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THE IMPACT OF INFLATION ON INSURANCE AND ANNUITY RESERVE VALUATION: THE C-3 RISK

Moderator: JOHN C. ANGLE. Panelists: CARL R. OHMAN, WALTER S. RUGLAND, CHARLES L. TROWBRIDGE

The panel will discuss studies of the risk of loss due to changes in the interest rate environment. Background information for the panel discussion is the "Report of the Committee on Valuation and Related Problems," Record, 5:1, pp 256-284. The panel will specifically address the following:

1. Why the C-3 risk is important. How inflation and stability in interest rates can affect the financial soundness of life insurance companies.
2. What theoretical work is being carried out to calibrate the C-3 risk of variation in interest rates? What is the mission of the Society's C-3 Task Force?
3. To what extent can the valuation actuary properly recognize the risk of loss from inflation and changes in the interest rate environment within the present framework of valuation laws and regulations? What changes may be needed?

MR. JOHN C. ANGLE: I would like to begin by reciting for you one case example. Most of you are probably aware that the net worth of savings and loans in the United States have declined by 7% during the first 7 months of this year, at the rate of 1% a month. An examination of the assets of these institutions shows that almost 9% of their assets consist of advances from the Federal Home Loan Bank at interest rates of 16-20% and that they also have significant holdings of negotiated rate certificates of deposit or repurchase agreements. The Board of Directors of the Guardian Life includes three economists, all three of whom sit on the boards of mutual savings banks in New York. As they go from a meeting of a particular savings bank to our Board, they carry with them a concern over our ability to meet immediate demands for our individual life policy cash values which are not yet encumbered by policy loans.

In response to persistent questioning by the board, we prepared a stress test of the Guardian Life as of June 30, 1981. We chose not to report on a wholly owned subsidiary which issued deferred annuities, at a time when the proceeds could be invested in long term bonds yielding approximately 9¼%, because that subsidiary would not have survived the stress test which I will describe briefly.

We tested the Guardian on two bases. The first was cash flow, which we defined as the excess of disbursements including dividends over premium income and investment receipts. We then added to the cash flow from operations the cash that would be generated by mandatory prepayments and maturities of the investments we held. We developed these cash flows before policy loans and discovered that we had cash flows in the range of $140 to $183 million. When we compared these cash flows to policy loans we found that the increase in policy loans, although serious, was taking from between 10% to 35% of the available cash flow depending upon which of the last five

years we picked. We observed that we were in a position to withstand literally a crippling of policy loans. These results seemed to reassure the Guardian Board but they wanted us to go further.

The second step was to do a market valuation of all of our assets. This valuation was straightforward with regard to stocks or securities which have a current market value. It was not straightforward for mortgages, which were simply assigned a market value equal to 60% of book. For our bond portfolio, we secured from Wall Street firms a yield matrix showing yields varying by years to maturity and coupons. Then through a rather laborious technique we obtained a market value based upon this yield matrix as of June 30th.

In trying to say what we would do if we had to immediately meet a demand for all unencumbered cash values, we obviously would start by converting to cash those assets which involve no surplus loss. We were quite gratified that we would have been in a position to have met a demand for slightly over 70% of cash values by June 30th without getting into substantial surplus loss from that source. This is primarily because of an investment policy which has continued to upgrade bonds and which has emphasized the purchase of stocks and convertible securities in some cases, and because of our short term and cash positions at that time.

The results overall were gratifying to us and reassured the Guardian Board at least temporarily. However, as a former friend in Nebraska liked to say, "no good deed goes unpunished" and in our case the punishment was that the Board has asked to see the same type of report every three to six months.

The point is that this is a very real and practical problem. It is a problem that we face without having in hand the theoretical underpinning or the accounting and analytical tools to allow us to either monitor the situation or really deal with it, which brings us to our panel and the work they are doing.

MR. CHARLES L. TROWBRIDGE: My part of today's discussions must be to lay some important background. Even the title of this Panel Discussion must be a bit confusing to some of you in the audience. To a great extent this background has already been given from the platform of today's general session and the reason for that is simply that Robin Lechie, the current President of the Society, is extremely interested in this matter and for that reason featured it in his Presidential address. Nonetheless, and not worrying too much about whether I give you background that you've already heard, that is what I intend to do from the platform here today.

Back in 1977, Bob Jackson, who was then President of the Society of Actuaries, appointed a high level committee, then and still known as the Committee on Valuation and Related Problems. Those of you who have been around for awhile and have good memories may recognize this Committee as in some ways a successor to an earlier Society committee under Henry Unruh.

The Committee on Valuation and Related Problems views as its function the development of a strong theoretical base for the balance sheet of an insurance enterprise. When one takes a good look at the methods that we now use for determining assets, liabilities and their differences called surplus we recognize that some of the theory is pretty thin. As just one

example, how do we determine the interest rate at which we discount assets and liability flows, and why is the rate for the valuation of assets so much higher than the rate for the valuation of liabilities? Obviously there is some substantial degree of conservatism in our inconsistent discount rates, but how far do we go with this and what is the purpose?

The Committee found itself concentrating on the kinds of risks an insurance enterprise is subject to in this uncertain world. The Committee was hoping that a good analysis of these risks would lead, first, to some answer as to how much provision is needed for these various contingencies, and second, whether such provision should be held within the liability or as a part of surplus. We asked ourselves what contingencies would be needed if assets and liabilities were valued on a strict best estimate basis, leaving to a later stage the question of how much of the contingency reserve might be appropriately required as a part of liabilities.

In the spring of 1979, now some 2½ years ago, the Committee on Valuation and Related Problems issued a preliminary report. This report was the subject of a panel discussion not too different from this one at a Society meeting in New Orleans. The gist of this preliminary report was the identification of three distinct contingencies against which some provision is clearly needed.

The first of these, which the Committee labeled C-1, is the possibility of asset depreciation. This is largely the risk of default in bonds and mortgages and the risk of a decline in the market value of real estate or common stocks. You will recognize C-1 risk as the risk toward which the Mandatory Securities Valuation Reserve is directed. Note that C-1, as the Committee defines it, does not include the risk of change in the market value of bonds and mortgages due to swings in the interest rate.

The second contingency reserve, C-2, is a provision against pricing inadequacy. The many ways in which an insurance enterprise can lose because it charges too little is the basis for C-2. For our discussion today, we can leave both C-1 and C-2 and go on to C-3.

C-3 is whatever provision that an insurer needs to make for the adverse financial consequences of interest rate swings. C-3 is closely associated with the matter of immunization, the set of problems that go under the name disintermediation, and the current concern with the more general problem of inflation.

The basic chain of reasoning goes something like this:

1. Life insurance companies ordinarily think of their liabilities as being longer than their assets. If so, it is the possibility of a decline in the interest rate that needs attention, since a lower interest rate will cause liabilities to increase more than assets. Today's practice of valuing liabilities at a lower rate of interest than assets is perhaps an adequate, although not very scientific, hedge against interest rate decline.

2. It has become apparent, however, that liabilities have a way of getting shorter under high or rising interest rate conditions. The shortening of liabilities arises from the tendency of policyholders to withdraw cash via any of the several routes the typical Life Insurance Company contract permits whenever interest rates, especially short term interest rates, are high. This tendency toward disintermediation can be counteracted only by delivering to the policyholder an investment return close to the amount he can achieve from Treasury bills, bank certificates of deposit or money market mutual funds. Life companies competing on interest rates find it very difficult when operating on aggregate interest distribution or Investment Year Method principles when short term interest rates are higher than long term interest rates.

3. Coupled with the shortening of liabilities when interest rates are high is the lengthening of assets. Residential mortgages are refinanced less frequently and other ways that a borrower pays a debt early are not employed as often.

4. The shortening of liabilities, with the current lengthening of the assets, can have an effect of producing liabilities shorter than assets. If so, the threat to solvency is the same high interest phenomenon that lead to this abnormal condition. An insurer's assets go down more than liabilities do when the valuation interest rate is raised. Under current conditions, it is the upside interest rate change that the insurer must fear.

5. In its worst form the combination of (i) a tendency for cash withdrawal to increase, (ii) a tendency for new money inflows to decrease, and (iii) a tendency for payback of existing loans to decrease, all three caused by the same high interest rates could well cause an insurer's cash flow to go negative. The insurer's options under negative cash flow conditions are all poor, and can be counted on to result in substantial loss if the problem lasts. One natural antidote is the basing of any withdrawal value on the market value of the underlying asset, however life companies have traditionaly guaranteed cash values based on book. Another is a matching of assets and liability flows so that each amount paid to policyholders is met by an investment then maturing. Such matching or one form of immunization is a part of insurance literature, but little attention has been given to it recently.

The foregoing discussion of what C-3 is all about comes pretty much from the Committee's 1979 preliminary report. Since then the Committee has been somewhat bogged down, partly because it has not been able to quantify C-1 and C-2 but more importantly perhaps because it has made no important progress as to C-3. As Chairman of this Committee over the last four or five years I've grown a little weary of lack of progress. But as of today, there is some new hope and we are going to hear today from Carl Ohman about a new effort that has recently been organized and is now attached rather loosely perhaps to the Committee on Valuation and Related Problems.

MR. CARL R. OHMAN: The Task Force to Study Risk of Loss from Changes in Interest Rate Environment (C-3 Risk Task Force) was appointed in March, 1981, with the charge to:

> "Support the Committee on Valuation and Related Problems by developing understanding and quantification of the risk of loss due to changes in interest rate environment. It is anticipated the work will include computerized displays of results of multiple economic scenarios by types of products backed by various asset configurations;"

and within a time frame of preparing "a working paper or papers for release for discussion in the Spring, 1982".

This paper provides background to the formation of the C-3 Risk Task Force, outlines its plan of operations, and summarizes results to date. A final report by the Task Force on its initial (one year) assignment will be prepared for presentation at the Society's Special Topic Meeting on Inflation in Houston, April 1-2, 1982.

Appointment of the C-3 Risk Task Force was one result of the separate but related efforts of two groups: (a) the Society's Committee on Valuation and Related Problems, chaired by Charles L. Trowbridge, and (b) the NAIC C-4 Subcommittee's Technical Advisory Committee on Dynamic Interest and Related Matters, chaired by Charles Greeley.

The preliminary report of the Trowbridge Committee was presented at the Society's April 1979 meeting in New Orleans and is published in the Record 5:1, pp 256-284. In this report, the Committee identified three contingency reserves that must be recognized in developing any new framework for valuation of life insurance company assets and liabilities: C-1 contingency reserve for the risk of asset depreciation, C-2 for the risk of pricing deficiencies, and C-3 for the risk of adverse financial consequences of interest rate swings. The Committee noted the need for thorough research into the nature and magnitude of each of these risks before work can proceed on developing a new framework for valuation laws, and recognized that the C-3 risk may well be the dominant concern in the current economic environment.

The NAIC C-4 Technical Advisory Committee (Greeley Committee) was appointed in the spring of 1980 with the specific charge to review the package of amendments to the Standard Valuation and Nonforfeiture Laws that were being proposed by the American Council of Life Insurance, with particular reference to the dynamic valuation interest rate feature in the proposed amendments. After thorough review of the extensive testing that had been performed by the ACLI in support of the valuation interest rates in its proposal on various assumptions as to current interest rates, alternative trends of future interest rates, and assumptions as to repayment of investments, and after performing additional tests of its own, the Greeley Committee concluded that the valuation interest rates actually adopted by the NAIC will result in minimum reserve standards that do make a good and sufficient provision, in the aggregate, for payments guaranteed under the terms of a company's policies and contracts provided there is a sufficient degree of matching of maturities of the company's assets and liabilities, provided there is sufficient call protection in the company's assets to limit the risk from

early repayment of assets if interest rates fall, and provided there are sufficient underwriting safeguards in the company's insurance and annuity contracts to moderate the risk from acceleration of payments under such contracts when interest rates rise. The Committee emphasized that if these conditions do not hold for a company, then the minimum reserve requirements, under either the current law or the proposed amendments, might not prove sufficient and that the company's valuation actuary would need to determine whether the conditions do hold for the company in order to ascertain whether the reserves do make a good and sufficient provision for the liabilities. This again directed attention to the need for actuarial research into the nature and magnitude of the risk of loss from interest rate swings (i.e., the C-3 risk).

