



AMERICAN ACADEMY *of* ACTUARIES

September 2000 PROGRESS REPORT

**AMERICAN ACADEMY OF ACTUARIES
HORBC TASK FORCE
Chair: Al Ford**

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TO: NAIC LIFE RBC WORKING GROUP
NAIC HORBC WORKING GROUP

From: American Academy of Actuaries
HORBC Task Force

The American Academy of Actuaries is the public policy organization for actuaries practicing in all specialties within the United States. A major purpose of the Academy is to act as the public information organization for the profession. The Academy is non-partisan and assists the public policy process through the presentation of clear and objective actuarial analysis. The Academy regularly prepares testimony for Congress, provides information to federal elected officials, comments on proposed federal regulations, and works closely with state officials on issues related to insurance. The Academy also develops and upholds actuarial standards of conduct, qualification and practice, and the Code of Professional Conduct for all actuaries practicing in the United States.

The Academy of Actuaries DI/LTC/SL/LB Working Group continues to work on developing long term recommendations for the RBC formula factors for disability income, long term care and stop loss products for the Life and MCO RBC formulas. Modeling has begun by all three Work Groups. Individual Workgroup reports are included below.

The HORBC Task Force has been asked by the HORBC Working Group of the NAIC to provide assistance in reviewing certain elements of the HORBC formula in light of modifications to the NAIC Accounting Practices and Procedures Manual to be effective on January 1, 2001. We have been asked to review the treatment of Health Care Delivery Assets, Common Stock, Health Care Receivables, Deferred Tax Assets, AVR/IMR and the Covariance Formula, as well as any other assets affected by Codification.

A small work group has been formed, with a goal of producing a recommendation for the NAIC for the December 3-5 meeting in Boston.

DI WORK GROUP—Chair, Dennis Lauzon

The subgroup continues to review data, ask questions of the submitting companies and correct the data where appropriate. The majority of the committees' time has focused on using the model to develop recommendations for the non-cancelable and Group LTD products.

The committee is working on several issues including:

1. The appropriate seasoning of a book of business before testing begins,
2. The reserve changes, if any, that should be reflected in the modeling. The loss ratio data implicitly includes all reserve changes other than a change in basis.
3. The use of higher ROE factors for products with a greater required surplus.
4. The appropriate tax assumptions.

Each alternative procedure or method the committee considers requires model enhancements. Results often lead to new questions and additional changes. Until the committee has resolved all the questions on procedures, methods and assumptions, it is difficult to estimate a completion data.

Attachment A contains documentation of the model and sample output.

LTC WORK GROUP—Chair, Bob Yee

The LTC RBC subgroup has been using the model supplied by Dennis Lauzon for the DI subgroup. Because of the similarities between the two product lines, it was deemed desirable to use the same model.

The subgroup has held discussions and agreed on a specific set of input assumptions and on a set of scenarios for sensitivity analysis. Initial model results have been produced. The subgroup is now reviewing these results and determining changes to certain assumptions. One input, in particular, the standard deviation of historic loss ratios, has significant impact on the results. The subgroup is in the process of suggesting various methods of deriving this input.

At the same time, the subgroup is reviewing the recent refinements made to the DI model in order to understand its implications to Long Term Care.

A survey of companies' practice on target surplus for Long Term Care is scheduled to be sent out shortly. This will be helpful in comparing any proposed formula with current industry practice.

The subgroup is targeting a March, 2001 recommendation.

Attachment B contains documentation of the LTC Input Variables and Formulas.

STOP LOSS SUBGROUP—Chair, Tim Patria

The group is now targeting a March 2001 recommendation. Although we were hoping to receive industry experience information broken down such that we would be able to develop RBC factors by attachment point, we found that companies were unanimously not able to provide this level of detail. Therefore, it is likely that we will follow the current format of a single factor.

The group has begun the modeling process and has decided upon the distribution functions and sensitivity analysis for the individual stop loss business. For the aggregate stop loss, the group decided we needed to look at the historical distribution function more closely. Some preliminary work has been accomplished regarding the aggregate stop loss, although the group needs to reconvene to reach final agreement.

The group just recently received the experience survey information from the Academy and will merge this information with that received from the early 1990's to analyze the volatility of the business results.

Other items we continue to consider;

1. Comparisons of results between the projection model we are using and the model developed by the disability group.
2. Taxation – Our models assume full taxation of profits and full deductibility of losses. This methodology may now be inconsistent with the proposed direction of the various RBC groups.

