Chapter VI

A POTENTIAL APPROACH TO VALUATION OF RESERVES AND SURPLUS IN STATUTORY FINANCIAL STATEMENTS

Section 1: Introduction

The modern approach to determination of appropriate assets underlying the sum of reserves and surplus needed for capacity utilized by inforce is rooted in explicit consideration of C-1, C-2 and C-3 risks and levels of ruin probability. Cash flows from assets and liabilities are fundamental. Extension to comprehensive surplus management and financial planning involves the dynamics of the balance of surplus (including MSVR and similar reserves). Ideally, the whole structure is tied together by an internal management basis financial accounting and planning system.

Precise theoretical approaches are impossible, but research has discovered practices which appear to provide acceptable results. The purpose of this chapter is to provide definitions, concepts, an outline of the structure of practice, and an outline of the relationships of practice to theory.

This chapter is confined to statutory financial statements and to measures of solvency and solidity using them. However, the concepts and procedures apply with suitable changes to other financial statements, such as stock company GAAP, prescribed for public reporting by stock companies, and to internal management financial reports desirable for financial planning and control by management.

The objective of this chapter is to present a discipline of theory and practice available to the actuary whose management wants a full understanding and control of its surplus management. While no reference is made to regulation, the theory and practice are applicable to the full range of recommendations of the Joint Committee on the Valuation Actuary. The chapter provides background applicable also to the recommendations currently being exposed to CIA membership as to adequacy of reserves and surplus for in-force and for plans for growth and change.

Section 2: Concepts and Definitions

In later sections, a number of technical terms will be used repeatedly. Here is a list of these terms with rather precise definitions and short explanations of the concepts.

2.1 Solvency on the Valuation Date

Nominal insolvency occurs when the sum of statutory reserves, other liabilities and minimum capital exceeds statutory book value of assets. Rehabilitation (actual insolvency under the law) can occur only under court order petitioned by the State Insurance Commissioner. Involved in the consideration by the court would be a careful scrutiny of all asset and liability items. Also, rehabilitation action would be preceded by negotiation with other companies as to purchase or merger. Absent nominal insolvency or rehabilitation, the company is called solvent.

2.2 Scenario

A scenario is a deterministic description of a defined future incorporating all material data and functions needed to determine the losses caused by a particular risk or combination of risks.

2.3 Solvency Along A Scenario

Assets exceed liabilities at each duration of the scenario.

2.4 Solidity

Solidity exists if assets equal to the sum of reserves and surplus needed for capacity utilized on the valuation date, together with future investment and product cash flow, are sufficient to provide for plausible deviations from expected.

2.5 Reasonable Deviations from Expected and Ruin Probability p_1

These are the universe of deviations from expected losses from C-1, C-2 and/or C-3 Risks for which assets equal to reserves on the valuation date, together with future investment and product cash flows, are sufficient to provide for future obligations and expenses with probability $(1 - p_1)$.

2.6 Plausible Deviations from Expected and Ruin Probability p_2

These are the universe of deviations from expected losses from C-1, C-2 and/or C-3 Risks for which assets equal to the sum of reserves plus surplus needed for capacity utilized by inforce on the valuation date, together with future investment and product cash flows, are sufficient to assure solvency at all future durations with probability $(1 - p_2)$.

2.7 Vitality

This refers to future solidity and corporate vitality and involves not only inforce on the valuation date but also financial plans for future growth and change. It is measured by analysis of the size and dynamics of vitality surplus (See the definition of "vitality surplus") over several future years and is an extension of the universe of plausible deviations to include financial planning for growth and change.

2.8 Reserves

Invested assets equal to reserves on the valuation date, together with future investment and product cash flows, on inforce business on a company wide basis, should assure that all future obligations and expenses on such business will be met, under reasonable deviations from expected experience. Such reserves may not be less in aggregate than the minimum reserves allowed by the Standard Valuation Law (SVL).

2.9 Surplus Needed for Capacity Utilized by Inforce (To be referred to as "Surplus Needed" hereafter).

Invested assets, equal to the sum of reserves and surplus needed, together with future investment and product cash flows on inforce business, should assure solvency at all future durations on a company-wide basis, under plausible deviations from expected experience, including catastrophic occurrences. Surplus needed is equivalent or related to benchmark, target, or allocated surplus used in pricing and in management basis financial statements. The latter may be higher or lower, since it represents surplus allocated to a product or line based on risk relativities, desire for favorable agency ratings, or other reasons, but ideally it should be equivalent to the surplus needed. Along scenarios of C-1, C-2 and/or C-3 risks, negative liability (product) cash flows include contractual obligations, expenses, taxes and policyholder and stockholder dividends; and accumulated assets should be no less than reserves at future durations of such scenarios. (Note that the desideratum as to accumulated assets being no less than reserves at future durations for determination of surplus needed based on plausible deviations assures that assets will be available to cover temporary excesses of reserves over accumulated assets in the test of reserves along scenarios of reasonable deviations; thus this desideratum does not appear in the definition of "reserves.")