Having completed its review of the ACLI proposed amendments and after adoption of those amendments with some modifications by the NAIC in December, 1981, the Greeley Committee and its Subcommittee on Surplus and Solvency Considerations, headed by Walter S. Rugland, then turned to the question of what further, longer range changes are needed in the laws governing the valuation of life insurance company assets and liabilities. The Rugland Subcommittee very quickly recognized, as had the Trowbridge Committee before it, that research to identify and quantify C-3 risk must be done before any progress can be made in formulating a new statutory valuation framework. Consequently, after some discussion among the Rugland Subcommittee, Greely Committee, and Trowbridge Committee, it was agreed that the Society of Actuaries be asked to establish a working group specifically charged to research the needed quantification, and to perform this research within a time frame of no more than one year. The Society leadership agreed, and the appointment of the C-3 Risk Task Force followed.

The problem of identifying and measuring C-3 risk has to do with the relationship between the liability or obligation undertaken by an insurance company for an insurance product or collection of guarantees and the assets held by the insurance company in support of the obligation.

The obligation undertaken by the company consists of a stream of future net cash payments (positive or negative) by the company over a span of time to some date of maturity (specified or contingent). The precise amounts and dates of such future payments are generally not known as of a current valuation date, and the incidence of such future payments may be influenced significantly by the trend of future interest rates -- i.e., if interest rates rise, it is likely that the payments under certain products will be accelerated.

The assets held by a company in support of a specific obligation may consist of one or more specific investments acquired for that obligation. More frequently, the assets will be a slice of the company's general account investment portfolio allocated among the company's various obligations -- pro rata, if the company allocates investment income using a portfolio method, or allocated on a basis that recognizes year of receipt of investable funds, if the company operates under an investment year method. In any case, the assets supporting an obligation on a valuation date may include both (a) an amount of cash or the equivalent available on that date, and (b) a stream of future cash payments from currently invested assets in the form of new investment income, net capital gains (and losses), and principal repayments. Again, the precise amounts and dates of such future

payments are not known as of the current valuation date, and the incidence of such future payments may be influenced significantly by the trend of future interest rates -- i.e., if interest rates fall, it is likely that unscheduled repayments of principal from investment assets will occur.

If an obligation is longer in duration than the assets held in support of the obligation and if interest rates fall while the guarantee is in effect, then assets may need to be reinvested at rates of return lower than anticipated, resulting in a loss. If the falling interest rates produce an acceleration in principal repayments, i.e. a further shortening of the assets, the problem is aggravated.

Conversely, if an obligation is shorter in duration than the assets and if interest rates rise, then investments may need to be sold at a loss to cover the payments required under the obligation. If the rising interest rates result in an acceleration of payments under the obligation, i.e. disintermediation, the risk of loss is worsened.

The situations described in the preceding two paragraphs are the simplest forms of C-3 risk. When interest rates both rise and fall during the period of the guarantee, the risk of loss can be much more complex.

The C-3 risk problem is to determine whether the assets supporting a block of business on a valuation date will be sufficient both to fund the obligation for the block of business over the entire period of the guarantees and to assure that assets at each future valuation date will be sufficient to cover statutory reserve requirements on such dates, given the current configuration of the company's assets and an appropriate range of future changes in interest rates.

The C-3 Risk Task Force consists of the following members: Donald D. Cody, Richard W. Kling, James D. Lamb, Daniel J. McCarthy, Robert A. Miller, III, Lew H. Nathan, James A. Tilley and Carl R. Ohman (Chairman). Others who have worked closely with and contributed importantly to the work of the Task Force are William Carroll (representing ACLI), Paul Kolkman, and Walter Rugland.

The Task Force held its initial meeting in Hartford, April 29th. Subsequent meetings were June 3rd in Detroit, July 21st and September 10th in Chicago, and October 18th in Atlanta. In addition, there have been a number of meetings of sub-groups, many telephone calls and frequent exchanges of correspondence.

The early meetings of the Task Force were devoted mostly to definition of terms and formulation of the C-3 risk problem. A series of working papers prepared by Don Cody provided an analytical formulation of the problem that was invaluable as background to the Task Force discussions. Mr. Cody has prepared a preliminary report on the underlying mathematics which is available for distribution to interested Society members at this (Atlanta) meeting.

The next step was to decide what tests to perform to identify and measure C-3 risk for various products under various assumptions as to current assets and future trends in interest rates, as well as the dependence, if any, of future cash flow from both obligations and assets on the path of future interest rates.

After much deliberation, we decided to approach the calculations in several stages of increasing complexity as to the implications of product design for C-3 risk, as follows:

1st stage: Calculations for guaranteed interest contracts and other insurance company products that are not unduly complicated by:

a) guaranteed surrender values and policy loans
b) reserves tied to cash values
c) federal income tax tied to level of reserves
d) expenses not matched to current premium margins
e) dividends

2nd stage: Calculations for conventional non-par whole life -- i.e. recognizing all of the above complications except dividends.

3rd stage: Calculations for par whole life, universal life, deferred annuities.

4th stage: Calculations for a company with more than one product or line of business -- to recognize that the assets needed to support a mixture of obligations with different C-3 risk characteristics will almost certainly be less than the sum of assets needed to support the individual obligations.

The 1st stage calculations were performed at Equitable under the direction of James Tilley. The calculations were completed in early September and are summarized briefly below.

The 2nd state calculations are being performed at Aetna under the direction of Robert Miller. The systems needed to perform the calculations should be in place by the end of 1981 so that calculations can be completed before April, 1982, and within the time frame of the Task Force's one year assignment.

The 3rd and 4th stages will be the subject of research that may extend beyond the initial time frame of the Task Force.

Mr. Tilley has prepared a report on the 1st stage calculations performed at Equitable for guaranteed interest contracts and similar products lacking the complications of individual life insurance.. This report is available for distribution to interested Society members at this (Atlanta) meeting.

The Equitable calculations measure the book value of assets needed for C-3 risk in relation to statutory reserve requirements for each of three specimen companies that have sold only interest guarantee business and have been selling such business for the past five years, assuming alternatively an up path and a down path of historical interest rates, and assuming thirteen different paths of future interest rates.

Companies A and B in the Tilley report are one product companies. Company C has sold a mix of several types of guarantees. Assets for companies A and B are all one type of investment, two alternative types considered. Company C's assets use a mix of investments with a modest effort at matching investments to obligations. Withdrawal rates and asset repayment rates are linked appropriately to the path of future interest rates.

While the results of the tests are of considerable interest in themselves, it is the technique used in the calculations and the range of assumptions that most merits attention. I believe that Mr. Tilley's paper can serve as a blueprint for a workable approach to measuring C-3 risk needed assets for any such product with any given configuration of supporting assets and any assumed path of future interest rates.

The Task Force is currently completing specifications for assumptions to be used in the 2nd stage calculations for C-3 needed assets in relation to conventional non-par whole life insurance. Critical components of the needed specifications include:

A. Detailed specifications as to surrenders and policy loans in relation to future interest rates. (This factor has been recognized in the Tilley calculations, but the relationship is undoubtedly more complex for life insurance.)

B. Detailed specifications for federal income tax to recognize that Phase 1 may or may not apply, possible reinsurance may or may not affect results, etc.

C. Detailed specifications for treatment of historical relation of assets to obligations. (The 5 year history assumed in the Tilley calculations will need to be extended to at least 20 years for conventional life insurance.)

Any suggestions on these or other aspects of the 2nd stage calculations would be most welcome and should be directed to Mr. Miller.

As indicated earlier in this report, the C-3 Risk Task Force will complete its one year assignment, including calculations through the 2nd round as defined above, in time to report to Society members at the April, 1982 meeting in Houston.

However, this represents only the beginning of a longer term effort toward fully understanding C-3 risk and its implications for the financial soundness of life insurance companies, and the need for future changes in laws governing the valuation of life insurance company assets and liabilities, as well as the need for surplus in life insurance companies.

Future steps might include any or all of the following:

A. More research, by this Task Force or some other group, at least through the 4th stage of calculations defined above.

B. Integration of C-3 risk research with similar research into C-1, C-2, and other forms of risk affecting life insurance companies.

C. Development of a proposal for a new framework of valuation standards, using the result of research from this Task Force and others. This development would probably occur outside the Society -- perhaps within the ACLI or NAIC committee structures.

D. Discussion and debate within the Society and elsewhere on the nature, magnitude and implications of C-3 risk -- at Society meetings, meetings of local actuarial clubs, and perhaps at special regional seminars organized for the purpose.

E. Development of educational materials and guidelines for use by actuaries responsible for signing actuarial opinions as to life insurance company annual statement liabilities.

F. Development of educational materials for eventual inclusion in Society's examination syllabus.

The C-3 Risk Task Force believes that to identify, understand, and measure the C-3 risk for each of the various life insurance company products, and for the aggregate of all of a company's products, may be the greatest research challenge facing life insurance company actuaries through the 1980's. We hope that the work of the Task Force will prove to be a useful contribution toward that effort. We welcome any suggestions or contributions that others wish to make to the work of the Task Force.

MR. WALTER S. RUGLAND: I want to take the opportunity presented by this platform to look at the future and focus on the practical problems or issues that are likely to face us as we learn more about the risks we have been discussing, especially the C-3 risk of fluctuating interest rates.

In a nutshell --- using the reference of William Jewell's comments in the General Session --- there looms before us a "scientific revolution." The old ways are not likely to work any more because the foundations upon which they are established may no longer hold.

To focus more directly (and I admit this is in generalized form), the fabric of the life insurance business in the United States is built on several basic assumptions. What do I mean by fabric? I mean the whole resulting from "pieces of cloth." Some pieces quickly come to mind that are obviously based on a supporting assumption. They include:

The 1959 Federal Income Tax formulas

3% to 4% interest for level premium prefunding

Dividend practices for policyholders' dividends

Investment policy-philosophy-restraints

Guarantees at Book Value

Guaranty funds

Equity

Non-discrimination

Expense limitations

Distribution systems and the compensation involved

Reported Earnings

Accounting practices

Administrative procedures

Valuation techniques and definitions

Note, first of all, that this list encompasses the turf of lots of professions, lots of people.

What assumptions support the fabric which has pieces such as those I just listed? Here are a few:

No noticeable inflation - 3% or less

Life Insurance is sold, not bought

Long term contractual agreements

Predictable business characteristics

Unique competitive scope

Solvency test on "Book Values"

All markets are equal

I am sure that others can be added to this list.

A basic redefinition, or elimination of any of these, can have (or <u>will</u> have) *a significant ripple effect (perhaps the effect of a strong wind) on many of* the pieces of the industry's fabric.

I believe that, even in the life insurance business, the marketplace drives the business --- and success is there for those that read it correctly. In the same breath, that means opportunities find takers.

I also believe that the life industry will have trouble surviving unless we can adjust the fabric to reflect redefined supporting assumptions.

Some of our assumptions no longer hold --- and I don't think the departure is short term. I believe it is in error to think they will hold.

What takes their place? I'm not sure. However, I don't think they will be at the same level of detail. The basic assumptions of our business in the future will *be much more basic -- more fundamental.*

The effect of this realization, and I believe it is beginning to occur, will cause shock waves on the industry's fabric and its pieces.

