present value of future deficits. There is a lot of debate about whether this is really a CARVM, because when you look at the language of CARVM, it talks about the benefits, but now this VA CARVM talks about the deficits. It's a little different. The VA CARVM has to be done on a before-tax basis, and the RBC Phase II is done on an after-tax basis. The 65 CTE is now the norm for the VA CARVM, but for the RBC Phase II it's 90 CTE. In doing this valuation, you would have to go through a lot of actuarial assumptions and asset assumptions. You have to have a clearly defined hedging strategy and crediting strategy.

Here comes the best part. I presume your company offers some kind of GMDB and VAGLB. It's not on a bucket basis, but more or less on a policy-level basis. In other words, if the account value goes below this level for the entire policy, then we give you this GMDB. When this policy has a general account, the general account is usually not decreasing, because they are on a fixed income. They are in a fixed account. So if you have some money in the fixed account, it actually would reduce a lot of the reserve requirement for your separate account guarantee, because this general account serves as a buffer. It carries a lot of the weight. I will show you a numerical example later on. When you do all of this, be aware that your auditors and your state examiner may want to know more about how you came up with the model. There are a lot of other issues involved, and I highly recommend clear documentation for future reference.

I have to talk about the modeling and its effects on the final reserve. Should the modeling have any impact on the final reserve? My personal opinion is that it shouldn't but how do you stop that? I don't know. The standard scenario is used to test the reasonableness of the actuarial models and the results. The other tough part is, how do you allocate these aggregate reserves back into your 10,000 policies? That is something that is still going on. Some small insurance companies may have only 100 VAs. Why am I doing this? Is there any way that I can get out of it? They come up with alternative factors that only apply to variable annuity contracts with very simple GMDB or no guarantees. Then you can just go ahead and use these factors or just hold the very simple reserves. I will say that, among all the companies I know, all except maybe two would be qualified to use this

alternative factor method. Most of the companies will have to go through the stochastic processes.

The last question is a very interesting one. According to the 1984 tax act, it was stated that whatever you do for your statutory, you should also do for tax. If you use this VA CARVM to calculate your statutory reserve, by definition you should also use it to calculate your tax reserves. The next question is, would the IRS accept this reserve as a tax reserve? Even if they do, would they consider that as a change in valuation method and then go through an 807 after a 10-year spread?

I think there is a technical assistance memorandum (TAM) coming out saying that by the time companies put in AG 34 in the 1998 tax return—the new AG 34 versus the old AG 34—the IRS considers that to be a change in valuation method. That one is ongoing. There are a lot of tax issues involved. Statutory reserve only requires you to hold a minimum reserve. Tax, on the other hand, tells you the maximum reserve you can hold. These two are different. For statutory, you can hold whatever you want, as long as you are higher than the minimum. For tax, you cannot go beyond the allowable limit. This is something that will need to be resolved later on.

Chart 2 shows you a numerical example with the implications. I have a very simple model that I created for myself just to find out what is going on. I tried to calculate the VA CARVM reserve as a percentage of the cash surrender value, because the cash surrender value is really the floor. I did this without using the standard scenario. In other words, I'm just comparing the stochastic numbers versus the cash surrender value. The first one I have is, what would happen if I only have GMDB? I don't have a GMAB, which is a guaranteed minimum accumulation benefit that you can withdraw. The first case is when I'm out of the money, in other words, your account value is greater than your GMDB.

If the GMDB roll-up percentage is equal to 0 percent, 4 percent and 6 percent, then the reserve would be marginally higher when the roll-up percentage is increasing. You may ask why it's only changing by such a little bit. It is mainly because when I'm offering a 4 percent roll-up, I have an additional mortality and expense (M&E) charge for it. If you go through the process and price it correctly, your reserve probably would not be affected that badly. But if you're saying that you're going to give the GMDB roll-up at 4 percent at no cost, then the number 100.35 percent, would be a lot higher, because all this reserve is based on the present value of future benefits minus the present value of the future extra revenues that you can collect. Before you look at this number, you have to think about how you should price this product.