2.10 Cash Flow Based Surplus (CFS)

CFS is an important measure of economic strength independent of all financial statements. CFS equals the present value of the excess of asset cash flows over liability cash flows along a scenario up to the termination of the last contract in the class being studied, where the discount recognizes the roll-over and reinvestment of assets along the scenario. It is thus the present value of gains and losses as of the valuation date for the scenario. CFS is determined for

a representative sample of scenarios of C-1, C-2 and/or C-3 risks in the universe of plausible deviation scenarios chosen. It is a means of demonstrating the inherent profitability or loss to be expected under a spread of possible futures, entirely independent of the statutory or other financial statements. (-CFS) on the worst scenarios in the plausible deviation universe is almost always less than surplus needed, because surplus needed must additionally assure that assets accumulated along the scenarios must be no less than reserves at each future duration of the scenarios.

2.11 Vitality Surplus

This is the excess of statutory surplus plus MSVR and similar contingency reserves over surplus needed. Increase in vitality surplus equals net income after dividends and FIT plus increases in other surplus account items minus increase in surplus needed. Vitality surplus thus excludes all inforce items and is the part of surplus available for growth and change, i.e. for new business strains, growth in marketing systems, new administration systems, products and lines, new subsidiaries and ventures, and financial planning in general. Its importance depends on its dynamics more than on its size, since income into it arises from profitability of inforce products adjusted for surplus needed; the larger this income, the more is available for growth and change. Indeed a large vitality surplus may indicate failure to expand products and systems appropriately. Analysis of vitality surplus dynamics over several future years is the best way to test financial plans for growth and change.

2.12 Net Premium Reserves

After appropriate C-1, C-2 and C-3 risk scenario testing, reserves in statutory financial statements are expressed as net premium reserves for reasons of simplicity, calculation convenience and statutory tradition. It should always be remembered that they are approximations to reserves reflecting all the financial dynamics, including rates of premium continuance, termination, withdrawal and expense as well as rates of interest and claims and gross premiums, dividends, FIT, profit charges, etc. Net premium reserves explicitly reflect claims and interest and usually have a CRVM type of issue expense allowance and may be subject to a deficiency reserve adjustment; also, the SVL establishes constraints on claim rate and interest rate assumptions. Margins in the claim and interest rate factors in net premium reserves should be related to the extent of C-1, C-2 and C-3 risks so as to reflect the missing rates in an optimum way. Nevertheless, the theoretical shortcomings of net premium reserves do not necessarily make such reserves undesirable as long as the level and pitch of the reserves allow a proper withholding of net income early for later availability as reasonable deviations emerge.

In the case of participating life insurance with a properly designed dividend scale based on the net premium reserves, it can be shown that the net premium reserve is identical to reserves involving all financial dynamics.

On net premium reserves for interest sensitive products, like SPDA, UL, etc., it may turn out that the SVL minimum net premium reserve should be loaded where there is poor matching of asset cash flows and liability cash flows.

2.13 Categories of Risk

C-1 Risk: Losses from defaults in fixed dollar investments and from decreases in market values of equity investments. Causes of C-1 risk losses requiring surplus protection are long serious deflationary depressions, like the Great Depression of the 1930's, and long serious stagflation recessions, with which the 1970's were a close encounter. A serious earthquake could be another cause. Less serious C-1 risk losses, for which provision should be made in reserves, arise in non-catastrophic environments from defaults in low quality investments and swings in the stock market and other equity investments, and reflect management's degree of investment risk-taking.

C-2 Risk: Losses from increases in claims and expenses and from pricing deficiencies, other than those from C-1 and C-3 risks. This is a large and varied category of classic concern by actuaries: Increases in aggregate death claims, disability claims, medical claims; decreases in annuitant deaths; epidemics and earthquakes; accidental catastrophes; inflated expenses; irrecoverable expenditures on products and systems; increased expense rates from inefficiency. Provision for smaller ("reasonable") deviations from expected should be made in reserves. But large ("plausible") deviations are matters for surplus provision; and losses from earthquakes, epidemics and magnitude increases in annuitant life expectancies are exclusively matters for surplus.

C-3 Risk: Losses from changes in interest rate environment causing decreases in interest rate earnings from intermediation in downside interest rate movements, and from disintermediation in upside interest rate movements. Included here are losses from interest rate changes causing inability to support guaranteed interest

rates even in absence of intermediation and disintermediation as a result of interest rates on reinvestment.

This is the most serious risk today on interest-sensitive products (GIC, SPDA, SPWL, UL and Structured Settlements) because of the volatility of interest rates in the foreseeable future. This risk is radically increased by the degree of mismatch of asset and liability cash flows and its control demands carefully coordinated product, pricing and investment policies at issue and renewal of contracts at all times. Provision for this risk must be made in reserves for reasonable deviations from expected interest rate patterns; minimum Standard Valuation Law (SVL) reserves will be found to be inadequate where there is poor matching of asset and liability cash flows. However, major provision for this risk should be in surplus against larger, but plausible, deviations.

