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Cash-Flow Testing Issues for Equity-Indexed and Variable Products

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Summary: Presenters identify issues and challenges faced by the valuation actuary when performing cash-flow testing on equity-indexed and variable products. Solutions and sources of information for implementing solutions are discussed. Attendees will gain an understanding of the methods used by practitioners to resolve issues involving:

- *Deciding when cash-flow testing is necessary and/or appropriate—the choice of models to generate equity paths*
- *Identifying sources of assumptions needed to run the models*
- *Use of the model results in cash-flow testing*
- *Setting assumptions for policyholder behavior*

Mr. Larry Gorski: It may be a little strange to bring a general-account product and separate-account product together in one session, but there are at least some similarities between some of the new products with respect to variable annuities and equity-indexed annuities (EIAs), so it makes sense to talk about them from a cash-flow testing standpoint. Our two speakers are Alan Downey and Noel Abkemeier. Alan is an assistant vice president and appointed actuary at Keyport Life Insurance Co., an ASA, and a member of AAA. He is responsible for statutory, GAAP and federal income tax valuations, and financial reporting. He is a noted authority on EIAs. Noel is an FSA and a member of AAA. He is a consulting actuary at Milliman & Robertson in Chicago, specializing in product development with a principal focus on annuities. He is a member of the AAA's Equity-Indexed

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

Products Task Force. That was the task force responsible for working with regulators in developing actuarial guideline ZZZ and ZZZZ. He is also a member of the AAA's Variable Annuity Guaranteed Living Benefits Task Force. He works extensively with equity-indexed products (EIPs) and variable annuity guaranteed living benefits (VAGLBs).

Mr. Alan R. Downey: I'm going to speak about issues pertaining to cash-flow testing of EIPs. My presentation will specifically address EIAs, the area in which I am most familiar. And, as you're probably aware, Keyport Life has the largest cumulative market share at this point in EIAs.

First, I'll briefly touch on the appropriateness of using cash-flow testing for EIAs. Then I'd like to get into some of the various modeling issues associated with cash-flow testing, some of the assumptions that you would want to use and should be using in your model, and finally go through some results of a case study that I put together. It's not an extensive case, but it gives you a flavor for the types of analyses you might begin to do.

It is appropriate to cash-flow test EIAs. And, for purposes of asset adequacy analysis I think the general rule of thumb is that you don't want to exclude any more than 5% of your total reserves from your asset adequacy analysis. If you do, then you probably are exposing yourself to a little bit more risk from an actuarial opinion standpoint than you should be.

Risks for EIPs are still not completely understood, in general. (I'm going on the assumption that everyone is familiar with Actuarial Guideline ZZZ, or Guideline 35.) And, if you're using the so-called enhanced discounted intrinsic method (EDIM), you may want a lower threshold, in spite of the fact that EDIM does have the hedged-as-required criterion. A higher threshold may be more appropriate under the market-value method.

Another reason that cash-flow testing would be appropriate—in fact it would be mandated—would be if a regulator requests a Section 8 opinion, which requires the actuarial memorandum supporting the opinion. In our case, we're required to submit the actuarial memorandum or at least draft the actuarial memorandum and have it available for submission if insurance departments so desire because of the size of our company. But state regulators can request a Section 8 opinion and a memorandum at any time.

Other analytical methods exclusive from cash-flow testing I'm not sure are entirely appropriate. If anyone disagrees I certainly would like to hear that, but I'm not

aware of any other methods that will adequately analyze the various risks associated with EIPs.

There are several modeling issues I'd like to go over. This is by no means an all-inclusive list, but I'd like to touch on issues such as portfolio segmentation, i.e., what you do with the portfolio in terms of how you allocate your fixed income and hedging assets to your EIPs if you do it at all. Then I'll touch on the hedging strategy, on various types of modeling software, and perhaps on issues involved with that. Then I'll touch on generating economic scenarios.

With regard to segmenting your portfolio for fixed income assets, if you have a formal segmentation of your fixed-income portfolio—formal in the sense that there are internal documents or something of that nature that dictate that you are investing in the portfolio to support EIAs—you really have to allocate those segmented assets to your cash-flow testing. You cannot, at least in my view, select other assets from the portfolio to do that.

If you don't have a formal segmentation process, the question might be, "Do you do cash-flow testing of your EIPs separately?" We've actually done that and, in doing so, we allocated our fixed-income assets in a manner that is similar to the overall distribution of the portfolio, but that also takes into account any potential limitations in the various models that we use.

Finally, if you have equity-indexed derivatives and they're part of your hedging strategy, you clearly have to allocate those for cash-flow testing purposes.