In my work on risk analysis, as a member of the NAIC Technical Advisory Committee on Valuation, etc., including the thinking on issues of Surplus and Solvency, I have conjured up some fluid ideas. Fluid because I think they will have much reshaping; ideas because that's all they are. But, fluid and idea oriented as they are, I think concepts and directions are beginning to take shape. The opinions I have are my own, but based on direct exposure. Using this platform, I want to share them with you.

Start by assuming or acknowledging that the life business is a marketing business. For some companies that already creates a conflict with stated purpose.

Next assume or anticipate there will be interest in long term contractual arrangements, both for benefit provisions, and for investment activity. Perhaps that is a current assumption that doesn't change much.

Then assume the opportunities are such that competition for resources allocated to premium payment is not uniquely life insurance companies, but lots of other industries have ideas on what they could do with those funds.

A small step from this initial assumption-setting leads to the conclusion that most of our current statutorially based regulation will need changing. Many will say it needs changing today, or needed it several years ago -- but let's look ahead, not back.

At the core of the statutory regulation is the valuation law. Most others build from it. Our work to date indicates that the valuation law's structure:

1. No longer is appropriate

2. Is restrictive

3. Needs to be changed

The law doesn't "protect" against some significant risks. It inhibits companies from efficient maximization capacity.

The problem is we do not have enough technology today to suggest a credible replacement. I am convinced that in 1990 we will have the capability of putting a new valuation structure in place. I do not know what it will be like --- but to think it will be like the one we have today, or Canada's, or England's, or someone else's would be too limiting. I will venture that at the heart of it will be the opinion of a professional actuary.

Think of it. A valuation law without minimum standards, without factor applications, etc. What would that do to the industry's facric? Can the business survive <u>without guaranteed</u> cash values, or market valued assets, on model based reserve tests? Can it survive with a different resource allocation approach to distribution expense? I not only think it can, but that it will. I think the market wants them.

The chaos in the industry today gives credence to this. We are all talking about market conditioned ideas. These market condition ideas are causing problems because they try to manipulate the existing structure to get at the market. My hope is that we can alter the structure sufficiently to be able to more simply address the opportunities.

So much for 1990. What about between now and then?

It is apparent that the immediate future is dangerous. The probability of the realization of the cause of the danger is lessened by the more we know about it. And we are working hard to learn more.

We will not know enough in the near term to construct a change in the valuation law structure. Fortunately, procedures are already in place to allow valuation actuaries to utilize new technology as soon as it is available.

The key to valuation work we do in the 80's will be the actuary's opinion. I believe you can already see more and more emphasis being placed on the important nature of the opinion -- it will be even greater.

The question in the program reads:

> "To what extent can the valuation actuary properly recognize the risk of loss from inflation and changes in the interest rate environment within the present framework of valuation laws and regulations? What changes may be needed?"

My answer: Do all that is possible to lessen the probability of realization of the cause of danger.

This requires:

1. Understanding of problems and causes of danger.

2. Expansion of the role of the Valuation Actuary to the entire balance sheet.

3. Using new techniques and approaches as they are/become available.

Let me summarize:

The future needs to assume:

1. The structure of the Valuation Law is deficient when it comes to C-3 Risk as well as others.

2. We should anticipate a new law will replace today's structure. We should not preempt the total creativity necessary in the design of that law.

3. We don't know enough today about the C-3 risk (and perhaps others). We are working on it and will get a handle on it.

4. The role of the Actuarial Opinion will be of increased importance in the near term. It needs to use all available results of research.

One final comment:

I believe that the result of all activity will mean several levels of scientific revolutions. Many are apparent. But one that I am pleased to note is that I think we will find a converging of the two life insurance actuarial functions: PRICING AND VALUATION. Also, it will bring a necessity for much greater interface with functions of other professionals within each company. I like that type of outcome.

MR. ANGLE: Panelists, someone who hasn't read the New Orleans discussion may still wonder is there really a C-3 risk? How sizeable is it? Should insurance company actuaries really be concerned about it or is this just a theoretical interest at this point?

MR. RUGLAND: I think it's a significant risk. It defies generalization. I think Jim Tilley's work so far shows that. It is my feeling that unless a company manages itself to minimize the risk that it's pure luck as to whether this risk will wipe it out or whether it can come out whole like your company did.

MR. ANGLE: We're not out yet.

MR. RUGLAND: The problem is that we do not know the answer to that question.

MR. ANGLE: But I think that Carl said that if we put all our assets into Treasury bills we face the risk from the other direction with the decline in interest rates. Can't you give us any advice for doing our job better?

MR. OHMAN: First of all,when most of us first went into the interest guarantee business ten years ago we recognized that this was something that did require a matching of assets and liabilities. Of course, at that time all of our business was done in the General Account and none of us had really thought about the concept of segmentation of General Accounts. Since General Accounts invested in nothing but long term bonds and mortgages with an average duration of maybe ten or eleven years, many of your early interest guarantees were of durations of eight or nine years of duration. Not because anyone thought eight or nine years was ideal for interest guarantees but because they were going to be backed by General Account assets that had long durations.

The concept of matching is not new and the concept of what could happen if you're not matched is not new. The events of the last ten years and the tremendous movement of interest rates have caused both the assets and liabilities to drastically shorten even in the General Account and we have recognized that you might be in trouble backing interest guarantees with General Account assets unless you have some sort of segmentation that enables you to tailor investments to liability needs. As a result, the industry has been moving to meet those needs.

Even so I think that many of us are making our tests to determine what reserves are appropriate for the annual statement this year. We're going to find that the current minimum reserve requirements aren't all that high;

that we think that they are adequate for most companies and will find that they are not that high. Even with the effort at matching most of the major companies in this business have done over the last ten years there is still a considerable C-3 risk underlying our interest guarantee business.

Now that is the business where the concept of matching assets and liabilities is easy to envision. When you get to individual life I don't know what matching of assets and liabilities means. I do not know whether we're talking about a long-term product or a short-term product. None of us do. And so is there a C-3 risk for individual life? Yes, of course there is It is a very profound risk and how to deal with it, I do not know. I think that the first thing is to understand it and try to measure it.

MR. JOHN MONTGOMERY: There are a number of comments that I want to make. One deals with the historical development of the Trowbridge Committee. Actually, the NAIC. Technical Task Force on Valuation and Non-Forfeiture appointed a committee chaired by Ed Lew which designed the questions. We then asked the Society to provide us with some answers. This is what was transmitted to, I believe, the Trowbridge Committee in the early stages.

Next I'd like to comment on John Angle's discussion at the very beginning about the way that the Guardian handled their investigation into whether or not they were adequately covered. This is something that the Financial Ratio Task Force is considering for all companies. One of the things that is being considered is placing into the Annual Statement Blank the total non-forfeiture liability. We are going to recommend that the 1982 blank include that. Also, at the Blanks Committee meeting in St. Louis a couple of weeks ago they put back in a requirement for showing the market value of assets. It is a very controversial item for the NAIC and I do not know whether it's going to stay in through the plenary session in New Orleans. I suspect that it may not. If it does not then there will probably be other proposals in connection with the bond maturity schedule to show the yields associated with each segment and then for other classes of assets to show the yield associated with them and thereby a market value could be estimated. This was actually what was proposed originally by the Committee on the Simplification of Blanks. So in some way we will be able to estimate the total market value. Whether or not it is actually disclosed, I do not know. Then the Financial Ratio Task Force intends to develop a ratio of the non-forfeiture liability to reserves and compare that with the ratio of the market value to surplus and thereby determine which companies are most likely to have problems with cash flow. There are many things that we can consider and we probably will. But that is basically one of the things that we are discussing.

In connection with the actuarial certification, the Financial Ratio Task Force of the NAIC originally proposed certification many years ago. Actually, the Valuation and Non-Forefeiture Technical Sub-Committee came about through a proposal of the Financial Ratio Task Force when we had no way of determining adequacy of reserves and had other problems that could not be solved directly from the Annual Statement Blank. The original proposal on certification by the Blanks Committee back in 1974 or 1975 stated the actuary was to verify the assets to make sure that they were properly matched. At that time, it was felt that there was not sufficient technical expertise on the part of actuaries to do that, so we moved away from that

point. We now are waiting for the Academy guidelines on this so that we can again make that a requirement for certification. However, until we get the guidelines to provide the actuaries with procedures we can't really include that in the certification requirements. We would like to very much but we just don't have the technology right now.

As to Walter Rugland's discussion of a new valuation law, the work of the Trowbridge Committee, and the C-3 work is going into the development of what we now call a statutory minimum surplus law. Now that may turn out to be a total reorganization of everything, but at this point this is the way we are going about it. It could be as we get down the line that may happen. However, we are hoping to get it going by 1985 and not by 1990. That is going to speed things up a bit. It may take us five years after we get it originally proposed to get it through, because it is a great re-education process, but I would like to see something by 1985. Already we have had one state, Wisconsin, that has gone off on their own and developed a minimum surplus law.

MR. EDWIN LANCASTER: I would very much like to applaud the work of this committee. In listening to Carl Ohman, I thought through the work that I have driven the Metropolitan actuaries to do in connection with our savings plans and guarantee investment contracts over the last ten years. I agree, you can model it, you can come up with something that you think that you can deal with but the individual contracts are so terribly complicated that we need to know a lot more about it.

I agree with Walter Rugland that our current valuation approach is simplistic. We need to have a valuation approach that takes account of the whole balance sheet and it has to be more than one-dimensional as the current one is.

All I'm saying is that I hope that we will proceed. A tremendous amount of work needs to be done and as I see it there is a lot of it.

MR. JOHN MAYNARD: The work that's being done is very new and it has been carried on in a very intense way. We are all trying to understand the impact of it as these reports and discussions take place. I'd like to ask a question that is aimed to bring out the nature of the methodology used. Carl Ohman brought out that the work is aimed to quantify the C-3 risk and the C-3 idea came from the Committee's designation of a contingency reserve in three parts. Of course an insurance company will probably only think of one contingency reserve pool. It will want to have assets covering its liabilities and that means that it will be solvent. It will want to have enough assets on hand to cover the contingency reserve that it needs. I think the Valuation Committee originally thought of the C-1, C-2, C-3 risks as convenient ways of looking at portions. I don't think that they meant that the contingency reserve would be divided up into these three sections. So I hope that in the quantification work that is proceeding the result will not be to try and define a pocket of the contingency reserve. I hope that the work will be capable of extending to the whole contingency reserve. Perhaps even to evaluate the other portions and the whole when you're finished. Is that true Carl?

MR. OHMAN: Yes. I'm glad that you mentioned it. Our initial effort has only been to look at the C-3 risk and to ignore in effect the C-1 and C-2 risks. Although there is work going on now on the C-1 risk, and Irwin Vanderhoof reported yesterday to your committee on some of the initial work that he has done there I think our examination of the C-3 risk is only a first step. Eventually, as we've had a chance to learn more about the other two risks by themselves, then we have to look at all three together because if you believe that there ought to be contingency reserves for each of these three risks then clearly the contingency reserve you need for the totality is not the sum of all parts. They are in some respects complimentary risks and then the question is to, how do you combine these and what sort of correlations or co-variance there is between these risks has to be explored. So merely identifying what the C-3 risk is, is only a first step in that direction. That's one aspect. The other thing you point out is the question of what assets you need to cover the liabilities. We're not addressing the question as to whether that asset should be included as reserve or surplus. That clearly is a question that ought to be addressed later on. We have not addressed it yet, but clearly we must. We thought that it was important first to understand the nature of the risk, and then to move onto these other questions.

MR. MAYNARD: Attempting to peer down the road a bit in the direction that we are headed, I'd like to put the company in the direction or position of wanting to have enough assets on hand to cover liabilities plus contingency reserve. Would any of the panel care to comment on the relation of product design to this question of a company living within margins to develop and continue liabilities and contingency reserve?