C-4 Risk: Losses from general business risks, such as external happenings, other than those above, outside the control of management, such as management incompetency or fraud. This risk is not considered to be within actuarial purview until its effect begin to emerge as C-1, C-2 or C-3 risks, and is not discussed further in this chapter.

2.14 Correlations Among Risks

Losses from C-1 Risk and from C-3 Risk are obviously dependent in some circumstances, such as catastrophic depression or stagflation, but C-3 Risk losses can occur without C-1 Risk losses, such as with poor matching of asset and liability cash flows in non-catastrophic environments. Some actuaries have

recognized the correlation between C-1 and C-3 Risks by using a correlation coefficient of ½ in statistical combination of risks. Serious (C-2) disability income losses and serious C-1 Risk losses are essentially 100% correlated because the former arise from unemployment which is a feature of the depression or stagflation environment of the latter. Also, serious (C-2) expense inflation is 100% correlated with C-1 Risk stagflation. There may be other correlations, but it seems reasonable to assume that all other risks are mutually independent for purposes of combination of risks.

Section 3: The New Environment for Assets, Reserves and Surplus Needed

Before volatility of interest rates became a predominant risk and interest-sensitive products proliferated, reserves and surplus needed could be regarded primarily as liability concepts; the actuary had to give only secondary attention to assets. And this attention was focused primarily on downswings in interest rates and intermediation. Vanishing of interest spreads from upward movement of interest rates and disintermediation were historically unimportant. Additionally, life insurance companies invested primarily in investment grade securities.

Now, reserves and surplus needed must be considered as asset segmentation concepts and the (C-3 risk) dynamics of interrelated asset cash flows and liability cash flows along reasonable and plausible scenarios of future happenings are basic. Also, the lower quality of some investments and new types of investments have introduced a new emphasis on C-1 Risk.

Assets equal to reserves and assets equal to the sum of reserves and surplus needed are required based respectively on levels of ruin probability p_1 and p_2 and

related universes of reasonable and plausible deviations from expected. Here, the more important concept is assets equal to the sum of reserves and surplus needed; the cut of such assets between reserves and surplus needed is less important than the total. Indeed, within reason, the lower the reserves and the higher the surplus needed, the more efficient is the use of capital, since surplus is available always for any and all risk deviations, while margins in reserves are released only by formula regardless of need. Also, the higher the statutory reserve, the larger are the total assets needed because along scenarios, the accumulated assets can be no less than the reserves at future durations of the scenario. Here are the relationships:

Determination of Assets for	Worst Class of Scenario	Illustrative Probability of Ultimate Ruin
Reserves	Reasonable Deviations from Expected	p_1 (= 10%, 25% ?)
Reserves Plus Surplus Needed	Plausible Deviations from Expected	p_2 (= 1%)

The ruin probabilities refer to the whole future of the inforce business and the scenarios are assumed to run to the termination of the last contract inforce. Mathematical relationships are treated in Section 4.

As noted earlier, the more significant ruin probability level is p^2, shown as 1%. p_2 is the probability that ruin will ever occur if assets on the valuation date are equal to the sum of reserves and surplus needed. Thus, p_2 = 1% seems pretty acceptable.

The value of p_1, used for reserve testing, is illustrated at 10% to 25%. Actual values of p_1 are much lower for minimum SVL minimum reserves on some

traditional products, and are much higher for SVL minimum reserves on some interest-sensitive products with poor matching of asset and liability cash flows. It is desirable that the SVL eventually be amended so that assets equal to reserves will be adequate at an appropriate uniform p_1 ruin probability level for all products. However, it seems doubtful that the SVL can ever be so amended, unless the valuation actuary is required to determine surplus needed at the p_2 ruin probability level; for instance, if reserves were to meet the 25% ruin probability level test, but surplus is very low, the company would be technically solvent, but it would not have solidity!

The single scenario gross premium reserve adequacy test is now inadequate. The modern "gross premium" valuation tests involve multiple scenarios of reasonable deviations from expected in the C-1, C-2 and C-3 risk categories.

Another historical concept now outmoded is the "most likely" assumptions. This concept should be replaced by the "expected" assumptions. Because of the skewness toward worse experience in most probability distributions in our business, the probability that experience will be worse than "most likely" is over 50%, while the corresponding probability for "expected" is below 50%. Furthermore, "expected" is statistically more conservative.

While surplus, including MSVR and similar reserves, is analyzed into surplus needed and vitality surplus (the balance of surplus), there is no implication that surplus is segmented into two parts, one part of which, surplus needed, is in the nature of a reserve. Such a concept would weaken solidity. Surplus is available

as a whole for all adverse happenings and for business plans; it is not divisible. The dichotomy between surplus needed and vitality surplus is solely for purposes of understanding and planning.