In terms of your company's hedging strategy, option replication is not necessarily trivial to model. There may be some product that is easier to model, but our particular product, which is the look-back product, is by no means an easy thing to replicate. Your dynamic hedging strategy should at least delta match the assets and liabilities. You may need or want to match other of the "Greeks" to hedge some of the other risks, such as volatility and interest rate risk, as well. You want to consider the effect of any projected decrements in your model. It occurred to me that, if you have a model that does not properly consider option replication in the context of the hedged-as-required criteria and your hedging strategy is not consistent with what you're actually doing, then you may end up in a situation where you violate, on a projected basis, the hedged-as-required criteria. Then, theoretically, you would have to project reserves going forward using one of the market-value methods, either the commissioner's annuity reserve valuation with updated market values (CARVM-UMV) or the market value reserve method (MVRM). So, in that sense, it's very important that you model your hedging strategy as closely as possible to what

you're actually doing on the assumption that, if you're using EDIM, you want to be hedged as required.

Modeling software is available from several different types of vendors. On the asset side, the Wall Street firms obviously can provide a number of different types of software to value assets and options. Then, on both the asset and the liability perspective, you can get commercial software from various actuarial consultants. Obviously, PTS and TAS are the most well known. Finally, you can develop your own models internally, but that will require a significant amount of internal resources and, if you don't have those resources, it's probably not cost-effective.

The type of modeling software you'll select depends upon the materiality of your block of business. If you don't have much business, you may just choose to ignore it. Also it depends on the sophistication and the robustness you require in your modeling. It depends on the expertise of the person who is developing a model. And, finally, perhaps the most important consideration is, how much it is going to cost. For the type of software we're dealing with, it can be somewhat costly.

Next I'd like to get into the topic of generating scenarios. For interest-rate scenarios it's really not any different from what you're doing now. The typical models that are available in the actuarial and other investment literature are lognormal types of models which have mean reversion.

For equity-index scenarios, we developed and use a lognormal model, although we didn't feel that mean reversion was necessarily an appropriate thing to incorporate into our model. You may or may not want to correlate your equity- index scenarios with interest-rate scenarios and there are actually two ways of doing it. One is to model your equity-index scenario as a direct function of interest rates. Obviously you'd want to base, or at least validate, your equity-index scenarios against historical returns and volatility.

I'm not aware of a lot of regulatory guidance pertaining to the application of equity-index scenarios to the New York 7. I know there are a couple of states that have adopted scenarios such as up 20%, flat, and down 20%. We produced what amounted to an equivalent of the New York 7 by assuming that the level scenario is an 8% annual increase in the equity index. The pop-up scenario is a significant pop-up of 56% and then it reverts to the "level scenario" of 8%. The pop-down is essentially a crash of 40% and then it goes back up to 8% again. In deriving these particular scenarios, I essentially assume that the interest-rate volatility that was used in developing the New York 7 was approximately 1% and that equity-indexed volatility is correspondingly approximately 16%. That is essentially how I got those particular scenarios.

The number of stochastic scenarios that you need is dictated by practical considerations. How long you have to run them, the volume of results, and the amount of results that come out of these models can be voluminous, to say the least. The results themselves can have an impact. If you, for example, run 20 stochastic interest-rate scenarios, pass them all, and feel comfortable with that, then you might be okay, whereas, if you only passed, say, 16 of those 20, that's probably an indication that you want to run more.

In terms of generating stochastic or semi-stochastic scenarios, there are methods where you can predetermine the path class. That is analogous to the Ho-Lee model and other types of approaches that essentially apply variance-reduction techniques and therefore reduce the number of scenarios that you would need to run, as opposed to running it in a strict Monte Carlo type of environment.

I'd like to touch on the various model assumptions that you'll need to look at in terms of cash-flow testing for EIPs and EIAs specifically. With respect to the various equity-index parameters, the first parameter is the return of the S&P 500, and I specify the S&P 500. You can certainly generalize it to be a return of any equity index. But the return of the S&P 500 has historically been around 8.5% since the early 1970s. I haven't actually done a calculation of this, but my impression is that, since October 1987, when the market crashed, it's been closer to 13–14%, and perhaps even higher. For purposes of cash-flow testing, you don't want to use a 13% assumption for the return of the S&P. I think you want to be conservative and use something in the 8–10% range.

The volatility of the S&P 500 has historically been around 16% since the early 1970s, but ,again, in the last couple of years it's been extremely high in probably the 25–30% range, on average, and during the crash of 1997, I think implied volatility went as high as the low 40s.

In terms of cash-flow testing, it may be appropriate to grade from whatever current volatility is to historical levels of volatility over some reasonable period, say three to five years. And sensitivity testing of this parameter is very important, particularly in light of what the environment has been in the past several years.

The dividend yield of the S&P 500 also has a surprising effect. Historically, the dividend yield has been roughly around 2.5% since the early 1970s, but in recent years it's been much lower. It's been running the last two or three years at around 1.5%. Again my feeling is similar to what you would do with volatility. You want to grade back to historical levels over the next three or five years and do a sensitivity

test of this parameter as well. Some good sources of historical data would be Bloomberg and any studies from Ibbotson.

In terms of your reinvestment strategy, when modeling assumptions with fixed-income assets, you want to consider whether or not you're formally segmenting the portfolio as we described earlier. You want to consider dynamic strategies, although they are more difficult to model, but the results should be better than for those that are fixed or non-dynamic, based on the assumption that your investment people have a good handle on what they're doing in terms of hedging the fixed-income side of the portfolio and your fixed-income product.