MR. OHMAN: I think that the point that you are making is the most critical. As we learn more about C-3 risk, one aspect is to make sure that on the valuation date, given what you've done in the past, you have properly structured assets and liabilities. But clearly this cannot help influence the way in which you design your products. Again in the guaranteed interest contract, as we understand the nature of the risk I think all of us are changing our products. The guaranteed interest products are inevitably moving toward durations that are more easily matched to the assets that you can acquire. Toward more careful structuring of the withdrawal provisions, and I think that all of us have learned a great deal about that. So certainly what we are doing in that particular area is greatly influencing the products. I think it is going to influence our individual life products perhaps even more. Obviously the whole concept of universal life is growing out of this concern. The concept that universal life needs to be supported by short term assets at least as presently envisioned is certainly one illustration of that. Another illustration is that with traditional individual life, if we are to survive, we have to find a way of dealing with the policy loan and the cash value question. And that means basically changing the laws governing cash values. I think that inevitably we are going to move in that direction. What we understand about C-3 risk and the other risks, could not help but support us in that direction.

MR. DONALD CODY: Mr. John Angle had invited me to say a few things about this paper that you have in your hands. I said that I thought that the paper spoke for itself, but if there was time I would be pleased to comment on it. I am encouraged to do it now because of John Maynard's questions because one reason for this discussion note was to put what the C-3 Task Force is doing in perspective. You will find, if you read this note carefully, that the position of the surplus need as described is made up of these three risks, C-1, C-2 and C-3. And there is discussion about the balance of it which we hope exists, which is the unused capacity available for growth and so forth.

To get back to John Maynard's question, a dollar in surplus is worth more than a dollar in reserves and if you set up a dollar for the C-1 risk and you need it for the C-3 risk that's fine. You will find in this paper our current ideas of the manner in which these various surplus needed items will be put together, with some recognition of the correlations between the risks (or the absence of correlation). Also important credits -- pass throughs -- the ability to reduce reserves. The extent to which dividend scales themselves in mutual companies are passthroughs.

Also you will find a careful treatment in the paper of the importance of product design and beyond that the kind of markets that the product is sold in. As was mentioned, we have some work available on the GIC which is very fine and demonstrates the simplest risks we have. We will shortly have something on the non-par risk and the participating risk, which is something I know more about. Participating insurance is very interesting. It is characterized more by different markets than non-par insurance. There are mutual companies that specialize in specific markets, so called specific sophisticated markets, where the cash values have been very high, the buyers have been very sophisticated and purchased the insurance on the basis of its investment value. The par risk is a greater risk because you have made representations about the level of dividends and you've got to earn enough on your assets, after the effects of disintermediation, to pay dividends. Of course you can reduce them and credit has to be given for that.

I do urge you to look at this discussion note. It is not final; I'm not even sure that all members of the Committee agree on all of its points. It is very different from some of my original ideas. It reflects the ideas of the Committee as fully as I could interpet them. You find some formulas in there that allow one to think through the material effects and the lesser effects which in some situations that can be very important. Also, the final section of the paper used these formulas to draw conclusions long before we had the figures. Some of the conclusions may be wrong, but they're pretty frightening. Another thing that isn't in there, but may strike you, is limitations on surplus to some companies don't make sense. I would say also, that the techniques that are being developed here you all may need when you sign statements. Because you're going to have to look at the extent to which the asset cash flow matches the liability cash flow, in order to give your actuarial opinion. If the future requires us in some manner to handle different products with

different aggregations of assets in the General Account you're going to need these techniques to communicate with your investment people. You'll have to have them computerized or you're going to have to do it orally in some way that's going to convince them. More importantly they are going to need them in order to see that we product people produce the kind of products that they can find assets for.

MR. HENRY B. RAMSEY, JR: My purpose is just to emphasize the tremendous intense inter-relationship between the pricing, the valuation and the financial statements, and the acceleration of the need to tie these things together in our work. Also to commend the increased use of book profit techniques in all of our work. I see no way in which you can ignore the direct tie between the pricing, the valuation and the financial statement. The financial results are clearly dependent on this structure and they do all hang together. In time, they must be a totally coordinated function. The Financial Accounting Standards Board work is moving formal reporting in this direction, so that valuation is now being recognized universally, not only in our own business, but as one of the most critical aspects of financial reporting. We have here all of the aspects of the financial management of our company held together in a way we have not recognized before. We really have a very intense job on our hands with a lot of dimensions to it.

MR. MONTGOMERY: What I would like to say relates to the remarks of John Maynard about the attention to the C-2 risk. Whenever it is investigated I believe that is important in health insurance and in the casualty and property lines of business and I think that if a study is made of that risk perhaps we should get some casualty actuaries involved. As a matter of fact, all of this work is important to the casualty actuarial field and I think that somehow we've got to get this across to them. I think we want to develop minimum surplus levels for all lines of business including casualty.

MR. TROWBRIDGE: I would like to respond to a part of John Montgomery's comments. The original Committee on Valuation and Related Matters was very cognizant of the fact that we were not talking just about life insurance problems. As a matter of fact if you will read that report you will see that the balance sheet of an insurance enterprise includes a lot of things besides life insurance companies. It is undoubtedly true that the C-2 risk is associated with casualty companies more than it is with life companies. Since we were operating across all casualty life lines the Committee has had a casualty actuary on it. Dave Grady was originally a member and still is.

I would like to make the plea that not only do we worry about C-3 but we certainly don't forget C-1 and C-2. C-1 has been bogged down in our Committee as well as C-2 and C-3, but C-1 has gotten some new lease on life also. That's not the subject of this discussion but I feel that our committee is now making some strides on C-1 as well as C-3. Frankly we're getting nowhere on C-2 and C-2 at least for some companies is the name of the game. Any researcher interested in C-2 field, we sure would like to see some progress along that line. It is relatively trivial for some kinds of life companies; it's not trivial for other kinds of life companies and it's important to casualty companies. We just have to make progress in that direction as well.

Discussion Note
Preliminary C-3 Risk Calculation
Prepared by James A. Tilley

This report describes the first major set of calculations by the Society of Actuaries Task Force to Study Risk of Loss from Changes in Interest Rates ("Task Force on C-3 Risk ").

I. Purpose of the Calculations

The purpose of the calculations is to demonstrate a methodology for (1) testing a given reserve basis with respect to its adequacy for protecting against the risk of loss due to interest rate fluctuations, and (2) determining the amount of surplus needed to protect against that risk.

II. Nature of the Calculations

The adequacy of a given reserve basis can be tested by performing the following set of calculations:

A. Build up a sample company from scratch to a certain point in time according to a set of "historical" assumptions — interest rate path, sales volume for each product, pricing margins, cash flow experience, asset mix, etc.

   The certain point in time — "today" — will be referred to as the "valuation date." Times before the valuation date make up the company's past or history and times after the valuation date define the company's future.

B. Determine the statement value of reserves (SVR) and the book value of the assets (BVA) on the valuation date, and scale the latter up or down by a factor SRF (statutory reserve factor) to equal the former. This is equivalent to scaling the book value of each asset holding by the same factor and allows the company to be brought into a state of exact statutory solvency while preserving its asset configuration. Equivalently, this balance at the valuation date is achieved by drawing from (or releasing to) a surplus reservior having the same asset configuration as the company,a block of assets with a book value equal to (SRF-1) x BVA.

C. Define a universe of future interest rate paths (commencing at the valuation date) and cash flow and asset mix assumptions for each path. The sample company is assumed to issue no new business beyond the valuation date. Project the company from the valuation date along each interest rate path until the last contract matures, and liquidate all remaining assets at their market value at that point.

   For each path, calculate the path sufficiency factor (PSF) that scales the BVA on the valuation date by the amount required to place the company in an exact break-even position at the time the last contract matures. The company will break even along the interest path if, on the valuation date, it draws from (or releases to) a surplus reservior having the same asset configuration as the company,a block of assets with book value equal to (PSF-1) x BVA.

D. Let MSF (maximum sufficiency factor) denote the largest of all the PSF's. The interest rate path having PSF = MSF is called the "worst path" since it requires the greatest addition to (or least subtraction from) the assets existing on the valuation date in order to assume the company of breaking even.

If every one of the interest rate paths in the universe defined in item C is possible, and the paths in the universe are the only ones possible, the MSF is the smallest factor by which the BVA on the valuation date can be scaled to be assured that the company will break even. Hence, the valuation methodology described here is based on a maximum decision criterion.

A measure of the adequacy of the given reserve basis must take into account that the BVA on the valuation date must be scaled by SRF to achieve a "starting" balance on that date. The reserve adequacy factor (RAF) is equal to the minimum additional scaling of BVA required to assure a break-even result. Thus, RAF = MSF $\div$ SRF.

A RFA $\leq$ 1 indicates that the statutory reserve makes sufficient provision to mature the obligations of the company along the worst interest rate path in the universe. A RAF $\geq$ 1 indicates that the statutory reserve does not make sufficient provision to mature the obligations of the company along the worst path.

The notation and equations are summarized below.

SVR - statement value of reserves on the valuation date
BVA - book value of "historical" assets on the valuation date
SRF - statutory reserve factor
PSF - interest rate path sufficiency factor
MSF - maximum sufficiency factor
RAF - reserve adequacy factor

$$SRF = SVR \div BVA$$

$$MSF = \text{maximum PSF}$$

$$RAF = MSF \div SRF$$

III. Sample Calculations

Interest guarantee contracts were chosen as the simplest example to illustrate the valuation methodology because interest rate risk is by far the dominant risk for that type of business.

Assumptions and the results of calculations for three sample companies are attached to this report. Each company has a five-year history. Companies A and B are single product companies — Company A has sold single sum lock-up interest guarantees and Company B has sold interest guarantees open to contributions for a one-year period from issue to be used as funding vehicles for qualified thrift plans. Company C has sold a variety of products. Different asset configurations, withdrawal assumptions, pricing margins, and historical interest rate paths were studied.

The column entitled "Guarantee Fund Factor" in the final three tables is the factor by which the BVA (book value of assets) on the valuation date must be scaled to equal the value of the interest guarantee fund on that date. The interest guarantee fund on a particular date is the accumulation to that date at the guaranteed rates of interest on contractual deposits less withdrawals.

The MSF (maximum sufficiency factor) for the thirteen future interest rate paths is the PSF (path sufficiency factor) that is underlined. The corresponding path is the "worst path." There is a unique worst path in each case but this is not evident from the figures shown because all results have been rounded to the nearest 0.01.

The reserve adequacy factors shown were obtained by dividing the MSF by the (SRF), using figures before rounding, and then rounding to the nearest .01.

IV. Discussion of Results

A. Investment strategy, that is, asset mix, and historical interest rate path affect the results in the expected manner. For example, 5-year par bonds are too short to back 7-year single sum deposit/bullet payout interest guarantees. A rising interest path is "good" and a falling path is "bad" for such an asset-liability configuration. It is no surprise, therefore, that the PSF's ≤ 1 for the "up" historical path and the PSF's > 1 for the "down" historical path.

B. For a given company and set of assumptions, there are several paths that have PSF's approximately equal to the MSF. Most of those paths are essentially the same in that they can be characterized generally as "up" or "down" or "up-down" or "down-up."

C. All other things being equal, higher (lower) pricing margins result in lower (higher) PSF's, as expected, but approximately the same RAF's (reserve adequacy factor).

D. Interest rate paths, historical and future, that are "good" for one product type may be "bad" for another. In such a situation, by playing off one product's strengths against another's weaknesses and vice versa, a reasonably stable financial picture can be achieved for the two products combined. As an example, Company C which is more diversified than either Company A or B with respect to both its asset and its liability portfolios, exhibits a smaller range of variation of PSF's (0.95 to 0.97 and 1.02 to 1.05) than does either of the other companies.