Section 4: Mathematics Underlying Ruin Probabilities, Scenarios and Combination of Risks

It is desirable to pursue some underlying mathematical probability theory in a cursory way before considering the practical procedures of later sections. In reading this section, it is well to bear in mind that rigorous mathematics serves only as a guide to practical applications. Procedures and formulas used in practice contain an unknown level of error which is presumed not to be material relative to the errors of estimation in the inputs to the models. Testing of reserves and determination of surplus needed are matters of magnitude, not precision, and ultimately are based on professional judgment.

4.1 Relationship of Worst Scenarios of Reasonable and Plausible Deviations to Ruin Probability Levels

Let:

N = number of risks in categories C-1, C-2 and C-3

X_i = random variable equal to present value of losses from Risk i defined in probability space of N dimensions, where i = 1, 2, 3.....N

$F(X_1, X_2, \ldots X_N)$ = probability distribution function of X_i

$f(X_1, X_2, \ldots X_N)$ = corresponding probability density function

$U(X_1, X_2, \ldots X_N)$ = aggregate loss where individual risk losses are X_1, X_2,...and X_N

u = surplus needed at ruin probability level $_p$

Then, u relates to p as follows:

$$\text{Prob}\,(U \leq u) \;=\; \sum_{U \leqq u} f(X_1, X_2, \ldots X_n) \;=\; 1 - p$$

where the summation is taken over the whole N-dimensional probability space in which aggregate losses are not more than u.

This formula is not directly useful in practice, except in the limited areas discussed immediately below, because our ignorance of the future prevents derivation of explicit theoretical distribution functions. And, if we could derive the distribution function, it would be unbelievably complex.

The only area where a theoretical distribution function has been derived is the sum of death claims. Here the Compound Poisson Distribution and several similar functions, incorporating average number of claims, the distribution of amounts of individual claims (reflecting retention limits) and level of risk charges, are available in the literature. Thus, the surplus needed at ruin probability level p_2 can be directly determined from these stochastic distributions. The results can then be combined with the surplus needed for other risks at probability level p_2, otherwise determined, by the procedures in the next section, "Simplification of the Combination of Risks Procedures."

Empirical distribution functions have been constructed from actual and presumed experience on mortality, C-1 and C-3 risks and reflecting possible correlations. A cash flow model is then used to determine U for myriad points in the 3-dimensional probability space of the three risks. These results can then be used to estimate the surplus needed at ruin probability p_2. The process involves

extensive computer modelling and examination of enormous outputs even with three risks.

Let us now return to the general situation where the formula above cannot be applied directly. There is, however, an approximate solution: It proceeds from the fact that in the probability space, there is a hypercurve on which U = u. Corresponding to each point on this hypercurve, there is a class of deterministic scenarios, called "worst" scenarios because all other scenarios not causing ruin produce $U < u$. These worst scenarios relate to p_2 and the actuary can define them heuristically by judging them to have a probability p_2 of not being the worst to occur in the future.

Such scenarios can most easily be defined for each risk separately with present value of losses on all other risks held a mean values zero. Then the present value of the losses on each separate risk can be combined by the formula in the material entitled, "Simplification of the Combination of Risks Procedures."

The formula for calculating the surplus needed, u, for a worst scenario is this:

$$U = -\sum_{t=1}^{\infty} (a_t - l_t) \prod_{s=1}^{t} (1 + i_s)^{-1} = 0$$

where a_t = asset cash flow in year t

l_t = liability cash flow in year t

i_s = interest rate earned in year s, taking account of rollover and investment, and

the initial assets on the valuation date equal reserves + u

The models used for the calculation are described in sections on procedures, notably Section 5, where a_t, 1_t and i_s are defined carefully.

If u is set equal to zero, the formula constitutes a test for reserves.

The surplus needed u determined above is a cash flow based surplus needed if there were no statutory financial requirements. But, statutory financial statements require that accumulated assets along a scenario be no less than reserves at future durations of the scenario. Thus, the formula above for the surplus needed u must be applied with an additional desideratum to assure assets no less than reserves at all durations of each scenario. This is accomplished by a simple enhancement of the software.

4.2 Simplification of the Combination of Risks Procedures

Developing a sufficient number of worst scenarios of all N risks together is a formidable, perhaps impossible task. It has been accomplished for three risks (mortality, C-1 and C-3 with correlations), but even here the size of the output is enormous.

Fortunately, multivariate probability analysis suggests that there is a simpler procedure, which appears to involve error which is immaterial considering the errors of estimation otherwise present. This simpler procedure involves the determination of surplus needed on each separate risk, ignoring all other risks, estimated by setting losses from all other risks at mean values. Then, these individual risk surpluses needed are combined by the following rules and formula, which recognize the marginal nature of each individual risk surplus needed.