In terms of hedging instruments, you want to model options and futures to the extent that they're incorporated into the hedging strategy. I think the modeling has to be realistic and done in such a way that, if you're using EDIM, you have to be hedged as required.

In terms of participation-rate strategies, they should be reasonably consistent with what you're using for pricing, and perhaps somewhat conservative because this is cash-flow testing and asset adequacy analysis that you're considering. The strategy is going to be dependent on interest rates and the various product design features, such as the type of product you have, whether it's a look-back or an Asian or a ratchet, whether there are caps and floors, and various other types of design features that might affect the participation rate. Also, volatility and dividend yield are going to have an effect on how the participation rate is ultimately priced.

Several factors that drive up option costs will tend to reduce the participation rate. They are lower interest rates, higher volatility of the equity index, and various aspects of the product design. For example, a look-back design is going to result in a higher option cost and therefore a lower participation rate.

Policyholder behavior is probably the most difficult of all the aspects to get your arms around, particularly because EIPs are new, and there really isn't a lot of experience with them. We introduced the EIA product almost four-and-a-half years ago. Our product was primarily the five-year look-back product, and we haven't had a lot of surrenders at this point. Quite frankly, we don't know what's going to happen when these policies start crossing their fifth anniversary.

Various aspects will affect surrenders. Base-level surrenders will be driven by policy liquidity, product design, and renewal commissions. Dynamic surrenders will be affected by those same three categories in addition to how interest rates have changed, how the equity index has changed during the current term, and burnout. Burn-out is essentially a phenomenon where you have policyholders remaining with

the current block who are relatively insensitive to interest rates or equity-index level because of the fact that almost everyone who is sensitive has already left.

As I mentioned before, we don't have much experience today. It's been predominantly a bull market. We've yet to experience a sustained downturn in a broad-market sense. There are some sectors of the market that have experience in downturns but, for the most part, it's just been a raging bull market for the last four years. Our experience has generally been in the 1–2% annual surrender rate range and, again, sensitivity testing is critical with regard to this particular aspect.

The worst-case scenario is essentially where the index tanks and you have a sharp increase in interest rates for policies that have just been issued, and the index credits have not yet vested. There's not really any particular incentive for the policyholder to stick around, so you probably want to try to figure out a way to incorporate that into your models. However, the crash of 1997 seemed to indicate that it had very little effect, at least on us. Perhaps the reason for that was that the market shot back up very quickly, but I think we were somewhat surprised that we didn't have more people leave at that point.

I guess we've reached the point where we can look at the small case study that I did. It's not particularly detailed but I think it gives you a flavor for the types of things that you want to look at and perhaps some of the results that you might see. EIPs are so many and varied that the results you would get from a look-back approach are not necessarily consistent with what you might see for other products, but it might give you a flavor for what you would be looking at.

The model that we used was designed by Genesis Development Corp., which we've consulted with for the past four years in developing our EIPs. The product design we're looking at is our typical five-year look-back, 20% annual vesting of index credits. Death benefits are vested in full and the minimum cash value is the minimum standard nonforfeiture value of 90% of the premium accumulated at 3%.

I assumed that we were going to have premiums of $1,000 a month for 12 months and Treasury yields at 5%, 6%, and 6.5% for short-, medium-, and long-term periods, respectively. The S&P 500 starts at 1000 and increases 8% per year. Volatility is 16% per year, the dividend yield is 2.5%; and the participation rate is 75%. And we are assuming the statutory reserve is starting at 95% of the premium.

I've used for purposes of this model the New York 7 interest rates and the New York 7 equity-index scenarios that I discussed earlier. I assume that volatility will continue at 16% and that the dividend yield will continue at 2.5%.

Renewal participation rates are linked to the five-year Treasury at the start of the term. There's no cap, the floor is 0%, and they're based on volatility levels of 16%.

Base surrenders are at 2% per year, with a 30% shock lapse. Interest-sensitive policyholder behavior is based on the increase in interest rates from the beginning of the term times a remaining term and times an early-term adjustment, which is there due to the disincentives that agents have of surrendering or encouraging surrender early on because of commission chargebacks. Then that's all divided by the effective surrender charge percentage, which is essentially the cash fee, or account value minus the cash value divided by the account value. Excess surrender is graded from 0–30% as the factor above grades from 125–175%, and interest-sensitive surrender has become zero in subsequent terms if a surrender charge goes below 4%, due to burn out.

The equity-index-sensitive policyholder behavior is based on decline of the index since issue. If the index has increased, there will be no excess lapses. The decline range is anywhere from 0–30%, and excess surrender is over and above the interest-sensitive surrenders and grade from 0–10%.

The hedging strategy that's assumed in the model is a delta match of the asset and liability options. We buy or sell one- and five-year European calls to delta hedge, and the options are held to maturity.