E. The results for Companies A and B show that, with respect to a single product type, minimum reserves calculated on the basis of the Dynamic Valuation Law (1980 amendments to the NAIC Model Standard Valuation Law) may not always make adequate provision to mature obligations. The sample calculations indicate inadequacy, for a single product type, along sharply rising paths if assets are invested too long for the liabilities and along sharply falling paths if assets are invested too short for the liabilities. The results for Company C, however, a multiple product (interest guarantees only) company that has managed its assets and liabilities together during its five-year history, do show minimum reserves based on the Dynamic Valuation Law to be adequate.

It would be premature to offer general comments on the adequacy of current minimum reserve standards at least until the Task Force on C-3 Risk completes its calculations for life insurance and other products.

V. Acknowledgement

The Task Force would like to thank Mr. Gordon Dinsmore, Jr. FSA, for designing the general model and directing the calculations described in this report and Mr. Walton Davis, ASA, for building the model and performing the calculations. Without many hours of their time, the Task Force could not have demonstrated significant progress.

Assumptions

1. Company history

   We assume a five-year history over which interest guarantee contracts are sold and an asset portfolio is developed.

2. Interest Rate Paths

   We assume two historical interest rate paths:

	Beginning of Year					
	-5	-4	-3	-2	-1	0
"Up" History	8%	9%	10%	11%	13%	15%
"Down" History	22	21	20	19	17	15

   To each historical path, we append the following thirteen future interest rate paths.

Interest Rate Path	Year										
	0	1	2	3	4	5	6	7	8	9	10
1	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%
2	15	17	19	21	23	25	25	25	25	25	25
3	15	13	11	9	7	5	5	5	5	5	5
4	15	17	19	21	23	25	23	21	19	17	15
5	15	17	19	21	23	21	19	17	15	13	11
6	15	17	19	21	19	17	15	13	11	9	7
7	15	17	19	17	15	13	11	9	7	5	5
8	15	17	15	13	11	9	7	5	5	5	5
9	15	13	11	9	7	5	7	9	11	13	15
10	15	13	11	9	7	9	11	13	15	17	19
11	15	13	11	9	11	13	15	17	19	21	23
12	15	13	11	13	15	17	19	21	23	25	25
13	15	13	15	17	19	21	23	25	25	25	25

   We assume that all yield curves are level, that is, short-, intermediate-, and long-term rates are all the same.

   Interest rates at fractional durations are computed by linear interpolation.

3. Liability Structure

New business is issued once a year at the beginning of the year over the five-year period. We assume no future issues — the last block of business is sold at the beginning of the 5th historic year. All contracts have the following specifications:

A. Guarantees conform to the "X-Y-Z" mold; contributions are permitted during the first X years of the contract, contributions are not permitted during the next Y years of the contract, and the fund payout is delivered in level installments over the final Z years of the contract.

B. In any issue year, the interest guarantee rates for each type of contract are calculated as some margin below the new money rate at the time of issue. For example, if at the beginning of a historical year the new money rate is 12% and the block of business issued then is composed of 0-7-0 contracts with a 50 basis point margin and 1-4-5 contracts with a 100 basis point margin, the 0-7-0 and 1-4-5 contracts are guaranteed at 11.5% and 11% respectively.

C. For each X-Y-Z type, an initial deposit (ID) occurs at inception of the contract and contributions are accepted once a year at mid-year in each of the first X contract years. The contribution is zero in years following and including the first year that the then current new money rate (CNMR) exceeds the new money rate at inception (INMR) by 100 basis points or more. In all other years of the contribution period, the contribution is assumed to be a linear function of the interest rate path and can be expressed as:

$$ID \times (1+2\times(INMR-CNMR))$$

D. Withdrawals occur once a year at mid-year beginning in the second contract year and ending in the last year of the Y period. Withdrawals are calculated as a percentage of the guarantee fund balance at time of withdrawal.

In any withdrawal year, the pro-rata withdrawal rate is:

$$.10 + \begin{cases} (.2/.09) \times (CNMR - (INMR + .01)) & , CNMR > INMR + .01, \\ 0 & , CNMR \leq INMR + .01. \end{cases}$$

In any withdrawal year, the LIFO withdrawal rate is:

$$\begin{cases} (.15/.06) \times (CNMR - (INMR - .04)) & , CNMR > INMR + .04, \\ 0 & , CNMR \leq INMR + .04. \end{cases}$$

There are no withdrawals on single sum (0-Y-0) guarantees.

Graphs of the three withdrawal scales are attached.

For each guarantee type, the accumulated fund at the end of the Y period is paid out over the Z period in equal installments at the guarantee rate once a year at mid-year.

4. Statutory Reserves

All reserves are calculated on an increase-in-fund basis according to the 1980 ammendments to the NAIC Model Standard Valuation Law. We approximate the 12-month average of Moody's Seasoned Corporate Bond Composite Index for applying the Dynamic Valuation Law by using the new money rate at the beginning of the current year and reducing it by 50 basis points.

5. Asset Structure

Cash flow, consisting of client transactions and investment returns, occurs semiannually and is invested (or borrowed) immediately. The investment strategy at any time is some mix of the following four asset types:

(i) One-year Treasury bills,
(ii) Five-year par bonds with bullet repayment of principal,
(iii) Ten-year private placement bonds with ten equal sinking fund payments,
(iv) Fifteen-year private placement bonds with ten equal, sinking fund payments commencing in the sixth year.

Issuers of T-bills and five-year bonds may not prepay principal. Issuers of the private placement bonds may prepay after a five-year call protection period has elapsed. Prepayment (without penalty) occurs once a year at the same time that scheduled principal repayment occurs. The percentage of the original face amount prepaid depends on the interest rate path. The prepayment rate is assumed to be:

0	when			CNMR	>	Yield - 2%
.10	when Yield -	2%	≥	CNMR	>	Yield - 4%
.15	when Yield -	4%	≥	CNMR	>	Yield - 6%
.20	when Yield -	6%	≥	CNMR	>	Yield - 8%
.30	when Yield -	8%	≥	CNMR	>	Yield - 10%
.50	when Yield -	10%	≥	CNMR		

Negative cash flow is treated as a negative reinvestment (disinvestment), or equivalently as a loan.

6. Expenses

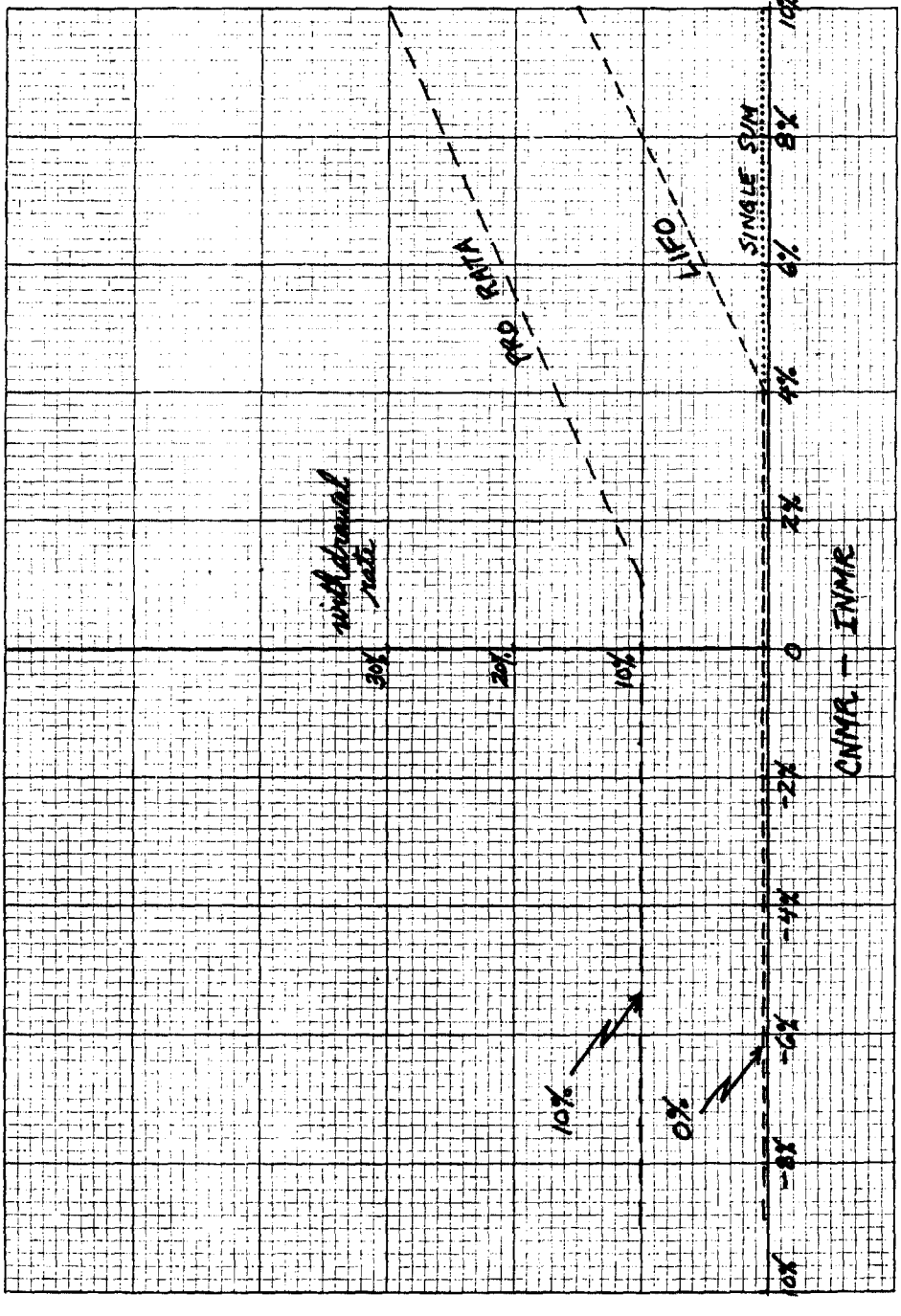
Expenses are ignored in the calculations. Alternatively, they can be considered to be treated approximately by assuming that new money rates are net of investment and all other expenses.

7. Federal Income Taxes

Federal income taxes are ignored in the calculations. If they were included, it would make sense to expand the asset structure to include discount bonds as an investment option. This will be modeled in later calculations.

Description of Sample Companies

Companies A,B, and C receive total initial deposits of $100,000 from each new block of guarantees at issue.


withdrawal rate
30%
20%
10%
PRO RATA
LIFO
SINGLE SUM
10%
8%
6%
4%
2%
0
-2%
-4%
-6%
-8%
10%
CNMR - INMR
10%
0%

Company A issues only 0-7-0 guarantees. No withdrawals are permitted.

Company B issues only 1-4-5 guarantees. Withdrawals are on either an all pro-rata or all LIFO basis.

Company C issues the following:

Beginning of Year	Type of Guarantee	Margin	% of Total Initial Deposits
-5	0-5-0	.50%	8.33%
	0-7-0	.50	8.33
	0-9-0	1.00	8.33
	5-0-0	1.00	25.00
	5-0-5	1.00	25.00
	4-0-5	1.00	25.00
-4	same as year	-5	
-3	0-5-0	.50	12.50%
	0-7-0	.50	12.50
	5-0-0	1.00	18.75
	4-0-0	1.00	18.75
	5-0-5	1.00	18.75
	4-0-5	1.00	18.75
-2	0-3-0	.50	8.33%
	0-5-0	.50	8.33
	0-7-0	.50	8.33
	1-4-5	1.00	25.00
	1-4-0	1.00	25.00
	5-0-5	1.00	12.50
	5-0-0	1.00	12.50
-1	0-3-0	.50	8.33%
	0-5-0	.50	8.33
	0-7-0	.50	8.33
	1-4-5	1.00	25.00
	1-4-0	1.00	25.00
	1-2-5	1.00	25.00

In addition, Company C invests all new cash according to the following investment strategy:

	% of Total New Money Invested In		
Year	5-yr.Bonds	10-yr. DP's	15-yr. DP's
-5	0 %	75 %	25 %
-4	0	75	25
-3	25	62.5	12.5
-2	37.5	62.5	0
-1	50	50	0
1-10	50	50	0

Company C allows no withdrawals on 0-Y-0 guarantees. All other guarantees allow pro-rata withdrawals.