Risks are assigned to categories of degree of correlation with other risks. Some correlated pairs (l,m) can be assumed to have correlation coefficients $r_{lm} = 1$; e.g., C-2 risk disability income losses and C-1 risk losses. Some pairs (j,k) have $0 < r_{jk} < 1$; e.g., C-1 risk losses and C-3 risk losses, where r_{jk} might be set at ½. Many pairs (i,x) are completely independent with $r_{ix} = 0$; e.g., C-2 risk sum of death claim losses and C-1 risk losses. The first step is to combine (l,m) pairs into a single risk, the surplus needed for the combination being the sum of the surpluses needed for the individual risks; such combined risks are then assigned appropriately to either the (j,k) or (i,x) pair categories as single risks. It is my observation that risks in the (j,k) category appear in only one such category, i.e. such risks are correlated only with one other risk. I am unaware of any important risk pairs with $r_{jk} < 0$.

Then, the surplus needed, u, for the combination of N risks at ruin probability level p_2 is as follows:

$$u^2 = \sum_{\substack{\text{All } i \\ r=0 \\ ix}} u_i^2 + \sum_{\substack{\text{All } j,k \\ j < k \\ 0 < r_{jk} < 1}} (u_j^2 + u_k^2 + 2\, r_{jk}\, u_j\, u_k)$$

where u_y is the surplus needed for risk y at ruin probability level p_2, estimated by setting losses for all other risks at mean values zero. This formula can be seen to be in the format of the variance of the sum of N correlated random variables; when the distribution of each variable is assumed to be normal, squared surpluses needed at ruin probability p_2 all are the same multiple of the corresponding variances.

A simple example of the above is the surplus needed at ruin probability p_2 for the combination of three risks; risk 1 (C-1), risk 2 (mortality) and risk 3 (C-3) with $r_{12} = r_{23} = 0$ and $r_{13} = ½$. u_x for x = 1, 2, 3 is the surplus needed at ruin

probability p_2, determined for each risk x, estimated by setting losses for the other two risks at mean value zero. u is as follows:

$$u^2 = u_1^2 + u_2^2 + u_3^2 + u_1 u_3$$

4.3 Comments on Determination of Surplus Needed for Each Separate Risk

Implicit in the determination of the surplus needed for each risk separately, estimated by setting losses on all other risks at mean values zero, is the availability of operating margin cash flow as a first line of defense against such risk. In the case of C-3 risk, the cash flow procedures described in Section 6 explicitly involve all operating factors and margins. For other risks the worst scenarios used must also reflect credits available, assuming losses from all the other risks are at mean values zero. These credits against gross losses, however determined, would essentially be the sum of tolerable reductions in policyholder dividends and credits, in stockholder dividends and in retained earnings as contemplated in the worst scenarios chosen. Essentially, these are also the credits inherent in the explicit C-3 risk procedures.

Section 5 also suggests that cash flow from all risks together could be included in the worst scenarios. If such omnibus scenarios are utilized, the operating credits could theoretically be more exact. However, the computer outputs are so enormous that few companies would have the resources and commitment to use omnibus approaches.

It is realized that the determination of credits in procedures for separated risks adds to error of the combination formula.

Section 5: Procedures

5.1 C-3 Risk on Products with Large C-3 Risk

On products and lines with large C-3 risk, especially interest-sensitive products (e.g. GIC, SPDA, SPWL, UL, Structured Settlements) but also conventional ordinary life products with guaranteed cash and loan values and immediate annuities, a computerized cash flow model is needed. Otherwise it is almost impossible to quantify the effects of mismatches of asset cash flow and liability cash flow. The model sums cash flow from assets less cash flow from liabilities with reinvestment of net cash flow along each selected C-3 interest rate scenario of reasonable and plausible deviations. Segmentation of the general account on an actual, proportionate or notional basis by product and line is needed (or a specialty company or separate account dedicated to the product and line). Reinvestment policy is applied to both positive net cash flow and negative cash flow (interline or surplus borrowing).

Asset cash flow includes the following elements (after appropriate marginal FIT): Interest, dividends and rent; maturities and repayments; prepayments as a (call) function of the scenario; hedges as a function of the scenario, etc. The assets arising from reinvestment of net cash flow from assets and liabilities (+ or -) as well as assets existing on the valuation date are included.

Liability cash flow includes the following elements (after appropriate marginal FIT): Income from premiums, policyholder charges, policy loan interest and repayments, etc., all as functions of the scenario and contract design and policy; outflow from claims, policyholder dividends and credits, withdrawals,

terminations, policy loans, recoveries of acquisition expenses, stockholder dividends, etc., all as functions of the scenario, product policy and design and company policy. Note that policy loans and policy loan interest, as a policyholder option, are treated as liability cash flow, i.e., as an insurance cash flow, not an asset cash flow item.

The model accumulates net assets forward over the scenario to the duration of termination of the last contract in the class, at which time the remaining assets (+ or -) are adjusted to market value according to the scenario interest rate then in effect. Potential management actions are reflected in the scenarios.

Assets needed on the valuation date for the scenario are determined so that the accumulated assets on the termination date of the last contract, adjusted to market, are zero. In the case of assets needed for the sum of reserves and surplus needed, the assets must be sufficient additionally to assure that accumulated assets along the scenario are never less than reserves at future durations.