Fixed-income reinvestment strategy essentially is noncallable corporate bonds, NAIC Class II, essentially single A or BBB, and the strategy is designed to minimize the mismatch of partial durations. Bond sales are limited on a monthly basis. I believe they're limited to 5% of the bond portfolio, and reinvestment of the fixed-income assets only occurs after you purchase the options that are necessary to hedge the equity-indexed part.

For purposes of the case study, I focused on economic surplus at the end of 10 years. The main criterion value that we use is asset adequacy analysis. At Keyport, naturally there are a number of other considerations, including aspects of statutory surplus and, in particular, interim values of statutory surplus and economic surplus. I call it "economic surplus." It's probably more appropriately called "liquidation value." The cash value of the liabilities is not the market value of the liabilities.

You can see in Table 1, of all the stock scenarios generated, the worst by far is scenario 5. That's the scenario in which you assume the equity index does not change at all for the entire period of the projection, so essentially your options are going to expire worthless or close to worthless. But even before they expire, the values will not be significantly high and, for the most part, you're going to be in a

situation, particularly in a low-interest rate environment, where you may end up with some significant strain on surplus. These results are a little bit higher than I might have expected in the context of the runs that I did. However, I think they give you a flavor for the potential variances between the various scenarios which have been run.

TABLE 1
CASE STUDY – RESULTS
Economic Surplus = MV of Assets – CSV of Liabilities
At End of Projection Period (10 Years)

Interest Scenarios	Stock Scenarios							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**Avg**
1	3840	3813	3242	5334	2382	3478	3609	3671
2	3890	3752	2620	5486	2404	3288	3507	3564
3	4529	4628	3727	6386	2871	3450	3639	4176
4	4291	4219	3303	6379	2707	3194	3153	3892
5	3580	3846	3339	4876	2266	3147	3247	3472
6	3271	3153	2733	4542	2023	3102	2962	3112
7	3259	3513	2735	4036	2049	2985	3092	3096
Avg	3809	3846	3100	5291	2386	3235	3316	3569

I also ran some sensitivity testing results, changing the base surrender rate under three scenarios: halving it from 2–1%; increasing volatility from 16–21% and reducing the dividend yield from 2.5–1.5%. Table 2 shows that reducing the surrender rate doesn't have a lot of impact on the results. It does have some, but reducing or increasing volatility has a substantial negative impact, as does reducing the dividend yield.

TABLE 2
CASE STUDY – SENSITIVITY TESTING
Sensitivity Testing Using Stock Scenario 5
Economic Surplus = MV of Assets – CSV of Liabilities
At End of Projection Period (10 Years)

Interest Scenarios	Base Scen	Base Surr	Vol	Div Yld
1	2382	2333	2125	2183
2	2404	2357	2152	2168
3	2871	2869	2640	2621
4	2707	2684	2480	2450
5	2266	2224	2111	2136
6	2023	1951	1892	1913
7	2049	1987	1924	1938

Other assumptions you may want to test are your dynamic surrender assumptions for both interest-sensitive and equity-index-sensitive assumptions, your participation-rate strategy, and decrements such as mortality, asset default and expense as in your typical cash-flow testing type of sensitivity testing.

In summary, the cash-flow testing issues for EIPs are more complex than the normal cash-flow testing issues, which are complex enough. To a great degree, I think practice is still evolving in this area. One excellent resource is the *AAA Equity-Indexed Products Task Force Report*. That's an excellent resource I use to try to understand the various risks associated with the product. although it's not directly related to cash-flow testing, I think you really need to understand the implications of guideline 35, particularly the hedged-as-required criteria, if you're using the EDIM method. I can't emphasize that strongly enough.

Mr. Gorski: Next is Noel Abkemeier, who has a few words to say about formula reserves in addition to cash-flow testing for guaranteed living benefits (GLBs) on variable annuities.

Mr. Noel J. Abkemeier: Actually, there is a considerable difference between what Alan spoke about and what I'll speak about, insofar as the EIA products already in-force in the market. There are quite a few of them, whereas there are some GLBs on variable annuities in the market, but not nearly as many.

On the surface you may think there's a lot of similarity between EIAs and GLBs because, in both cases, you put money in, your returns are going to vary in proportion to the movements in something that's equity-based, and there's a floor of protection. So, on the surface, they sound like they're doing the same thing. When you drill down into them, though, they're very different animals. The EIA is a fixed annuity and you saw that woven through a lot of Alan's comments. It's a fixed annuity with a nontraditional way of crediting interest to it. In contrast, GLBs on a variable annuity are built on a variable annuity foundation and, although the results in many cases have similarities, it operates in a very different fashion. EIAs are call-option-based benefits. The GLBs on variable annuities are put-based benefits, just as your guaranteed minimum death benefit (GMDB) is, so they operate with different kinds of underlying options. As a result, a lot of the thinking in the products or in the cash-flow testing will differ between the two.