COMPANY A

Investment Strategy	Withdrawal Scale	Margin	Asset Value (in 000's) Book	Asset Value (in 000's) Market	Guar. Fund Factor	Stat. Res. Factor
			"Up" Historical Path			
5-yr Par Bonds	zero	25 pts	$ 662	$ 626	.99	1.02
		75 pts	662	626	.97	.99
15-yr DP's	zero	25 pts	662	553	.99	1.02
		75 pts	662	553	.97	.99
			"Down" Historical Path			
5-yr Par Bonds	zero	25 pts	903	951	1.01	1.08
		75 pts	903	951	.99	1.05
15-yr DP's	zero	25 pts	903	999	1.01	1.08
		75 pts	903	999	.99	1.05

COMPANY B

			"Up" Historical Path			
5-yr Par Bonds	Pro-rata	50 pts	957	904	.98	1.00
		100 pts	961	908	.97	.97
	LIFO	50 pts	1,277	1,207	.97	.99
		100 pts	1,277	1,207	.96	.96
15-yr DP's	Pro-rata	50 pts	957	789	.98	1.00
		100 pts	961	792	.97	.97
	LIFO	50 pts	1,277	1,075	.97	.99
		100 pts	1,277	1,075	.96	.96
			"Down" Historical Path			
5-yr Par Bonds	Pro-rata	50 pts	1,361	1,440	1.00	1.03
		100 pts	1,371	1,443	.98	1.00
	LIFO	50 pts	1,730	1,822	1.01	1.05
		100 pts	1,730	1,822	1.00	1.02
15-yr DP's	Pro-rata	50 pts	1,367	1,516	1.00	1.03
		100 pts	1,371	1,520	.98	1.00
	LIFO	50 pts	1,730	1,910	1.00	1.05
		100 pts	1,730	1,910	1.00	1.02

COMPANY C

------"Up" Historical Path------	$ 841,214	$ 748,658	.96	.96
---- "Down" Historical Path-----	1,815,837	1,956,343	1.00	1.04

COMPANY A

Path Sufficiency Factor													
1	2	3	4	5	6	7	8	9	10	11	12	13	*
"Up" Historical Path													
.89	.87	.91	.87	.87	.87	.87	.87	.91	.91	.91	.91	.91	.90
.86	.84	.88	.84	.84	.84	.84	.85	.88	.88	.88	.88	.88	.90
1.01	1.10	.96	1.10	1.09	1.05	1.01	.97	.95	.92	.94	1.00	1.07	1.09
.98	1.07	.93	1.07	1.05	1.02	.98	.94	.92	.89	.91	.97	1.04	1.09
"Down" Historical Path													
1.11	1.08	1.11	1.08	1.08	1.08	1.08	1.08	1.08	1.11	1.11	1.11	1.11	1.03
1.06	1.05	1.08	1.05	1.05	1.05	1.05	1.05	1.08	1.08	1.08	1.08	1.08	1.03
1.04	1.10	1.05	1.10	1.09	1.07	1.05	1.04	1.04	1.03	1.03	1.05	1.09	1.02
1.01	1.07	1.02	1.07	1.06	1.04	1.02	1.01	1.01	1.00	1.00	1.02	1.06	1.02

COMPANY B

"Up" Historical Path													
.90	.89	.93	.89	.89	.89	.89	.90	.93	.93	.93	.92	.90	.94
.87	.86	.90	.86	.86	.86	.87	.88	.90	.90	.90	.92	.88	.94
.86	.84	.91	.84	.84	.84	.84	.86	.91	.91	.91	.90	.87	.92
.84	.81	.88	.81	.81	.81	.82	.84	.88	.88	.87	.86	.84	.91
1.03	1.10	1.01	1.11	1.10	1.09	1.06	1.02	1.01	.97	.97	1.01	1.04	1.11
1.00	1.07	.97	1.08	1.07	1.05	1.03	.99	.98	.94	.95	.98	1.01	1.11
.97	1.05	.95	1.05	1.03	1.01	.98	.95	.94	.90	.92	.97	1.01	1.06
.94	1.01	.92	1.02	1.00	.98	.95	.92	.91	.87	.89	.94	.98	1.06
"Down" Historical Path													
1.07	1.04	1.11	1.04	1.04	1.04	1.04	1.06	1.11	1.11	1.10	1.10	1.07	1.07
1.04	1.01	1.07	1.01	1.01	1.01	1.01	1.03	1.07	1.07	1.07	1.06	1.04	1.07
1.09	1.05	1.14	1.05	1.05	1.05	1.06	1.09	1.14	1.14	1.14	1.12	1.10	1.08
1.06	1.02	1.11	1.02	1.02	1.02	1.03	1.06	1.11	1.11	1.10	1.09	1.07	1.08
1.01	1.04	1.05	1.04	1.03	1.02	1.01	1.03	1.04	1.05	1.05	1.04	1.03	1.02
.98	1.00	1.02	1.01	1.00	1.00	.98	1.00	1.01	1.02	1.02	1.01	1.00	1.02
1.04	1.08	1.08	1.08	1.07	1.05	1.04	1.05	1.07	1.06	1.07	1.07	1.07	1.03
1.01	1.05	1.05	1.05	1.04	1.02	1.01	1.02	1.04	1.02	1.04	1.04	1.04	1.03

COMPANY C

.95	.97	.95	.97	.97	.97	.96	.96	.95	.95	.94	.95	.95	1.00
1.02	1.02	1.04	1.02	1.02	1.02	1.02	1.03	1.04	1.05	1.04	1.03	1.02	1.00

* Reserve Adequacy Factor

Discussion Note

Contingency Surplus Needed for (C-3) Risk of Change in Interest Environment

Donald D. Cody

This paper provides technical background intended to aid understanding of the work of the SOA Task Force to Study Risk of Loss from Changes in Interest Rate Environment (C-3 Risk Task Force). It consists of three sections:

1. Total Contingency Surplus Needed for C-1, C-2 and C-3 Risks
2. Contingency Surplus Needed for the C-3 Risk- General
3. Contingency Surplus Needed for the C-3 Risk- Technical

For an appreciation of how C-3 Surplus Needed relates to the overall Contingency Reserve Needed, the first section will discuss all types of risk.

1. Total Surplus Needed for C-1, C-2, and C-3 Risks

1.1 Structure of Reserves and Surplus

Consider first the reserve and surplus structure of a life insurance company: Reserves Actuarial reserves held in the statutory financials are intended to provide good and sufficient provision for in-force contractual obligations based on reasonable variations of claims, expenses, terminations, withdrawals and investment earnings (including capital gains and losses) from those expected under normal conditions.

Contingency Surplus Needed Contingency surplus needed is intended to provide additional good and sufficient provision for in-force contractual obligations on the assumption of further plausible variations of which the probability of occurrence is quite small. The level of such needed surplus varies inversely with the level of probability e.g. surplus needed at the .0001 level is higher than at the .001 level; management must decide on this level of probability and regulators would have an interest. This surplus needed represents the extent in-force business has used capacity.

Statutory Surplus (including MSVR and other such reserves) Statutory surplus held in statutory financials consists of capital, any special surplus funds and unassigned surplus. This statutory surplus should be augmented by the Mandatory Security Valuation Reserve and similar reserves set up for potential asset impairments and claims fluctuations for purposes of this discussion.

Vitality Surplus What I call "vitality surplus" is the excess of the augmented statutory surplus over the contingency surplus needed for risks on in-force business. It is a revolving fund from which capital is drawn to provide for growth of new business and marketing systems, for new administrative systems, new products and lines, new subsidiaries and blocks of business, and for bolder underwriting and investment policy; into which net income (after stockholder dividends and FIT) flows; and from which increase in contingency surplus needed is subtracted. It thus represents the available capacity of the company to improve, grow and undertake risks. Its appropriate size can

be determined only by projecting capital needs under a long range plan, subject to a minimum size appropriate to the least ambitious plan deemed reasonable and sufficient to allow the company to recover its vitality, should contingency surplus needed be largely dissipated by realization of heavy losses.

1.2 Categories of Risk

The SOA Committee on Valuation and Related Problems has defined investment and insurance risks as follows:

C-1 Risk: Asset default and related loss of income and loss of market values of common stocks and related reduction of stock dividends.

C-2 Risk: Losses due to premium inadequacy, other than C-1 and C-3 risks.

C-3 Risk: Losses due to changes in interest rate environment, other than C-1 risks.

An additional risk category not in the SOA nomenclature involves risks of an accounting nature, such as potential FIT liabilities, bad debts, or lawsuits, not yet admitted in the statutory financials.

1.3 Contingency Surplus Needed for C-1, C-2 and C-3 Risks - In General

The contingency surplus needed is defined as an amount which has a defined very small probability P of being dissipated at some future time by realization of one risk or a sequence of risks. In a well defined mathematical world, all plausible risk scenarios would be modelled and assigned specific probability distributions and then combined into an overall global model and distribution function, enabling a precise determination of surplus needed at various probability levels of ruin. One of these levels would then be selected by management as appropriate. In the real world, such a theoretically ideal approach is impractical. This suggests the theoretical approach only for the stochastic portion of the C-2 risk involving variations in total death claims amenable to classic ruin theory and specific deterministic scenarios, with estimated probabilities of occurrence, as surrogates for the ideal approach in all other areas.

C-1 and C-2 Risks Contingency Surplus Needed for C-1 and C-2 Risks can be estimated by deterministic and stochastic methods as outlined in RSA 3:1 (1977) pp 27-40. In most life insurance companies, the C-1 risk will be found to dominate the C-2 risk; however, C-2 risk can be sizable in companies specializing in reinsurance, group life and health, or long term disability. For purposes of this paper, it is assumed that the surplus needed for each risk within the C-1, C-2 and C-3 categories is established approximately at probability level P (say, .001). C-3 risk is treated in Sections 2 and 3.

Combination of Risks Obviously, contingency surplus needed in total is not the simple addition of the surplus needed for each specific risk within the SOA major categories. To determine the contingency surplus needed in total accurately, it would be necessary to have the distribution function for the sum of losses from all possible risks, enabling one to say that there is probability P that losses will exceed a contingency surplus CS. As indicated

above, this approach boggles the mind. Instead, there is a simplistic combinatorial method which combines surplus needed on specific risks into groupings and then into larger groupings and finally in total. The order of combination, which is not unique, involves separately combining fully correlated risks and partially correlated risks and finally the uncorrelated combination of these and other risks. It is believed that this simplistic process is compatible with the magnitude nature of surplus needed determinations. The simplistic formula for combining two risk combinations is as follows:

Let S_A = contingency surplus needed for risk combination A at probability level P

S_B = contingency surplus needed for risk combination B at probability level P

S_{A+B} = contingency surplus needed for risk combination A+B probability level P

$r_{A,B}$ = correlation coefficient between risks A and B

Then

$$S_{A+B}^2 = S_B^2 + S_B^2 + 2\, r_{A,B} S_A S_B$$

Incidentally, this formula applies rigorously to the sum of losses from risks A and B related to each other on a bivariate normal distribution with correlation coefficient $r_{A,B}$. Each of the losses separately and the sum of the losses are then normally distributed with standard deviations in a constant ratio respectively to S_A, S_B and the square root of $S_A^2 + S_B^2 + 2\, r_{A,B}\, S_A\, S_B$.