The assets needed for reserve testing and for reserve plus surplus needed testing are respectively based on worst scenarios of reasonable deviations and worst scenarios of plausible deviations.

The process is identical for determination of cash flow based surplus (CFS), except that in the latter there is no requirement that assets be no less than reserves at each future duration along the scenario.

Surplus needed for other risks can be determined as discussed in the material under C-1 and C-2 risks, and then combined with the surplus needed for C-3 risk by the combination formulas of Section 3. Or, the scenarios referred to above may be expanded to include other (or all) risks, but the output from the model becomes enormous.

5.2 Products Without a Large C-3 Risk

On such products, such as medical care insurance and term life insurance, where the risks are almost entirely C-2 risk, the model is much simpler in design because the C-3 risk from intermediation and disintermediation can be ignored, except for the group medical care line, which involves options of administration-only or minimum-premium, resulting in sudden massive outflows of assets behind claim reserves. However, these more traditional models treating C-2 risk claims variations have their own complications because stochastic variations are usually less important than wild cards, like inflation, cost-shifting by the Federal government, and policyholder anti-selection at renewal. The concepts of "reasonable" and "plausible" deviation scenarios continue to apply. More detail can be found in the material on C-1 and C-2 risks which follows this discussion.

5.3 C-1 Risk

For Surplus Needed

C-1 risk relates to type, quality and distribution of invested assets. The worst scenario of plausible deviations is an economic episode, for which there is a (ruin) probability p_2 = 1% of its being the worst ever to occur in the future. This economic episode might be visualized as one which would require govern-

mental assistance for the life insurance business, e.g. cash flow freezes, pegging of security values, Federal Reserve accommodation. Such an episode would destroy the solidity of many companies and the solvency of some companies. The appropriate level of C-1 risk surplus needed is that which would assure the solidity of a company so that the company would not be worse off than its best competitors, with time available to recover its previous strong financial condition. A corollary of this reasoning is that it is unrealistic to contemplate worse occurrences, which would change our economy beyond possible return to normalcy as we know it.

Such an episode might take two forms:

- o A deflationary depression, like that of the 1930's.
- o An inflationary episode, with serious recession of 4-5 years, double digit inflation, tight money and widespread insolvencies, and high unemployment peaking at, say, 12% and then decreasing. This is followed by a less serious stagflation.

The episode should be assumed to start immediately, however unlikely this may be under current conditions, since when such an episode does become imminent, build-up of surplus needed would not be feasible probably.

Investment officers would analyze each security and parcel of real estate individually or in classes so as to estimate its probability and timing of default and the percentage and timing of recovery on assets held at book and to estimate the maximum downside movement of the market value of common stocks.

The procedure for determining surplus needed is this: Capital losses on default, decreases in market values of stocks and cash income losses, less capital

gains on recovery, less tolerable reductions in policyholder dividends and credits, stockholder dividends and retained earnings, with interest on cash items, and with appropriate marginal FIT adjustments, are accumulated over the episode. Surplus needed is the discounted value of the maximum amount of this accumulation, the discount being after marginal FIT. In simplistic terms, neglecting the interest and maximum adjustments, the surplus needed on book value investments equals (Book value) x (Chance of default) x (1 - % recoverability) + (Income Lost after FIT) and the surplus needed on common stocks equals (Market Value) x (potential market value decrease %) + (Reduction in dividends, after FIT); tolerable credits decrease this in aggregate. Stock market recovery late in the episode probably should not be credited since it is too problematical.

Surplus needed would be expressed as a percent of book value by type and quality of investment. For example, the percent for bonds would vary from 0% for U.S. bonds to at least 15% for bonds with quality well below BAA. Commercial mortgages and real estate might have percents of 3% or so. Common stocks at the end of a bull market might have a percent of 50% or so, and well into a bear market a percent of 20% or so.

For Reserve Testing

As a generality, it is probably sufficient in reserve testing to handle C-1 risk by reducing interest earned by a charge for C-1 risk (based on the type and quality of investments underlying the product class) in the C-3 risk model described earlier in this section. The charge should be based on a scenario of

reasonable deviations with ruin probability p_1. A simplified approach would also be used in reserve testing on contracts without sizable C-3 risk discussed in this section.

However, on interest-sensitive products where the investment policy selected involves sizable mismatch of asset and liability cash flows and especially if the investments are of low quality, even the scenarios of reasonable deviations at ruin probability p_1 can involve large C-3 risk losses and large C-1 risk losses. Here procedures similar to those used in the material discussed in "For Surplus Needed" should be used because average charges do not develop surplus needed at point of maximum need.

5.4 C-2 Risk

The following treatment of this large, varied and complex class is quite superficial and is intended as only a guide to the many procedures which are either available in actuarial literature or are obvious once the actuary decides to undertake the challenge.