The other thing that I want to say is that when you are out of the money, at the money, in the money, then the ratios start climbing. That makes sense, because when you are in the money, you are supposed to hold a higher reserve. Also, you show the same trend that the higher the roll-up percentage goes up, you should have a higher reserve. You may ask why they aren't the same; if you price it

correctly, they are supposed to be the same. The only problem is that this reserve is based on 65 CTE. It's not really based on expected value. As a result, your reserve will be climbing higher, even though you price it correctly. This is unfortunate, but that is the way it is.

The second one is, what happens if I have GMAB but not GMDB? In this case, I would like to compare two sets of percentages. Even though everything is the same but one is GMAB and the other one is GMDB, you'll recognize that the reserve requirement for GMAB is a lot higher than GMDB. What does that mean to us? This VA CARVM is focusing on VAGLB, not on GMDB. GMDB is just part of it. That's why when your contract only offers simple GMDB you can use alternative factors, but when you have VGLB you cannot, because this entire thing is focusing on VAGLB, not GMDB.

The next thing is, what would happen if I have some of my money invested in a fixed-income security? In the first example I gave you, everything is in the equity account, a separate account. This time I have 20 percent of my money in the fixed account and the other 80 percent of the money in the equity-type investment. You will see that the percentages are a lot lower. For example, you will see that instead of 100.33 percent, now the entire block in here is 100 percent, because your general account can actually help you to shoulder that drop in your equity account and still keep the GMDB in line so that the account value will not go bad. But the general account can only do so much. When you go to VAGLB, even if you have a general account business, it would dampen the effect, but it cannot eliminate the effect. Don't get upset when you read the VA CARVM asking you to combine the general account business into the entire stochastic process. It's actually helping you to reduce the reserve requirement, even though it's more work.

In summary, I would like to point out two things. First of all, this VA CARVM is focusing on VAGLB rather than GMDB. The second thing I want to point out is that the general account is your friend. If you say, "I have a lot of surplus. I really don't care. I can put up additional reserve," then go ahead and have fun with it. Then you'll run into the problem of whether your tax reserve is adequate.

MR. RICCI: I think that you raised a point that hopefully we'll be discussing later, concerning regulatory and the difference between stochastic and deterministic and how the regulatory agencies are going to respond to this. As we see up here, the genie is out of the bottle on this stuff. You really can't come up with a reasonable valuation without some kind of stochastic determination, and certainly not from the risk management perspective. The stresses that are going to be placed to bear have already begun to show, particularly at the latest Life and Health Actuarial Task Force (LHATF) meetings when they've been discussing this and UL secondary guarantees as well.

The last presenter is Ben Yahr, who is manager at Ernst & Young in the Philadelphia office. He's going to talk about considerations in applying the principles of

stochastic modeling and about policyholder behavior taken into consideration when generating these economic scenarios.

MR. BENJAMIN J. YAHR: I'm going to talk about four topics. The first will be policyholder behavior. The next will be scenario generation. Then we'll go through some nested stochastic processing examples and talk about what that is. Then the last topic—we've touched on this already—is improving run time when we're running stochastic models. A lot of what I'm going to talk about is predicated on two items. The first is that you have a deterministic model that's constructed so that you're happy with how it works. You validated it through the income statement balance sheet. It's a validated model. It has assumptions in it with which you're comfortable, just from a baseline deterministic scenario. That's going to become important when you try to validate your stochastic results and the functions that you're going to put in place. The second item (I'll get more into this later on) is that you have a clearly defined goal of what you're trying to do. We've had some discussion on that with respect to whether you're doing a valuation task or a risk management task, or maybe you're doing a plan or budgeting exercise. The requirements of what you're going to need to come out at the end will be very different based on your goal. You're probably going to want to take a different approach depending upon your goals.

The policyholder behavior is a fancy way of saying that we're going to build in some dynamic functions that take into account external variables such as the relationship between the credited rate and the market rate, or market performance, or guarantees versus account values. Some examples of dynamic functions that you probably have in your model today are lapse, utilization and benefit payments. Some others might be whether investors choose to rebalance and when they would rebalance their portfolios. How far out of balance would they need to get? Another one is a reset provision or a step-up provision. This is something where, as guarantees are more out of the money, some policies have provisions where you can step up the guarantee so it's back in the money, and then there's another waiting period. That's an important facet that you'd want to put in your model if it doesn't already have it.