Here are some illustrations of this formula applied to various pairs of risks:

$r_{A,B} = 1$: $S_{A+B} = S_A + S_B$

e.g. A is the C-1 risk due to serious recession or depression
B is the C-2 risk on disability income in the recession or depression

$r_{A,B} = 0$ $S_{A+B}^2 = S_A^2 + S_B^2$

e.g. A is the C-1 risk due to serious recession or depression
B is the C-2 risk from stochastic variation in total death claims

$r_{A,B} = .5$ (?) $S_{A+B}^2 = S_A^2 + S_B^2 + S_A\, S_B$

e.g. A is the C-1 risk due to serious recession or depression
B is the C-3 risk due to change in interest environment which could precede or coincide with the recession or depression

Credits Against Contingency Surplus Needed Contingency surplus needed is first calculated gross ignoring various credits. Then, such credits are subtracted to obtain the net contingency reserve needed. Examples of such credits are as follows: Reductions in policyholder dividends to the extent such reductions can be made without destroying company reputation and viability

in the marketplace. Pass-throughs to policyholders on IPG Group Annuities to the extent realistically applicable. Destrengthening of annuity reserves to the extent of any conservatism introduced for FIT reasons. Destrengthening of A & H claim reserves to the extent of any conservatism.

Contingency Surplus by Line It is desirable to develop contingency surplus needed by major line and even for products within lines in the process of developing it for the total company. This makes it possible to determine which products are using up capacity and to judge whether they are producing sufficient net income to cover their utilization of capacity.

2. Contingency Surplus Needed for (C-3) Risk of Change in Interest Rate Environment - General

All insurance, investment and annuity contracts involve guarantees of interest rates, termination and withdrawal values, and maturity values. These contract obligations are supported by asset configurations with selected maturity schedules and providing investment income dependent on the level and shape of the yield curve at the time each asset was purchased with net cash flow (+ or -) during the lifetime of the contract. The dynamics of the assets (e.g. call provisions) and the dynamics of the liabilities (e.g. presistency of premium payments, voluntary withdrawals, claims, etc.) are dependent on the on-going changes in the new money interest rate environment, which affects the attractiveness of competing investments and replacing contracts. Losses caused by these dynamics are the C-3 risk, which is of two types:

Downside Movement of Interest Rates Here the risk is that interest earned will not support interest required on contract reserves. This risk exists where contract liabilities are longer than supporting assets, since assets roll over more rapidly than liabilities decrease and are reinvested at lower interest rates.

Upside Movement of Interest Rates Here the risk is that disintermediation (voluntary withdrawals and terminations) will occur, leading to sales of assets at market values below book values, or equivalently, to borrowing from other contracts or lines with the obligation of paying the new money rate to the other contracts or lines, so that the resultant IYM earnings rate is lowered algebraically. This risk exists where liabilities are shorter than supporting assets, leading to negative cash flow under the contract.

It is notable that assets tend to shorten and liabilities to lengthen as interest rates fall and, conversely, assets tend to lengthen and liabilities to shorten as interest rates rise, thereby increasing the C-3 risk further. Also, as steps are taken to ameliorate the upside risk by shortening assets, the downside risk is increased; the downside risk is quite real even in the present high interest rate environment on GIC's with high interest guarantees and on indexed deferred annuities and universal life insurance.

The upside risk can be large on investment type contracts with book value voluntary withdrawal guarantees or on life insurance policy loan interest rates of 5% and 6%, if supporting assets have long maturities. Because of the volatile, high inflation, high new money rate economic environment expected in the foreseeable future life, insurance companies are anticipating disintermediation by various actions:

Shortening maturities of new investments

Segmenting general accounts and using separate subsidiaries and separate accounts so as to match asset cash flow and liability cash flow better on different types of contracts.

Planning to adopt the dynamic policy loan interest rate as legislatures approve the new model NAIC statute

Introducing new types of product (GIC's, deferred annuities with high total interest credits, universal life insurance, indeterminate premium life insurance) with supporting asset configurations designed to match liabilities.

These actions, properly taken, can reduce the upside C-3 risk but cannot remove it. The 1980 NAIC model dynamic interest valuation, non-forfeiture and policy loan interest statutes, now slowly working through the legislatures, are an important feature in this revolution; their design was based on the C-3 risk theory set forth in this paper.

The SOA C-3 Risk Task Force is in the process of quantifying the C-3 Surplus Needed in the only possible way: running a large number of plausible new money interest rate scenarios on contracts of all designs in markets of different sophistications. Consider the factors involved in such determinations:

Interest rate scenarios:	Upside, downside, mixed (cap and cup), past, future
Assets:	Long, medium, short, very short, calls
Product:	Investment (GIC, individual deferred annuity, universal life, S.P. life, group annuity)
	Insurance: (non-par conventional life, par conventional life, indeterminate premium life)
	Immediate annuity
	Group life and health
	Long term disability
Design:	Guaranteed interest rates
	Maturity values (book and market)
	Voluntary withdrawal values (book and market)
	Policy loan interest rates
	Statutory reserve bases
Markets:	Sophisticated with large average size: unsophisticated with medium or small average size
Voluntary termination and	withdrawal rates (including policy loans): dynamic functions of all of the above
IYM Prodedures:	In these tests, an IYM procedure will be followed on the assumption that C-3 risk will affect only on-going investment income i.e. assets will not have to be sold with immediate capital losses in upside situations to provide cash for disintermediation, but rather interline borrowing will be possible. C-3 surplus needed, so determined, will be adequate to meet such capital losses on forced sales because of the equivalency of selling assets and borrowing assets at market. Of course, if assets have to be sold at a loss, company surplus

is immediately reduced, rather than being subject merely to long range erosion.

The SOA Task Force tests are being run at the product level, and results can then be added for the whole company with attention to any offsets among products.

The C-3 Contingency Surplus Needed in essence is an amount which will fund future potential losses consisting materially of the excess of required interest on reserves over IYM earned investment income, after FIT, less a credit for effective surrender charges on withdrawals and terminations, according to scenarios at probability level P. This will be described more fully in Section 3.

This essential definition of C-3 Surplus Needed, while valuable analytically, is not sufficiently complete, is dependent on reserve basis and is complex for calculations. The Task Force has, therefore, decided to compute Assets Needed at each valuation date to assure breakeven at maturity along the "worst path" scenario among the scenarios chosen. The contingency surplus needed is then the excess of the Assets Needed over the reserve. While this determination is less conservative in the case of conservative reserves than the above "differential" approach because it tolerates negative surplus at future durations of the scenario, it is believed to be a satisfactory procedure. James Tilley's companion paper illustrates this approach for GIC's using two past scenarios and thirteen future scenarios (up, down, cup, cap). The GIC is a simple contract to analyze because FIT can be ignored, it is non-participating, and expenses can be charged against investment income and loading. In tests of other contract types, the calculations will include loadings, expenses, FIT, mortality effects and dividends.

While work is proceeding so far only at product level, we recognize that different products have different cash flow characteristics, with some offsetting, and that products must be combined into years of issue, into lines, and into companies. However, even at the product level stage, we hope to provide guidance as to the interplay of asset configurations, product design, and interest rate scenarios. Investment planning and dynamics must be tied to product design and marketing planning intelligently in the future volative interest environment. Segmentation of the general account appears to be needed and capacity available appears to be a prime planning tool.

An attempt will be made to estimate the probability level P attaching to this multiple scenario deterministic approach to C-3 Surplus Needed for eventual combination with C-1 and C-2 Surplus Needed determinations.

3. Contingency Surplus Needed for (C-3) Risk of Change in Interest Rate Environment - Technical

This section will present analytical background for Section 2 and will provide some tentative conclusions based on the mathematics.

3.1 Immunization Theory

Classical immunization theory is not directly useful in determination of C-3 Surplus Needed because of inapplicability to statutory asset values and reserves and because of certain serious simplifications. It relates to an

interest scenario consisting of a constant increase or decrease in new money rates into the future. It assumes applicability of Taylor's Exapnsion, implying a surplus function completely defined by all orders of partial derivatives with respect to the interest rate valued at duration zero. It assumes that the remainder term involving the third partial derivative is negligible. And, in its simplest form, it assumes that the asset and liability cash flows are independent of the interest scenario, thereby ignoring the effects of voluntary withdrawal values, terminations, and call provisions on bonds and mortagages. However, immunization theory does supply insights into the basic effects of varying interest rates. First some definitions:

t = duration

a_t = asset cash flow at duration t (dividends, interest, rent, mortagage payments, maturities, prepayments, repayments, etc.)

l_t = liability cash flow at duration t (claims, cash and withdrawal values, policy loans, expenses, taxes, (-) premiums, etc.)

i = new money interest rate (assumed level into the future)

$$A(i) = \sum_{t=1}^{\infty} (1+i)^{-t} a_t$$ = assets at market value at t = o

$$L(i) = \sum_{t=1}^{\infty} (1+i)^{-t} l_t$$ = liabilities at "market value" at t = 0

$$S(i) = A(i) - L(i)$$ = surplus at "market value" at t = 0

Suppose that i_o is the value of i anticipated and that the cash flow stream of a_t and l_t is estimated for an i_o scenario. What happens to S(i), if the interest scenario is i where $|i - i_o| > 0$? On the ideal assumption that S(i) can be expanded by Taylor's Exapnsion, the following results:

$$S(i) = S(i_o) + (i-i_o)\left(\frac{\partial S}{\partial i}\right)_{i_1} + \frac{(i-i_o)^2}{2}\left(\frac{\partial^2 S}{\partial i^2}\right)_{i_o} + \frac{(i-i_o)^3}{6}\left(\frac{\partial^3 S}{\partial i^3}\right)_{\bar{i}}$$

where $\bar{i} = k i_o + (1-k) i \qquad 0 < k < 1$

Now, let $S(i_o) = A(i_o) - L(i_o) = o$

$V_o = (1+i_o)^{-1}$

$$D_1^A = \frac{1}{A(i_0)} \sum_{t=1}^{\infty} t v_0^t a_t$$

$$D_1^L = \frac{1}{L(i_0)} \sum_{t=1}^{\infty} t v_0^t l_t$$

valued at i_0 · D_1^A and D_1^L are respectively the Macauley duration of asset and liability cash flow, referred to in the Section 2 text as "length" of assets and liabilities.

$$D_2^A = \frac{1}{A(i_0)} \sum_{t=1}^{\infty} t^2 v_0^t a_t \qquad D_2^L = \frac{1}{L(i_0)} \sum_{t=1}^{\infty} t^2 v_0^t l_t$$

valued at i_0 · D_2^A and D_2^L are respectively the second moments of asset and liability cash flow, representing "spread" of payments.

(The algebraic difference between D_1^A and D_1^L, and between D_2^A and D_2^L are measures of the degree of immunization of assets and liabilities or degree of matching.

Then
$$\frac{S(i)}{L(i_0)} = -(i-i_0)\left[D_1^A - D_1^L + \frac{1}{L(i_0)} \sum_{t=1}^{\infty} v_0^t \left\{\left(-\frac{\partial a_t}{\partial i}\right) + \left(\frac{\partial l_t}{\partial i}\right)\right\}_{i_0}\right]$$

$$+ \frac{(i-i_0)^2}{2}\left[\left(D_2^A - D_2^L\right) + \left(D_1^A - D_1^L\right) + \frac{2}{L(i_0)} \sum_{t=1}^{\infty} t v_0^{t+1} \left\{\left(-\frac{\partial a_t}{\partial i}\right) + \left(\frac{\partial l_t}{\partial i}\right)\right\}_{i_0}\right.$$

$$\left. - \frac{1}{L(i_0)} \sum_{t=1}^{\infty} v_0^t \left\{\left(-\frac{\partial^2 a_t}{\partial i^2}\right) + \left(\frac{\partial^2 l_0}{\partial i^2}\right)\right\}_{i_0}\right]$$

plus remainder term assumed neglible.

where $\left(\frac{\partial l_t}{\partial i}\right)_{i_0}$ and $\left(\frac{\partial^2 l_0}{\partial i^2}\right)_{i_0}$ are assumed positive for smaller t

$\left(\frac{\partial a_t}{\partial i}\right)_{i_0}$ and $\left(\frac{\partial^2 a_0}{\partial i^2}\right)_{i_0}$ are assumed negative for smaller t

because of the usual response of a_t and l_t to changes in interest,

The second term on the right is usually positive and smaller than the first term. It indicates that a larger excess of the spread of asset cash flows over liability cash flows favorably affects S(i).