Stochastic Deviations in the Sum of Death Claim Amounts

Extensive literature is available on explicit probability distributions of the sum of death claim amounts and their application to calculate ruin probability for a given surplus level and premium margin level. There is no need to resort to deterministic scenarios. The most widely used probability distribution function is the Compound Poisson Distribution involving convolutions of the amounts distribution of individual claims and explicit recognition of retention limits. Modern solutions no longer involve the tedious classic Esscher formulas. As

described in the section entitled, "For Surplus Needed," the premium margins available can be approximated as tolerable reductions in policyholder dividends and credits, stockholder dividends or retained earnings on the contract class.

For reserve testing, it is probably always satisfactory merely to load the expected mortality charges for this deviation at ruin probability level p_1.

The similar risk of deviations from expected reserve releases on life annuities can be handled using the normal distribution with an enhanced standard deviation to reflect the skewness in reserve released amount distributions, which are difficult to determine from experience records.

Other Deviations in Death Claims and Health Claims

Epidemics (e.g., influenza, AIDS), earthquakes, and quantum changes in life expectancy affecting life annuity losses are matters solely for surplus provision and not for reserve provision. They should be handled by appropriate scenarios of plausible deviations corresponding to ruin probability p_2, with offsets for tolerable reductions in policyholder dividends and credits, stockholder dividends, and retained earnings. The process is similar to that in the section "For Surplus Needed" for C-1 risk.

On such contracts as ART, where progressive anti-selection assures future mortality losses, the present value of these losses at ruin probability level p_1 should be covered by reserves and at ruin probability level p_2 by reserves plus needed surplus.

Surplus needed on non-can disability income, guaranteed renewable disability income, group long term disability income, and waiver of premium contracts should be based on the same economic scenario of serious, long depression or recession as for C-1 risk, because the large unemployment levels in such episodes are the major causes of catastrophic losses on these contracts.

Surplus needed should provide for the following losses:

Increase in open and unreported claims from lower recovery rates.

Increase in number and persistency of new claims.

Increase in policy terminations on healthy lives.

On contracts with rerateable premiums, there is a credit:

Increase in premium rates, subject to delay and terminations of healthy lives.

There would also be a credit against surplus needed from tolerable reductions in policyholder dividends, stockholder dividends and retained earnings.

On coverages with short claim periods and rerateable premiums like group and individual medical insurance, stochastic deviations are overwhelmed by deviations caused by inflating costs, poor underwriting, concentration of risk, delays in rerating, cost shifting and other wild cards. Aggregate claims deviations tend to be cyclical as premiums vary from insufficiency to sufficiency. Surplus needed becomes a scenario process aimed at levels of surplus needed to cover peak losses at ruin probability level p_2. Determinations of active life reserves and claim reserves on individual contracts are currently under debate in the SOA; once the basic procedures are agreed upon, it will be desirable to refine the definitions so that reserves will meet the p_1 ruin probability criterion with worst scenarios of reasonable deviations.

5.5 Further Comments on Products with Large C-3 Risks

"Good and Sufficient Reserves"

This is a term being given to reserves determined by a method currently being researched, which may be suggested to enhance the 1980 SVL to make statutory reserves on interest-sensitive products more responsive to coordination of asset/liability cash flows.

The formulas imbedded in the 1980 SVL for determining minimum reserves on interest-sensitive annuities and GIC's have shortcomings and the law does not recognize the extent of matching asset/liability cash flows. The result is that the minimum SVL reserves are sometimes too high and sometimes too low relative to reserves determined by the full C-3 Risk procedures for reasonable deviations from expected as set forth previously in this section. The approach to the "good and sufficient reserves" utilizes the procedures of this section and could have characteristics like the following: They would be the highest ones emerging by duration for scenarios bounded by worst reasonable upside and downside C-3 Risk interest rate scenarios. They would reflect product design, extent of matching of asset/liability cash flows and plans for coordinating investment and product policies. They might reflect quality of assets and thus include provision for C-1 Risk.

How such a concept would be adapted in an amended SVL is open. Perhaps the reserves could be placed within upper and lower limits like those currently in the New York SVL. FIT is naturally a consideration in the design.

Section 6: Coordination of Investment Policy and Product Policy

For control of C-3 risk, especially on interest-sensitive products, the portfolio of investments must be dynamically managed as to type and duration of investments to accommodate to changes in the level and shape of the yield curve. The objective is to control the net duration of assets/liabilities with minimal effect on statutory surplus. Many new investment vehicles, like futures, options, zero coupon bonds, etc., have become available. New theories paradigms and models proliferate in the literature and in practice. Intention to use these new vehicles and techniques should be a feature of the expected investment policy in the C-3 risk scenarios.

It would be nice if these new theories could produce a more direct practical approach to determination of surplus needed, but so far no such approach has appeared in the literature.