What do you want to consider when you're looking at setting up these dynamic functions? What we're very good at is when there's a lot of information available. We can run some sort of regression-type analysis, determine what variables are material and build a function that uses those variables. We have information, and we can figure out what the function would look like. There are some things right now, with variable annuities and withdrawal benefits specifically, where there's not a lot of actual experience that we've seen in practice. They're new products, and there are always new things coming into play. When that happens, and there are no data available, we have to look for alternative approaches. One that we typically would fall back on would be just using our own judgment. What makes sense? Does this relationship feel right? Look right? We'd want to talk to our colleagues. To get an opinion of how the function might work, you'd want to maybe ask your auditors,

maybe ask other consultants with whom you work or other reinsurers. You'd want to get other people's thoughts and ideas.

The last item is validation. After you've put your dynamic functions into place, you'd want to run a set of deterministic scenarios so that you can look at the results and identify whether that pattern makes sense and that it fits in with your beliefs and philosophies on the function you've put in place.

Chart 3 is an example of a dynamic utilization function for a withdrawal benefit. Here we see two functions: Function A and Function B. They're showing something pretty different. In a scenario where the market steadily increases, Function A is not going to generate any additional utilization. Function B still has increased utilization. That has to do with the underlying philosophy of the two functions. Function A is a purely market-based performance assumption, so if the market is doing well and the value of your guarantee is not increasing, we don't see any increase in dynamic utilization. In this case, Function B is a blend between market performance and pure income protection. Pure income protection would say that people will utilize the withdrawal benefit purely because they're getting old and they want to make sure they're able to maintain the value of their annuity. So you can see a pretty big difference in the steady-up. In the steady-down, they both perform similarly because it's a blended approach. Then you can see that when it goes up and down, or down and up, there's a pretty big difference in terms of the outcome of the function. This example is intended to show that you could have different beliefs in how you think the market or your clientele is going to react; you just want to make sure that your dynamic function, when you look at it after you run your deterministic scenarios, is something with which you're comfortable.

Chart 4 is' an example for a dynamic lapse. –My guess is that everybody in the room has this programmed in already. This case looks at how much your guarantee is in the money. Clearly, if you have no account value left, nobody's is going to lapse, because they're in the money. It's guaranteed that they're going to get their payments. –When it's at the money at 1 or greater, you see there's a slight difference in terms of dynamic lapse. But these two functions are a little more similar. One chooses linear; The other is more of a curve. But this is something where we have a lot more experience.

The next item I want to discuss is scenario generation types and uses. There are two basic types of scenarios. You have realistic or real-world scenarios, and you have risk-neutral scenarios. The realistic or real world is what you would see or what you would expect to happen as you move through time. These would be something that you'd observe. Examples might be the American Academy of Actuaries' 10,000 scenarios. Those are realistic or real-world scenarios. Risk-neutral scenarios, on the other hand, are used for valuation purposes. For asset valuation, for hedging or whenever you want to come up with a fair value, you need to use a set of risk-neutral scenarios. What they do is maintain the structure of the forward rates in the scenarios that are projected. So they're different. Each has its own

separate generator. Depending upon what you want to do, you either need the realistic or the risk-neutral, or you need combinations of the two. If you want to get the market value of your assets, you'd have a risk-neutral set of scenarios. These might be provided by your investment department. You might have a tool to develop a risk-neutral set of scenarios and your asset characteristics. You could come up with your market value, and that'd be something you could observe as well.

Under nested stochastic (realistic with risk-neutral for valuation), if you're doing a hedge strategy analysis, you're going to need to do that type of work. So you'll have a realistic framework, and then along the path you're going to need to, on the fly, develop risk-neutral scenarios.

What is nested stochastic processing? This is also referred to as stochastic on stochastic. Steve showed us Chart 1 that has the underlying fundamentals in it. In simple terms, you could think of it as you have two things that are operating. One is your experience path, and that's the path that you're projecting. If you're thinking of a path where you have an 8 percent return, after one year your account value to your market might have gone up 8 percent. At that point, you need to run a set of stochastic scenarios. Maybe it's 1,000 or maybe it's 10,000. You're going to collect the results for whatever variables that you really care about over that set of scenarios, you're going to bring that back to the experience-level scenario, and then you move on to time two.