DI RBC MODEL DOCUMENTATION 8/17/00 DRAFT

A stochastic model is being used to develop risk based capital factors for disability income products. This memo documents that model. Below are definitions, an explanation of the model's logic (algebra), and descriptions of the Excel worksheets and Visual Basic Modules used to implement the model.

DEFINITIONS OF MODEL INPUT

Adjust Reserves for Loss Ratios over is the level of loss ratio above which reserve adjustments are made during the testing time horizon. If it equals the target loss ratio plus the pre-tax profit, it is like an adjustment to ensure gross premium reserves. If the reserve strengthening percent is set to zero it has no effect.

Cap Surplus Accumulation: If this input item is set to zero, the accumulated surplus over the testing time horizon is allowed to exceed the inputted required surplus (there will be no dividends). If it is set to one, any surplus accumulated in excess of the required surplus target is removed as a dividend.

(GAAP - Statutory) Equity: is the capital invested in the form of statutory strain.

High Loss Ratio Phase in Factor: is the percent of inforce units re-priced each year when the loss ratio "Phase In Delay" years ago is above the "High Re-price Ratio". It will be much lower in a stationary population where the only source of turn over is lapse and death (such as non-cancelable products) than for stationary populations where premiums can be changed by re-pricing (Group or Guaranteed Renewable products).

High Re-price Ratio: The loss ratio above the target loss ratio which must be reached before management decides to re-price business to the target loss ratio.

Interest Income: the revenue from investments. In the model it does not change the probability of ruin since it changes the "Non FIT Expense Margin". It is the Pre-tax interest Rate on funds times the estimated after tax required surplus plus reserves.

Implied Non FIT Expense Margin: The margin for expenses other than tax on statutory gain. This item has no impact on the "Probability of Ruin". It is a balancing item that is calculated from other inputs. However, if the "Required Surplus", "Target ROE", and "Target Loss Ratio" that result in an acceptable level of ruin require an unreasonably low expense margin, the product is not a viable product. The implied non FIT expense margin is calculated as follows with all items as a percent of premium:

$$(1 + \text{Interest Income}) - (\text{Pre-Tax Profit} + \text{Target Loss ratio})$$

Loss Ratio Cap: the model replaces loss ratios generated above the cap by the cap.

Loss Ratio Floor: The model replaces loss ratios generated below the floor by the floor.

Low Loss Ratio Phase in Factor: is the percent of inforce units re-priced each year when the loss ratio "Phase In Delay" years ago is below the "Low Re-price Ratio". See High Loss Ratio Phase

in Factor.

Low Re-price Ratio: The loss ratio below the target loss ratio which must be reached before management decides to re-price business to the target loss ratio.

Number of Scenario: Is the number of runs the model will make with each run either resulting in exhausting the starting surplus (a ruin) or not. Many scenarios are run to find the ruin probability of one set of input assumptions. Scenarios in excess of 50,000 may run into program limitations (e.g., on calculating run data).

Phase In Delay: This is the time required from recognition that pricing is not producing an acceptable loss ratio to adjust pricing accordingly, get approval of the new pricing and begin to sell business on the re-priced basis. As the model is an annual model, the phase in delay has to be at least 1 year.

Pre-tax Interest Rate on funds: is the net earned rate on funds (after expenses and defaults etc.)

Pricing Pre-tax Profit: Is the pre-tax profit margin as a percent of premium. It is implied in the model from follows:

“Target ROE”(“GAAP-Statutory Equity” + After Tax Required Surplus)/(1-“Tax Rate”).

If required surplus is not on an after-tax basis it is estimated as follows:

After Tax Required Surplus = Required Surplus * (1- Tax Rate (1- Tax Recognition %))

Probability of Ruin: The number of scenarios where surplus was less than zero sometime during the testing time horizon divided by the total number of scenarios.

Random Seed: A seed number to generate random scenarios. If the seed is greater than or equal to zero, the Visual Basic function Rnd is used to generate random numbers. If the seed number is less than zero the random numbers are read from the worksheet Rnumbers (see the description of module 1 below).

Required Surplus: This is the surplus held as a percentage of premiums available to absorb losses.

Reserves this is the reserves as a percent of premium. It is only used to determine the Interest Income.