Section 7: Aggregate Reserves and Surplus Needed

Solvency and solidity are concepts which are meaningful only for the company as a whole. Subject to the regulatory requirement that aggregate reserves may not be less than aggregate minimum SVL reserves, aggregate reserves ideally should satisfy the criterion of probability of ruin equal to p_1. In order to equalize risk across all products and lines, it is desirable that the criterion be applied uniformly to each product and line separately, i.e., that reserves on each product and line be adequate along worst scenarios of reasonable deviations from expected consistent with ruin probability p_1. It is therefore implicit that reserves held on some products and lines on the basis of

the reasonable deviations test may be less than the minimum SVL reserves, provided that the deficiency is offset by margins over minimum SVL reserves elsewhere.

Reserves plus surplus needed on each line and in total should be adequate on the criterion of ruin probability p_2, i.e., on the basis of worst scenarios of plausible deviations from expected.

Because of the diversity of type and extent of risks on different products and lines, the first step is always to determine appropriate reserves and surplus needed by product and line and then put the results together for the whole company, recognizing offsets; e.g., lower surplus needed for overall death claims is usually less than the sum of surpluses needed for individual and group separately. Moreover, reserves and surplus needed for each product and line are central to planning so as to optimize use of surplus in order to enhance company vitality.

Section 8: Simplification

This chapter surveys a complex process calling for a high level of professional competence and judgment. Individual actuaries can choose practices which are deemed appropriate to them even though less detailed, as long as the practices are not incompatible with the principles and provide results allowing acceptable professional judgments without material error as to magnitudes.

Absent important changes in operations, the full job does not have to be done annually - and indeed cannot be done annually because of its complexity. No doubt, the surplus needed can be expressed by a linear compound of (coefficients) x (parameters) for each product and line, with the coefficients verified at intervals.

Section 9: Financial Planning for Growth and Change - Corporate Vitality

9.1 Pricing

Initial and renewal pricing on inforce business is a given input into liability cash flow used in determination of assets needed equal to the sum of reserves and surplus needed. Pricing for products to be issued in the future should include charges to repay advances of surplus for acquisition expenses, charges for utilization of surplus advanced to provide for surplus needed, and profit charges. Surplus needed in pricing and in management basis financial statements is called target or benchmark surplus, and ideally it should be equivalent to the surplus needed to be determined later by the valuation actuary.

9.2 Management Basis Financial Planning and Accounting System

In this chapter, the focus has been entirely on statutory financial statements, which are basic to solvency and solidity and which apply to inforce business. General purpose stock company GAAP financials are mandated for external reporting by stock companies. However, neither statutory nor GAAP financial statements are satisfactory without modification for such objectives and goals as the following, for which management basis financial statements are

designed: management information in needed form and detail; operational and strategic planning; direction of available surplus to products, lines and markets to optimize earnings; monitoring of emergence of profit by products, lines, and markets relative to planning; evaluation and control of efficiency, productivity and profitability; accountability of product and line managers to realize plans; compensation programs based on profitability; and all the other plans and measures conducive to company vitality.

There is no intention in this short chapter to try to present the many designs and operational procedures of management basis financial statements and systems. But, regardless of the designs of such financial statements, there are several details of the designs which should be consistent with the basic procedures of this chapter.

- Invested assets equal to the sum of reserves and surplus needed on statutory financial statements should be identical with the invested assets in management basis financial statements by product and line.

- Presumably total assets in management basis financial statements will equal such invested assets plus going concern adjustments like unamortized acquisition costs, deferred expenses for new systems and projects, and other GAAP-type adjustments. This implies that adjusted surplus needed on the management basis should be equal to surplus needed on the statutory basis plus such adjustments, since vitality surplus should be identical on both bases. This assures that vitality surplus on both bases involves only future plans for growth and change and that statutory reserves and surplus needed are the

sole repositories of inforce dynamics. This dichotomy is basic for such measures as ROI.

- Also, both bases are then consistent with pricing factors, as discussed previously.

In both statutory and management basis financial statements, the increase in vitality surplus for the year is retained earnings plus other surplus account increases minus increase in surplus needed. The financial analysis of plans for growth and change under management basis financial statements is equivalent to examining the changes in vitality surplus over future years. As to the size of vitality surplus, the larger it is, the more solvent the company is currently; however, to the extent that vitality surplus is reduced by its application to profit producing products, lines, systems and ventures, the company has more inherent vitality because the profits earned from such applications of surplus over time should be larger than those from just investing the vitality surplus. Thus, the dynamics of vitality surplus are more important than its size.

In financial planning, the management of total surplus, whether on a statutory basis or on an adjusted internal management basis, is central. As total surplus varies from year to year, it is desirable for the company to make sensitivity tests for options available, not only as to planning for growth and change, but also as to controlling the level of surplus needed for inforce, e.g., operating expenses, coordination of investment and product policy to minimize the C-3 risk. If total surplus decreases toward or below the level of surplus needed for inforce, changes and new directions are strongly indicated.

Section 10: Reinsurance

It is assumed that the actuary is familiar with the terms of reinsurance agreements before making adjustment in reserves or surplus needed. It is important that the actuary be concerned with the solidity of the reinsuring company. If there are serious questions as to the solidity of the reinsuring company, the actuary should consider making appropriate adjustments to the surplus needed.