Another type of nested stochastic processing is realistic with realistic. 'If you're doing a GAAP projection, and you cared how your SOP 03-1 reserve might change over time, you'd want to use realistic-with-realistic nesting. If you wanted to forecast how your RBC C-3 Phase II would change over time, you would also use this type of approach. To see what would happen with a hedge strategy analysis, you'd want to use realistic with risk-neutral for valuation. ––You'd have your set of scenarios that you cared about in terms of what's going to happen in reality, and then at each point you'd have to generate a set of risk-neutral scenarios on the fly based on the interest rate environment that was in effect at that valuation point. One of the keys is that you're going to need a tool that lets you move through time. When you get to a valuation point, you're going to need to be able to create a new set of risk-neutral or realistic scenarios (depending upon what your use is), calculate the variables that you care about, bring them back up to the experience scenario and then move to the next point.

You' want to think about how you validate this. How do you know that you actually set up something that works? Having a deterministic scenario that you're comfortable with is key. You can set up a brief example with only a few scenarios in it and just make sure that at time zero everything works. You roll it forward to time one, and you run a couple scenarios to make sure that your value at time one is consistent with your time zero evaluation if you moved it forward a period and then ran it. There are ways to validate to make sure that you've set up your

process correctly. It's something you'd want to do before you kicked off 10,000 runs or 1,000 times 10,000 or anything of that nature.

The next topic that I'm going to discuss is RBC C-3 Phase II and the stochastic approach. Vincent talked about this already with the proposed AG 39. The key here is that you want to start with the deterministic model that you validated. You need to get the scenarios from the American Academy of Actuaries and move those into an environment that your modeling tools can actually handle. That isn't necessarily a trivial exercise. The process is 'that you're going to determine the initial assets and liabilities at that point in time. Then you're going to calculate the statutory surplus at each interval and then calculate the additional amount of assets that are required under each scenario. At each point in time, you're going to figure out what the surplus is. You're going to discount that to time zero or to the valuation point. You're going to take the least value from that set. The negative of that value ' would be the additional assets that are required. We'll add that to the initial assets to get our total assets that are required, and then we take the CTE 90 on the total assets. Then you've got your last step where you calculate the RBC, which is the total assets that are required less the statutory reserve. So at a high level, that's the way the calculation is going to work.

If you wanted to forecast what's actually going to happen with your C-3 Phase II over time, you need to build in a nested process. You'd want to be able to move through time, and whatever your capital market experience has been up to that point, it's going to change your C-3 Phase II capital requirement at that point. As we move through time, if we have poor experience, our reserve is going to be relatively higher than if we had good or positive experience. So, the way to think about this is that we've moved through time. If in the first year our equity returns were negative 30 percent and as a result all of our guarantees were in the money, we've had a big capital requirement that has come into play. We can contrast that with real positive experience, which would show that a minimal amount of additional capital would need to be set up in those scenarios.

Another use of the nested stochastic processing is VA hedging. There are a lot of different sessions –that talk about this, so I'm going to talk at a high level here. I'm only going to talk about one piece, which is the calculation of the liability Greeks. Once again, we'll start with a model with which we're comfortable. We'll generate the set of experience scenarios that we care about. At this point, it could be several scenarios if you're just exploring what might happen, or it could be "Here's the set of scenarios that I think would give a realistic representation over time." Maybe it's the set that your investment department is using for purchasing assets. Then, at each point in time, the capital market is going to move across the experience scenario. Based on the interest rates that are in effect at that point in time, we have to generate a set of risk-neutral scenarios. In this case it isn't just one; it's going to be seven, nine or 11 sets. It's going to be a lot of risk-neutral scenario sets, each set being, say, 1,000 scenarios.