As Larry mentioned, I do want to build a foundation for us talking about the formula reserves for GLBs. You have to know where reserves are coming from before you start thinking about cash-flow testing. Also, I have a very brief comment on what is proposed for risk-based capital (RBC). This is coming out of the AAA. Then I'll get into the tricky aspects that you have to consider when looking at GLBs, and end

with a few words about other variable annuity cash-flow testing issues that are quite independent of GLBs.

On the proposed formula, which the AAA has put together, there has been a presentation to the Life and Health Actuarial Task Force of the NAIC and there will be another one at the June 1999 meeting. The concepts are becoming clear, but the details have not all been worked out. What has been done so far focuses most heavily on guaranteed minimum accumulation benefits, which are the simplest of the living benefits, and their concepts, such as to how to expand into guaranteed minimum income benefits. But there may be some unknown turns in the road between now and when something comes to fruition.

On what is proposed, the target is to have some kind of guidance that companies can use at the end of 1999. It's too late in the calendar year to really get an official guideline out of the NAIC. That will happen during the year 2000 and will be carved in stone for year-end 2000, but right now what is being proposed and what has been looked at a little bit by the NAIC is intended to give some guidance about what you should do this year-end to stay on the good side of your regulator.

As a starting point, I'll spend a few minutes describing the GLBs that are common in the marketplace now. And insofar as the vast majority of you don't have these products, it's good to put a few foundation stones in place. In brief terms, guaranteed minimum accumulation benefits (GMAB) guarantee that the account value at a specified time will be no less than a specified amount. There are a couple of specified variables. The guarantee period could be anything, but five to 15 years is a common range. So at the end of, let's say, 10 years, there is a guarantee that you'll get some kind of floor-protection benefit. There are only a few GMABs in the market right now, but the guarantee amount tends to be a percentage of premium, such as 90–110%, so it's kind of a return of premium benefit. Conceptually, it could also be a maximum anniversary value benefit. There aren't any like that now, but sooner or later one's sure to show up. That happens with this kind of product evolution.

With the GMAB, it's probably going to be an automatic one-time benefit so, at the end of 10 years, we guarantee that you'll get the return of your premium. If your account value hasn't made it to that amount, we will top it off to bring it up to that amount. There are other designs that could have other frequencies of utilization, such as making them contingent on events such as when you surrender or if you're hospitalized or something like that, but those don't exist right now.

If we go to its running mate, the guaranteed minimum income benefit (GMIB), this benefit guarantees that the amount available for annuitization at a specified rate

after a specified time will be no less than a specified amount. Once again, the waiting period most probably is going to be between five and 15 years before you can utilize this benefit, and it's possible that the contract will say that, in no case, can you use it before age 60, which is a more reasonable annuitization age.

The amount of the benefit base is commonly expressed in one of two ways. The first is premium accumulated at a specified percentage, let's say, 0–7% or maybe 5% or 6% rollups. The second is having a maximum account value, with anniversary date being the most common maximum point that people tend to look at. Both of these are common in the marketplace.

The guarantee at the time of annuitization is a very big variable. It is either at the contract rates, which will commonly contain an interest assumption or an interest guarantee of 3% or at your current single-premium immediate annuity (SPIA) rates, which could be feeding in an interest rate of 5%, 6%, 7%, or whatever. Again, that makes a very big difference in the value of the benefits and the cost when you're cash-flow testing it.

Finally, GMIB generally can be utilized on each anniversary. As a customer, if you want to utilize it in the 10th year, you may. If you don't, you'll have another change a year later, a year after that, and so forth. The essence of the benefit is that a customer is faced with the choice (actually the choice will make itself). If he wants to annuitize, he will get the greater of the income that can be produced by the account value of the variable annuity applied at the current annuitization rates, the SPIA-type rates, versus taking this guaranteed floor applied at whatever was guaranteed, such as a contractually guaranteed rates with 3% interest and whatever mortality. So you get the better of the two worlds.

The methodology for formula reserves being forwarded by the Academy to the NAIC is similar to Actuarial Guideline 34. You do the same thing as you do for GMDBs, which is the Guideline 34 Foundation, and calculate an integrated benefits stream reserve that includes the GLB. You develop your reserves for everything in total. It is consistent with CARVM principles because 100% utilization is assumed. If it's a GMAB with a one-time execution, 100% utilization is exactly what the contract does anyway. If it's a GMIB, the 100% utilization is at a given anniversary. That's on the conservative side, because that is not how customers are going to use it, but being consistent with the Guideline 33 principles of CARVM, 100% utilization is what is felt will be the standard for formula reserves.

Once you've calculated the formula reserves with everything integrated, you would then subtract the benefit stream reserves under Guideline 33, excluding the GLB. The difference between the all-in calculation and the Guideline 33 calculation

without this benefit is the residual amount that becomes your GLB reserve. This reserve is then held in the general account, so you'll see this immense parallel to what's being done today for a GMDB.