If $D_1^A = D_1^L$ and $\frac{\partial a_t}{\partial i} = \frac{\partial l_t}{\partial i} = 0$, we obtain the classical Reddington 100% immunization formula: $\frac{S(i)}{L(i_0)} = \frac{(i-i_0)^2}{2}\left(D_2^A - D_2^L\right)$

This is a formula of no direct interest in C-3 risk theory, but investment managers of managed funds have successfully used it to assure yields by in effect continuously equating Macauley duration to the investment horizon by routinely rebalancing the fund by purcahses and sales of securities.

Let us assume that, for purposes of basic understanding, the first term is a sufficiently accurate representation of the function S(i):

$$S(i)/L(i_0) \doteq -(i-i_0)\left[\left(D_1^A - D_1^L\right) + \frac{1}{L(i_0)}\sum_{t=1}^{\infty} v_0^t \left\{\left(-\frac{\partial a_t}{\partial i}\right) + \left(\frac{\partial l_t}{\partial i}\right)\right\}_i\right]$$

If $D_1^A \quad D_1^L$, then $S(i) < 0$ for $i > i_0$

and $S(i) > 0$ for $i < i_0$

with the effect increased by changes in a_t and l_t.

If $D_1^A < D_1^L$, then $S(i) > 0$ for $i > i_0$

and $S(i) < 0$ for $i < i^\circ$

with the effect moderated by changes in a_t and l_t.

These relationships were the basis of the general remarks in Section 2 as to the effects of the direction and size of the mismatch of the lengths of assets and liabilities.

3.2 Material Factors Involved in C-3 Surplus Needed

Now, let us move to the real world of the statutory financials and develop some analytical formulations displaying the manner in which the many factors and functions in Section 2 affect the C-3 Surplus Needed. Again, some definitions.

n = policy year or duration

A_n = asset share per unit of issue on book basis

V_n = statutory reserve per unit of in-force (NLP, CRVM, or CARVM)

Π_n = gross premium per unit of in-force

L_n = loading per unit of in-force $= \Pi_n - P_n$

P_n = net premium per unit of in-force

q^{w}_{n-1} = termination or withdrawal rate

q'_{n-1} = actual mortality rate

$p'_n = p'_{n-1}\left(1 - q^{w}_{n-1} - q'_{n-1}\right)$

q_{n-1} = mortality rate of reserve basis

i'_n = IYM net investment income rate (including effects of policy loans) after FIT applicable to investment income and assets, investment expenses and C-1 risk charge. The IY asset segments can be + or -; negative cash flow is covered by borrowing from other products and not by sales of securities.

i = interest rate of reserve basis

$\bar{\imath}_n$ = i plus dividend excess interest or excess interest credit on universal life and individual deferred annuity

F_n = death benefit per unit of in-force

D_n = policyholder dividend per unit of in-force

C_n = cash value per unit of in-force

E_n = expenses, other than investment expenses = E'_n(premium based) + E''_n(other)

$_R(FIT)_n$ = FIT component unrelated to investment income (zero for Phase 1 company)

m = duration at maturity e.g. GIC or deferred annuity

S_n = surplus per unit of issue on book basis = $A_n - p'_n V_n$

S^{M}_{m} = surplus at maturity per unit of issue on market basis

α = factor applying to post-mortem divident (0 for 100%, 1 for 0%, ½ for pro-rata)

$_{CR}(FIT)_n$ = FIT credit for required interest reserves

$i''_n = i'_n + _{CR}(FIT)_n$ effect

The sequential formula for asset shares along an interest scenario is as follows:

$$A_n = (A_{n-1} + p'_{n-1}\Pi_n)(1+i'_n)$$
$$- p'_{n-1} q'_{n-1} F_n (1 + i'_n/2)$$
$$- p'_{n-1} q^w_{n-1} C_n$$
$$- p'_{n-1}\left[E'_n(1+i'_n) + E''_n(1+i'_n/2)\right]$$
$$- p'_{n-1} D_n \left[1 - a q'_{n-1} + (1-a) q'_{n-1}(i_n/2)\right]$$
$$- R(FIT)_n + cR(FIT)_n$$

$$A_0 = \Pi_1 - E_0$$

$$S_n = A_n - p'_n V_n$$

At maturity, $V_m = 0$ after C_m is paid, so that $S_m = A_m$ on a book value basis. The equation can be reduced to the following by introducing P_n and V_n and using the relationship $V_n = (V_{n-1} + P_n)(1+i_n) - q_{n-1}(F_n - V_n)$:

$$S_n - S_{n-1} = S_{n-1} i'_n$$
$$+ p'_{n-1}\left[(V_{n-1} + P_n)(i''_n - i_n)\right]$$
$$+ p'_{n-1}\left[(L_n - E'_n)(1+i'_n) - E''_n(1+i'_n/2)\right]$$
$$+ p'_{n-1}\left[q^w_{n-1}(V_n - C_n)\right]$$
$$+ p'_{n-1}\left[q_{n-1}(F_n - V_n) - q'_{n-1}\left(F_n\left\{1 + \frac{i'_n}{2}\right\} - V_n\right)\right]$$
$$- p'_{n-1} D_n \left[1 - a q'_{n-1} + (1-a)\frac{i'_n}{2} q'_{n-1}\right]$$
$$- R(FIT)_n$$

$S_n - S_{n-1}$ = profit (loss) in year n.

Now, we introduce some changes to make Equation 2 applicable to the determination of C-3 Surplus Needed:

(a) In the statutory financials, profit (loss) is absorbed at the end of each year into surplus, so that surplus at the beginning of each year is zero i.e. $S_{n-1} = 0$ in Equation 2.

(b) As a simplification, also let us assume the following as reasonable relatively immaterial adjustments solely to highlight material C-3 ingredients:

- The moratlity term, the loading-expense term, the ${}_{R}(FIT)_{n}$ term, and the whole dividend, except for the excess interest factor are nill in total. (These will not be neglected in the actual Task Force work.)
- In the dividend term, a is taken as 1 and q'_{n-1} is ignored.

Then, Equation 2 becomes this:

S_n = profit (loss) in year n assuming $S_{n-1} = 0$

$$= p'_{n-1}\left[(V_{n-1}+P_n)(i_n - i''_n) - q^{w}_{n-1}(V_n - C_n) + (V_{n-1}+P_n)(\bar{i}_n - i_n)\right]$$

This is an elaboration of the formula used by James Bridgeman to test the designs of the 1980 NAIC model dynamic interest valuation statute.

C-3 Surplus Needed at each valuation date is the amount required to fund negative S_n over the future lifetime of the policy class along the scenario of interest rates with credit for any future positive S_n to the extent that the Surplus Needed fund does not become negative at any future duration. At maturity duration, m, $V_m = 0$ and $S_m = 0$ on a book basis; however S^{M}_{m} on a market basis is approximately equal to the capital gain (loss) resulting from the assumed sale of the securities (+ or - IY segments) left, whose net book value is zero.

This C-3 Surplus Needed, so defined, at duration n is the present value of negative S_{n+t} over all t to maturity at interest only, with future positive S_{n+t} allowed as long as the surplus needed fund at n+t-1 does not turn negative. The interest rate used is i_{n+t} less the FIT required interest credit. This determination would be made by working backwards from S^{M}_{m}, if negative, otherwise from the last negative S_{n+t}.

3.3 Implications of Equation (3)

The characteristics of C-3 Needed Surplus and certain implications can be seen from Equation (3):

- Equation (3) applies to upside, downside and mixed interest scenarios and gives appropriate credit to level of reserves.

- The IYM interest rate reflects the effects of the interest scenario, cash payouts from terminations, withdrawals and policy loans, investment rollover, investment earnings, asset configurations (past investments and reinvestments), etc.

- Cash payouts on voluntary withdrawals and terminations and on policy loans are a function of the policy design interacting with the interest scenario.

- The third term applies only on participating policies, individual deferred annuities and universal life policies. In effect, it serves to replace i_n in the first term by $\bar{i}_n$. Thus, on participating policies, individual deferred annuities and universal life policies, losses develop faster than on nonparticipating policies because of the excess interest dividend factor or credit. Also, it is doubtful that for reasons of conservation, $\bar{i}_n$ could be reduced fully to track i'_n in a long upside interest situation. This indicates the need for quite short assets to support individual deferred annuities and universal life policies in the foreseeable volatile interest rate environment. It also suggests the need for much shorter assets against participating insurance policies, especially those with 5% and 6% policy loan rates than most companies hold today. As to nonparticipating life insurance policies, the higher valuation interest rates allowed under the new NAIC dynamic interest valuation statute will increase i_n and, hence, C-3 Surplus Needed on new contracts.

- The surrender charge credit term shows the effect of such charges in reducing Surplus Needed. These charges can be much higher under the new NAIC dynamic interest nonforfeiture statute. If the surrender charge is equal to the capital loss taken on presumed sale of securities in an upside interest situation (equivalent to the present value of future IYM interest reductions caused by borrowing within the company), the loss equal to the present value of the interest differential first term is negated by the surrender charge. In other words, if withdrawal values are on a 100% market value basis, there is little C-3 risk on withdrawals in an upside interest situation.

- Variable policy loan interest rates close to the new money rate would reduce disintermediation in the upside interest situation. Thus, i_n would not deteriorate so fast. Of course, loans actually made would still cause a loss since the loan would be a payout in the IYM system, earning interest near the new money rate, which is higher than i'_n. This is like a bond swap with a capital loss. Today, 5%, 6% and even 8% policy loans are causing severe disintermediation and, of course, providing less ongoing interest income than a variable rate policy loan.

• C-3 Surplus Needed, determined as indicated, would be sufficient to cover capital losses on forces sales of securities in an upside interest environment. Of course, company surplus would immediately be reduced by the capital loss, rather than suffering the slow annual erosion of net income and surplus implied by Equation(3).

• For very large and long upside interest movements, disintermediation effects could become so large on guaranteed cash value insurance and annuity policies in companies backing such contracts with long assets that capital losses on bond sales could severely deplete surplus before the long assets roll over for reinvestment in short assets. Thus, C-3 Surplus Needed could approach or even exceed company surplus.

• In a permanent very volatile high upside interest environment, one must question the viability of contracts with book value guarantees on voluntary withdrawals unless backed by short assets. It would appear that in such an environment, the only contracts which could be funded by long assets must have voluntary withdrawal values on a market value basis, policy loans consistently defined and with variable rates, and both assets and liabilities valued on a market basis.

3.4 The Actual Task Force Approach

As mentioned in Section 2, approximate Equation (3) for C-3 Surplus Needed will not be used. Instead, the approach will be straight forward and will calculate Assets Needed at each valuation date to assure breakeven at maturity, using all the factors shown in Equation (1), looking forward from each valuation date to maturity along each interest rate scenario. As described in Section 2, the C-3 Surplus Needed will be the excess of Assets Needed along a "worst path" interest rate scenario over Reserve. This approach is the design of James Tilley and Gordon Dinsmore and its application to GIC's for illustrative purposes is shown in a companion paper by James Tilley.