Your baseline is going to take your interest rates that are in effect at that point, And it's going to generate a set of risk-neutral scenarios. Then you will need to generate the shock. That might be the shock to the S&P 500. What happens if your volatility parameter changes? What happens if your interest rate parameters change? With each going up and down? That would create another six sets of 1,000 scenarios. So we run that set of 7,000 scenarios at that valuation point. We bring that back to present values, and we can calculate the liability Greeks at that point. Then we'd move along the path to calculate what the liability Greeks would look like at each point. The same set of scenarios would need to be used by the investment department or as you model your assets in your hedge to determine what the breakage might be, what the mismatch is. What are your hedged results actually going to look like?

The last topic that I'm going to talk about is ideas on how to improve run time. An obvious one is just buy a better machine. With the change in technology now, there's probably something on the market that's bigger and faster than the machine you bought a month ago. Keeping up with your technology can definitely help improve the run time. Another idea—a lot of companies have already employed this—is to implement a high-performance cluster or high-performance computing processing environment. You could think of this as just a bank of computers where we could kick off a job from one computer, it can distribute the calculations to the different computers and then re-aggregate the results. I'm not a systems person. I couldn't tell you how to set it up, but it's definitely something we've seen in practice. We use it internally and it works pretty well. You get orders of magnitude improvement in run time.

There are ways to optimize your model to improve run time. Think about minimizing the times that you read and write to your hard drive. An example that would fit here would be, what output do you really need from your model? Rather than saving everything, if you only care about a handful of values, just write out that handful of values and don't bother printing everything else out. Print everything when you need to validate one scenario or a small set of scenarios, but when you're running 1,000 or 10,000, only spit out the values that you really need.

As far as what information to keep in memory or in the active memory, what we've seen is that at certain times your random access memory (RAM) can become a big obstacle. Once you exceed your RAM, then you're going back and forth to your hard drive. There' are ways to set up the model to minimize the data kept in memory. If you can do a calculation recursively, you only need to hold maybe the last period and this period's value. Another way to set it up would require you to hold every single value, and when you're running 1,000, 10,000 or 70,000 scenarios, that becomes pretty important.

Another way to optimize model design is to reduce the model size. Vincent talked about this. We can go through and shrink down a liability population to a more manageable amount for scenario generation. One of the practices that you might

want to think of is, is there a minimum size that you would require for a bucket? I've seen different companies go through a process to generate a modeled book, yet 15 percent of their sales have 90 percent of their business or 20 percent has 90 percent or 80 percent. You find that most of these sales are really small. They only have a small handful of policies, maybe five or six policies, and a small amount of account value. You don't want to lose that information, but you could re-map it to one of the bigger buckets and just go through the validation process. You might be able to drastically shrink the size of your model and still have something with which you're pretty comfortable.

The last way to optimize model design is to employ some sampling techniques. In this approach, if you've run a set of scenarios at a certain time, and you know that you can pick your 100 or 200 that are the worst out of the 10,000, you can sample out of the set. If all you care about is your tail, then you can just sample the worst in the tail, if you've already done one run and you're pretty comfortable with that or if you're doing some sort of sensitivity testing of that.

Identify different time-intensive calculations that might not be necessary or things that you can approximate. If you're calculating liability Greeks for hedging, you probably don't need to have the proposed AG 39 CARVM logic in place, because you're not going to care about that in generating the cash flows for the liability Greeks. It's just another thing that's going to slow down your run time.

The last step is, at what frequency do you really need to calculate your cash flows? If you're doing something for planning maybe you need monthly for the next year, but after that it's an annual number that senior management cares about. You'd want to make sure that you're running annual projections of, say, your liability Greeks or your FAS 133 reserves or SOP reserves, possibly rather than doing it monthly. You're going to get the same result once you collapse it to an annual number.

Those are some general things to think about. One other thought, just to wind up, is that as you think about what you're trying to do from a stochastic model or stochastic run, and you match that back to your goal or objective, you're going to come up with a different model depending upon your answer. One thing that we as actuaries need to be conscious of is that for each purpose there's probably the "best" model, but the "best" model isn't the right model for every purpose.

MR. RICCI: One thing Ben touched on, as well as Vincent, is that a large part of the artistry that is in the whole modeling process has to do with determining what the important items are versus what can be more or less aggregated or simplified. This is particularly an issue with variable annuity-type guarantees, because you can get a tremendous amount of aggregation there if you don't intelligently go through that process. Do you want to comment at all on that, Vincent?