The reserve for this requires determining an amount at risk. It uses what has been called the "keel" method. In the keel method, project where account values will be year-by–year, measured from the valuation date, or anniversary-by–anniversary. It's looking at how bad the account value is; if it's 85% bad, it is the 15th percentile of accumulated value. So we are projecting things at the 15th percentile. The annual change from year to year is then noted and that becomes the go-forward rate that is used in your amount of risk calculation. As you're going forward, you have to subtract out the various charges that are assessed against gross return, so you would be taking out the investment management fees, the mortality and expense (M&E) charges, administration charges, and the charge for this particular benefit before you come up with the go-forward rate.

In looking at the keel method, and this has not been firmly resolved, but it has a possible extension on how you will calculate GMDB reserves, which you probably know use the drop-and-grow-back method. The keel method is a little bit of a smoothing out of that and it's a little more technically based. It is possible that, in order to get consistency and seamlessness between GMDB reserves and the GLB reserves, this keel method may well apply to those when the time comes.

The shape of the projected account value is what is called the keel (Chart 1). If you start off at your account value, it's at 0% variance from itself. As you go to the first year, this happens to use a go-forward rate of 11% and a volatility of 17%, which is a not unreasonable for a return after investment management fees. It shows that after one year at the 15th percentile, the account value has dropped about 10%; at two years, it's a little bit more than 10%; at three years it's coming back up; and, as time goes on, it grows. It's a nice picture of amount at risk. If you look at it, the amount at risk is that difference between the zero line in the middle and the gray line down below.

The GMDB would literally have a drop of 12% or so and a grow-back of about 12% minus M&E charges, which might bring you back to say a minus 2–3%. If you use the GMDB numbers and call it the GMDB keel, it will be floating at a level much higher than this, showing a lot less amount at risk, so there's a fair amount of difference to be reconciled between the two approaches. But the key thing is that it was very important to find something that gives you a reasonable picture of risk, five to 10 years down the road, whereas the GMDB profile, when it was developed a couple of years ago, focused on the short term because people die right away. In this, the benefit is deferred by definition.

This development of the keel factors and the 15th percentile fund value figures are consistent. Looking at the year-to-year differences gives you your annual fund growth. And, after subtracting 150 basis points for M&E and the cost of this benefit, I came up with the annual account value growth, which is the smaller figure in the right-hand column. The reason I didn't take out investment management fees from this is that the keel you saw in Chart 1 had those subtracted from it in the 11% go-forward rate.

If we then take the figures that I just showed you and look at a few cases of the implied amount at risk at the end of the 10th year for various different account values and assume that there's $100 of account value at time zero, the amount at risk projected by these figures is about 1% of account value. That would be the amount at risk that would feed into the reserve calculation. If we clock forward one year, let's look at three possibilities: That the account value has dropped to $90, stayed at $100, or gone up to $110. The projected account values at the end of the 10th year show up in the next column and, importantly, the amount at risk is not unexpected. If your account value has dropped to $90, your amount at risk is at the 13.5% level; if you're still at $100, it's 3.9%. The reason you've gone from 1% in the first year to 3.9% in the first year is that you have one less year to dig your way out of the hole and, therefore, you have more amount at risk. If you've grown to $110, the projection is that you're not going to have anything at risk at the end of the 10th year.

Five years down the road you see that all of the amounts at risk have become more severe because, when you compare it with the previous tier, you have four fewer years to dig yourself out of the hole. Finally, when you get to the ninth year, there's only one year to go. You have significant amounts at risk based on where you are and, even if you're at $110 level, there's a certain amount at risk. Even though your guarantee is only that you're getting $100 back, there's still a risk when you have $110 that you can puncture the floor; therefore, you do have an amount at risk. If your account value is at $120, there is zero amount at risk, which is saying that there is a low probability that you're going to have to pay off.

What I just showed you related to GMAB reserves. If you are going to have GMIB reserves, one of your variables is the probability that your benefit is going to have a guaranteed annuitization rate that is attractive in relation to the current market rates, assuming that you're using contractual guarantees such as the 3% interest rate. If interest rates have shot through the ceiling, the guarantees in your contract aren't very attractive. Let's just be very extreme and say current interest rates are 12%. The 3% rates in your contract aren't going to be very attractive and, by using this adjustment, the ratio of the cost of per $1 of annuity income on the SPIA basis divided by $1 on the guaranteed basis can give you a very low percentage. In the

extreme case I made up, I haven't calculated the ratio but maybe the annuity costs only 50 cents on the dollar at the SPIA rates versus the guarantee. On the other hand, if interest rates have plummeted and the SPIA rates are equal to your guaranteed rates of 3%, then the value of your GMIB benefit is essentially equal to the benefit base of the floor that had been calculated by either your rollup formula or your maximum anniversary value calculation.

In a typical range, you might expect that the value of your GMIB benefit is 75–85% of the benefit base that has been projected forward. Also, when you're using GMIB, you have to make some assumption of utilization. For reserving purposes, we're assuming 100% utilization on each projected anniversary.