MR. TSANG: I think one of the most common mistakes is to combine two contracts, one of them having a GMDB or VAGLB in the money with one of them that's out of the money. By combining the two, everything is fine, so you don't have to do anything. You have to be aware that at the end your risk profile is not reduced. The model validation is a key point. I highly recommend that a company first separate the in-the-money policies from the out-of-the-money policies, and after that, do the modeling from that perspective, so that you can minimize the unnecessary upsetting.

MR. RICCI: Yes, the degree of in-the-money-ness is a critical element. I remember modeling 60,000 policies, looking at it on a seriatim basis and then doing aggregations. Even with trying to be extremely specific about the in-the-money-ness, you have a higher level of requirement involved in terms of the scenario percentiles when you do an aggregate basis. It may be that even with intelligent grouping, you may still need to apply some kind of an additional factor to bring it up to what might be considered a more reasonable level.

MR. TSANG: Yes. Another comment I would like to make is that a lot of companies have the GMDB and VAGLB. They try to be innovative and differentiate themselves from the other competitors in the industry by having some really creative VAGLB. Your valuation system may be able to be modified so that you satisfy that, but when you go to a projection system, your projection system may not have all these bells and whistles, all these complicated VAGLB and GMDB for you to model. Besides looking at modeling yourself, you also should look at the software that you're going to use to see whether it can support your company's product in the projection, so that you can come up with a minimal reserve.

MR. RICCI: Another issue might have to do with policyholder behavior after something becomes extremely in the money. It may be that your general account is so much your friend at that point that you take all the variable money and then put it into the general account to, in essence, freeze the amount of accruals from that point on. You've basically frozen the amount at risk, and you're on the hook for that amount going forward.

–We've referred a number of times to the Academy scenario generator. Is everyone familiar with this generator? It's based upon regime switching and asset type, right?

MR. TSANG: Yes. If you read the VA CARVM or the RBC Phase II, there is a section that talks about how they came up with this parameter for the generator. What they are trying to do is use the historical equity volatility and the interest rate for the last 30 years to come up with a parameter and then use that to generate the future interest rate in the equity scenarios. The question I have for myself is, how often does history repeat itself, especially when you talk about equity? Are we going to see the 1990s again? Probably not. One of the weaknesses in this 10,000-

scenario generator is that it was based on some historical data. It may not be based on the current marketer's prediction of what is going to happen in the future.

MR. RICCI: Well, they went through a second set, and they used different periods of time. The regime switch is interesting. Most people consider it to be an improvement over the lognormal process, and I guess it is, in estimating the fatness of the tails or whatever.

MR. TSANG: Yes. I think that regime switching was first introduced by Professor Mary Hardy of University of Waterloo, my alma mater. It is supposed to be able to track the historical equity return a lot better. The linear lognormal model was primarily used for Black-Scholes calculations of the call and put options, but there's no need to stick with the linear lognormal because that is really useful for valuation purposes only. The regime switching is just another way of looking at the equity risk. Personally, I believe the regime switching with two regimes is a much better model to look at the equity risk, but if you want to do a valuation using the regime switching with lognormal, it can be done, too. The actuary should come out having the same answer, because it's impossible that an option would have two different values depending on which model you use. They're supposed to be the same.

MR. ROBERT J. LOLANDE: I've never calculated one of these reserves using 10,000 stochastic scenarios. If I were to issue a policy—let's say it's a policy with a guaranteed maturity accumulation benefit, which seems to produce some healthy reserves, or we can do either one—and I run through these 10,000 scenarios, what kind of reserve am I going to get on the instant of issue? Am I going to get 100 percent of the accumulation value, or am I going to get something less than the accumulation value because I'm getting some kind of discounting process, or am I going to get something more than the accumulation value the day I issue it? I've seen the chart, where if you have a 30 percent drop, it looks like you could take a big hit. You'd have to put up more reserves. If you could all kind of describe that process, I would appreciate it.

MR. TSANG: Let's assume that you sell a block of brand new VA contracts with GMAB. Your question is, what kind of reserve am I expecting at time zero? Should it be cash value? Account value? Somewhere between the two or even higher than the account value? I don't think I can give you a discrete answer, because the reserve amount depends on your charges for the GMAB. If you have a mispriced product such that GMAB M&E charges are very low, then you are going to hold a lot of reserves. But if you price it in a way that the GMAB actually will bring you some profit in the future, you probably will be holding closer to cash surrender value. So it depends on how you price the M&E charges for that feature. Normally, it should be priced in a way such that the reserve will be close to the cash surrender value rather than much higher than the cash surrender value.

MR. RICCI: Would anybody like to comment on what they feel to be the future of regulatory activity in this? Is modeling going to play a greater role or a lesser role?

How can we bring the regulators on the side of the process? Is there something we can do as actuaries to help educate those that are looking for our guidance?

MR. STROMMEN: If there are no comments from the floor, I'll say a few words. I think there's no question that modeling will become a bigger part of our work in the future, just looking at the direction of statutory reserving, looking at the direction of the International Accounting Standards Board and the FASB, which is saying they will move in the same direction, toward some kind of a fair value framework. As modeling becomes a larger and larger part of the work we do, I have a little concern that our profession as a whole needs to upgrade our level of education on some of these techniques. With regard to the misconception and the error that I mentioned in my presentation, I have heard them coming from some very high-ranking actuaries, very experienced people. These are fundamental concepts that I think need to be more widely understood within our profession. I think we have a lot of work to do to come forward and be able to take up the mantle, as it were, of doing this kind of work.

I have a related question. I'm just curious. As we talk about building these models, I know that most companies tend to use commercially purchased models. I'm wondering how many people in the audience also build models on the side because the commercially available models don't always handle new product designs and the new kinds of issues that are coming up. How many people build their own models from scratch for some purpose or other related to valuation or projections? There are a number of hands, but a minority anyway. That means that we are relying—this doesn't surprise me—on commercial vendors for many of these models. I think it's important that we keep them up to date and make sure we demand of them what we need.

MR. MICHAEL P. SPARROW: What are your thoughts on the issues, particularly with C-3 Phase II, and the modeling of hedging strategies within the projections, especially with complex dynamic hedging strategies that are necessary to be employed in order to get RBC credit?

MR. STROMMEN: At a point where there's a big shift in market or there's a shift in regime, something similar to October 1987, is the market going to be able to trade continuously so you can actually make the trades that you need? How would you reflect the trading cost with that? I'm not up to speed with the details of C-3 Phase II and how the hedging is rolling into that. One of the questions that I would raise back at that would be, however they roll that in, they would need to take into account if you went back to certain points in time, would you actually be able to employ the trading strategy that you're proposing in different market environments, or are there any discontinuities that might prevent that? I'm not sure where the task force actually is and what they've decided on how to do that.

Chart 1

Calendar time vs. Valuation time

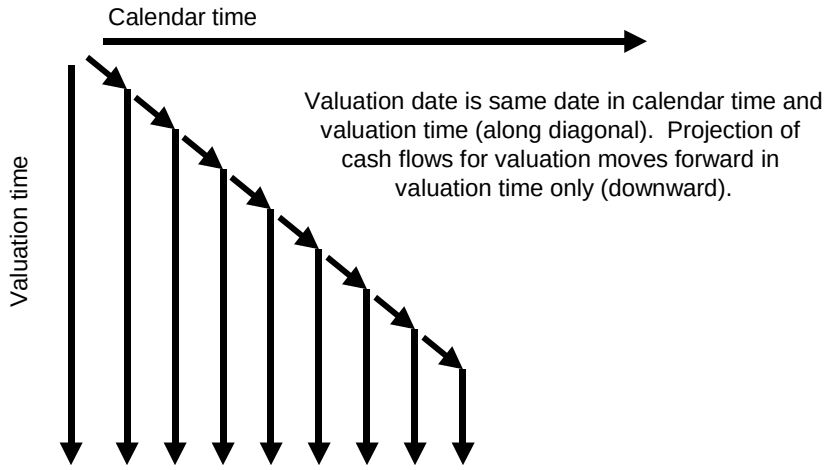

Chart 2

Reserve as Percentage of Cash Surrender Value

Stochastic Results Only, Results of Standard Scenario Not Shown
Cash Surrender Value is the Reserve Floor