Let me give you one quick snapshot of RBC considerations. A proposal is being made on an interim basis. The C3 RBC for variable annuity guaranteed living benefits (VAGLBs) is that generally it would be considered in the high-risk category, which would require capital of 2% of policy reserves. If you do not have an actuarial opinion, it would be 3%. An effort has been made by the AAA RBC group to keep it looking similar to C3 RBC, which is (going from high to low) 2%, 1%, and 0.5%. This is poured into that numerical structure, so if your benefit is in the money, you're going to be putting up either 2% or 3% reserve. It will be in the medium risk category if two things are satisfied: (1) give an unqualified reserve adequacy opinion for the company and (2) the account value exceeds the effective floor, which means the benefit is at the moment out of the money. If your benefit is a GMAB, it's a straight comparison of account value versus guarantee. If it's a GMIB, the simplified adjustment is assumed—that the value of your GMIB is only 80% of the floor guarantee as it exists at that time.

When you're trying to look at asset adequacy analysis of GLBs, there are a lot of new variables brought into the picture. First is that the hedging of these is not easy and that's going to project into how you feed the hedging into your asset projections in your cash-flow testing. Actually, going to Wall Street and buying hedges is probably not what companies are going to do. You will find that the cost of hedging this benefit on Wall Street is five to 10 times the inherent cost of the benefit. It is one of those big problems of pricing and managing these products, but buying the hedges is a very expensive proposition. Contrast that with EIPs, where the standard procedure is that you do hedge it on Wall Street. You might buy over-the-counter options and do dynamic hedging and replication, but, by and large, on EIPs, the insurer has in place something that is going to cause a virtual wash job of what you're paying the customer and what you're getting in from your hedged vehicle.

On the GLBs, again, going to Wall Street is not an affordable proposition. When you do find a way to do it, with dynamic hedging, perhaps, or actually some combination of going naked and having dynamic hedging, you'll find out that the precise matching of your hedge to the subaccounts isn't a piece of cake either, whereas on EIPs, the products tend to be denominated in the S&P 500 or Dow Jones Industrials. You can buy SPX call options, for example, that will exactly match what your risk is. On these products, your underlying risk is a basket of equity risk, fixed-interest risk, or a lot of different things, so you aren't going to find exactly perfectly matches for your dynamic hedging, but you're going to have to do the best you can.

The utilization of GMIBs is an interesting area. At what frequency are people going to utilize these? The debate rages on. Is the GMIB a floor of protection for a customer so that, for the people who would normally annuitize, this provides a floor so that the benefit doesn't plunge too far? Or is this a valuable put option where the customer's utilization is somewhat independent of annuity income needs, but is used as an investment vehicle that is going to be in the money at times and out of the money at times? When it's in the money, he'll want to use it. So, with the utilization question, the one end of the spectrum is it's only for people who normally annuitize. It's only a couple of percent utilization.

The other end of the spectrum is, when it's deeply into the money, people are going to use it aggressively and the numbers will fly around. Say your account value is a certain amount, called it $100 and the value of this benefit is $150. You're 50% in the money. You might say the utilization is half of the in-the-moneyness, so if it's 50% in the money, utilization is half of that, or 25%. Or using another characterization, maybe utilization is in-the-moneyness squared, which happens to come out to the same answer as if you're 50% in the money, but those two approaches will give you different answers if you're less in the money. The point is that the issue of utilization has to be addressed as you are projecting your liabilities into the future.

Also, the current interest rates are key in GMIBs. Since the value of your benefit is inversely proportional to current interest rates, you want to model what interest rates are going to be at the time somebody hits the point of utilization. On the asset and liability side, they're really speaking the same language. So, when I say the liabilities are difficult to quantify, it's taking the same issue I was just talking about—What is the probability of utilization? What is the value out there?—and feeding it back to the asset side. You do have to understand what the potential liabilities are so you can establish your reinvestment or hedge purchase program, which then will have to be carved into your projection methodology.

There is also the question of, do you use static testing or dynamic testing of these benefits? Static testing probably isn't going to work; it doesn't give you much information. If you're thinking about static testing and why you're going to convince yourself it doesn't work, you would use interest rates following the New York 7. Investment yields need what I call the Wall Street *N*. What is *N*? If you were to have the $N=6$, you will find that there's a set of scenarios very much parallel to what Alan described for equity-indexed benefits.

On the stochastic considerations, variables include the mean return, volatility, and the interest rates. All of those have to be brought onto your radar screen. The assets may be difficult to model. You'll have put options, futures, and more exotic mixes. Those are not what you're normally used to working with, but you're going to have to have those in your toolbox. The liabilities have additional variables. Whereas on fixed-interest products you have interest-sensitive lapses, here you have in-the-money-sensitive utilization of the benefit, particularly for GMIB. You'll have in-the-money-sensitive persistency, which has two dimensions to it. One is, in your underlying variable annuity, you'll have to have some kind of scheme that addresses, "How willing are people to hang around with a variable annuity when it's down in the hole? How much more willing are they to stick with it when it's really paying off well?" That's your underlying variable annuity. Then put another layer on top of that. If you have a GMIB benefit or a GMAB benefit that is in the money, and if your customer understands the value of this rider (and she may not normally understand it and you might have to keep her informed on each anniversary), it's to her advantage to stick with the product and collect her put-based benefit at the end of the 10th year or whatever it is. That can improve the persistency for your overall variable annuity from where it normally would be, but I think that has to be brought into the picture.