All Deposits Are Invested in Equity Type Investments

			GMDB Roll-Up Percentage		
GMDB	GMAB	GMDB/AV at Valuation Date	0%	4%	6%
Yes	No	Out of the Money 80%	100.33%	100.35%	100.43%
Yes	No	At the Money 100%	100.48%	100.63%	100.84%
Yes	No	In the Money 120%	100.70%	101.02%	101.41%

			GMAB Roll-Up Percentage		
GMDB	GMAB	GMAB/AV at Valuation Date	0%	4%	6%
No	Yes	Out of the Money 80%	100.98%	102.86%	106.87%
No	Yes	At the Money 100%	102.78%	106.42%	113.07%
No	Yes	In the Money 120%	105.48%	111.17%	120.82%

80% of Deposits Are Invested in Equity Type Investments and 20% in Fixed Income Securities

			GMDB Roll-Up Percentage		
GMDB	GMAB	GMDB/AV at Valuation Date	0%	4%	6%
Yes	No	Out of the Money 80%	100.00%	100.00%	100.00%
Yes	No	At the Money 100%	100.00%	100.00%	100.00%
Yes	No	In the Money 120%	100.00%	100.00%	100.00%

			GMAB Roll-Up Percentage		
GMDB	GMAB	GMAB/AV at Valuation Date	0%	4%	6%
No	Yes	Out of the Money 80%	100.00%	100.25%	103.63%
No	Yes	At the Money 100%	100.00%	101.36%	106.22%
No	Yes	In the Money 120%	100.11%	102.81%	109.32%

Chart 3

Dynamic Utilization

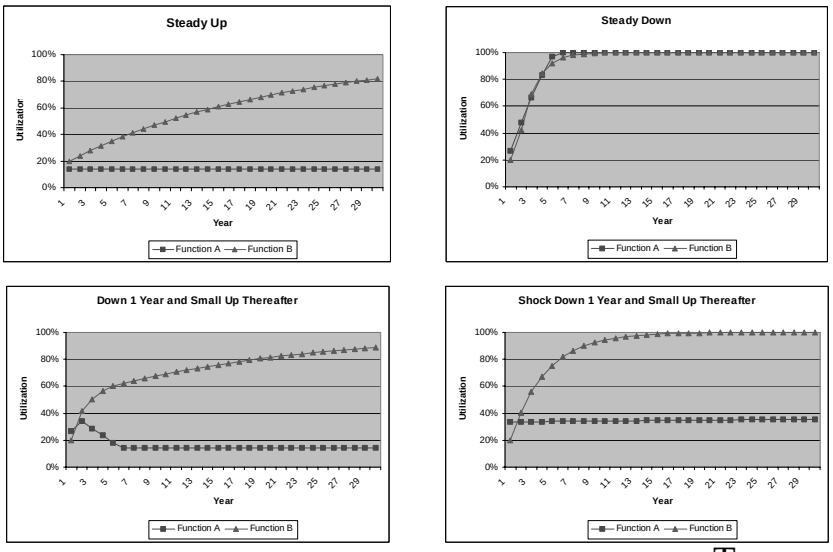

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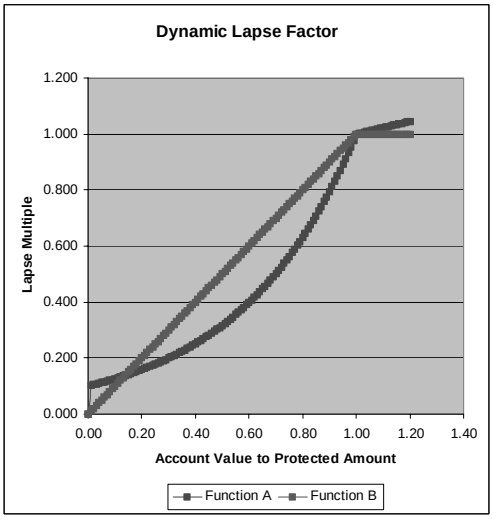
Chart 4

Dynamic Lapse



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