In looking at the stochastic path return generation, the issues include what mean return do you use? Do you use current mean return of the stock market? Do you use a typical mean return? Do you use the stochastic interest-driven mean return? Stochastic interest-driven is useful if you feel that your equities market return 6% over a risk-free return. If you could use your stochastic interest rates, which are bouncing around, to drive where your mean go-forward rate is for your equities, I would say you probably want to lean toward the typical mean return. In looking at things over a long term, what is a reasonable go-forward rate for equity-type investments and actually for the whole blend of equities and fixed income which are in your variable annuity?

What kind of volatility do you use? Do you use today's volatility, which can be very high? Do you use historic or fluctuating volatility? Do you want volatility in itself to be a stochastic variable? I lean again toward the typical mean. The

volatility itself introduces enough bouncing around in your projections that varying the volatility may not be a necessary step at this stage of the game. A few years down the road, when it's time for refinements, maybe you'll think about it.

Finally, in looking at volatility, you want to use actual volatility, not implied volatility. When you go to Wall Street to buy options, they charge you on an implied volatility basis, which is a way to cover their risk. But when you're looking at the true liabilities of your company, actual volatility is the kind of number that should be in your mind. The difference between actual volatility and implied volatility is all over the place, but over time it tends to be a 3–4% difference in volatility. That's huge. And, if you look at the difference between actual and implied today, it might be in the 10% neighborhood, which is really huge. The point is, you should get yourself on an actual volatility wavelength.

On the stochastic asset issues, maybe you can net some over-the-counter hedges against the matched liabilities to short-circuit some calculation problems. Time will tell how well that works out. If you have partial over-the-counter hedges, you're going to have to do some kind of modeling. Get ready to do it. If you're using delta hedging or dynamic hedging, where perhaps the foundation of it may be going short in index futures, and/or using some out-of-the-money puts in your hedging, you again have to be ready to build replication of those into your projection techniques.

On the liability issues, what interest rate do you use as a kick-off rate for your stochastic interest rates and for the future? I would say you probably want to use what you feel is a reasonable long-term rate, not necessarily today's rate, as the kick-off point, but then let it vary stochastically over time.

What's the in-the-money-sensitive utilization rate of the GMIB? You'll have to come up with some kind of formula that you think is responsive. And what's the persistency rate? Again, that has to be responsive to market movements.

When you're doing GLB testing, I think it raises the issue that GLBs are put-based benefits and GMDBs are put-based benefits. You probably should start doing some testing of GMDBs, which I think companies are not necessarily doing. Particularly if you're reinsuring them, you don't do it, but reinsurance is a hard-to-get commodity on living benefits. It's becoming a hard-to-get commodity on GMDBs, so I think they all fit into the same picture. They're marching to the same catastrophe drummer and you'd better be ready to bring them altogether.

Another interesting question is, what is "adequacy" when you're doing stochastic testing? I think Alan mentioned that maybe 80% of the cases ought to pass. Your

living benefits are way out in the tail. In over 75% of the spectrum, you have no anticipated liability, then they start zooming and you have some real killers at the 95th percentile and the 97th percentile. Therefore, if you say 80% adequacy is OK, you're fooling yourself. You have to start talking about something that starts with a nine to have a meaningful test.

Mr. Harold H. Summer: Noel, you mentioned an RBC proposal before the NAIC. There is a current proposal out there to change the way C3 is determined. I was wondering if there was anything in the works for equity-indexed or guaranteed-income benefits or accumulation.

Mr. Abkemeier: In the Academy task force for the GLBs, Bob Brown is the leader of the new methodology for RBC for more traditional products, which is considering something like taking seven specified scenarios at the worst 25th percentile and forcing things through that and so you have a stochastic RBC. The same concepts are anticipated to be brought into the GLBs, although right now I'd say reserving and RBC for GLBs are still in the third, fourth, or fifth inning of the ball game, and adjusting to what you're talking about is probably in the eighth or ninth inning of the ball game.

Mr. John M. O'Sullivan: Noel, could you elaborate on how you determine the keel? You mentioned that you basically pick something that's at the 85th percentile. Do you do that with respect to just one particular duration or for all durations and then pick the maximum reserve that would come out of that?

Mr. Abkemeier: First of all, there are various ways to develop the keel. The one I showed was using a lognormal projection methodology, an 11% go-forward rate, and a 17% volatility, so it's doing something smooth. The Academy task force is trying to do the keel on a historic basis, taking 38 years of experience and finding out what the 15th worst percentile is. It is something that has no memory, so at any given time we are where we are and things are going to go forward following the shape of the keel. So, whether you're at 0% in the first year or in the fifth year of your product, it will be the same shape, because it is simply prospective with no memory.

CHART 1
CASH FLOW TESTING OF VARIABLE ANNUITIES

- Profile of fund value “keel”