Reserve Strengthening % (RS) is the percent of the reserve strengthening during the testing horizon. If RS is 100%, the pricing loss ratio (PLR) based on the phase in delay is 80%, the “Adjust reserves for loss ratio over” factor (RALR) is 65%, the tax rate (TAXR) is 35%, the high loss ratio phase in factor (HPIF) is 10% and the tax recognition percent, TRP is 100% then;

$$\text{Reserve} = \text{MAX} (0, \text{RS} * (\text{PLR} - \text{RALR}) * (1 - \text{TRP} * \text{TAXR}) * (1 - \text{HPIF}) / \text{HPIF}) \\ = 100\% (15\%) (65\%) (9) = 87.75\%$$

Serial Correlation is the assumed underlying serial correlation of successive deviates from the distribution from which the random numbers are generated for a scenario.

Standard Deviation: Is the standard deviation of a normal distribution with mean zero. It is used to generate random deviations in the loss ratios.

Starting Loss Ratio Cap caps the historic loss ratio during the seasoning period less the phase in delay. IF the cap is set at 80% and the seasoning is 20 years and the phase in delay is 2.5 years, the first 17 loss ratios in the seasoning will be capped at 80%.

Target Pricing Loss Ratio: This is the expected loss ratio in a stationary population (paid claims/earned premium) on which pricing is based. It has no reserve change component.

Target ROE: The target roe is an after tax return on capital goal. It implicitly sets the profit margin based on the capital invested (statutory surplus plus GAAP equity in excess of statutory

equity) and the tax rate.

Tax Rate on Profit: The tax rate paid on statutory gain before tax.

Tax Recognition %: determines the effective tax rate applied to profits and losses. If it is 80% and the tax rate is 30% losses/profits will provide a tax credit/payment of 24%.

Testing Time Horizon: The number of years over which the required surplus is modeled to see if it turns negative. At the beginning of the time testing time horizon the surplus in the model is set to the “Required Surplus” level and random loss ratios are generated equal to the number of years in the testing time horizon. If at the end of the testing time horizon the surplus is negative, a ruin is recorded.

Years of Seasoning: is the number of years the model is run before surplus is set equal to the inputted required surplus and the testing time horizon begins. If the years of seasoning is zero, the assumed prior loss ratios at the start of the testing time horizon will equal the target loss ratio. If the years of seasoning is greater than zero, then the prior loss ratios at the start of the testing time horizon will be random.

MODEL LOGIC

The Model generates a loss ratio at time t, LR(t), which can be viewed as the sum of three terms.

$$\begin{aligned} \text{LR}(t) &= \text{LR}(t-1) && \text{[the prior loss ratio]} \\ &+ \text{CD}(t) && \text{[a correlated deviate at time t]} \\ &+ \text{P}(t)\text{LR}(t-1)([\text{M}/\text{PLR}(t)]-1) && \text{[a phase in amount]} \end{aligned}$$

Here CD(t) is a correlated deviate. If std is given as the standard deviation and sc as the serial correlation (cells B8 and B9 in the worksheet “Model”) the deviates are generated as follows: set $s = (\text{std}) \times (1-\text{sc}^2)^{1/2}$. Then the first deviate is drawn from a normal distribution with mean 0 and standard deviation s, (i.e., $s \times N(0,1)$). Subsequent deviates are given by $\text{CD}(t+1) = (\text{sc}) \times \text{CD}(t) + s \times N(0,1)$.

Here M is the **Target Pricing Loss Ratio** (see the definitions above).

Here PLR(t) is the loss ratio experience in year t that is the basis on which new re-priced business is being put on the books.

$\text{PLR}(t) = \text{LR}(t - \text{Phase In Delay})$ see the definitions above for **Phase In Delay**.

If the total time from change in experience to re-pricing is 1 year, than $\text{PLR}(t) = \text{LR}(t-1)$. If the **Phase In Delay** is not a whole number PLR(t) will be an interpolated value of earlier loss ratios.

P(t) is a phase in factor. It is the dollar equivalent of P which is either the “**High Loss Ratio Phase in Factor**” or the “**Low Loss Ratio Phase in Factor**”. See the definitions above. If we started with \$1 of premium and 10% of units phase in, $P=.1$, the new premium dollars, PD, will be

$$\text{PD} = .9 \text{ (from old units)} + .1 \text{ PLR}/\text{M} \text{ from new units} = (1-P) + \text{P} \times \text{PLR}/\text{M}$$

That is, to get the target loss ratio to M when the experience is PLR premiums need to be changed to by $\text{PLR}(t)/\text{M}$. Thus the dollars phased in $= \text{P} \times \text{PLR}(t)/\text{M}$.

The expected dollar loss in the next period (as the experience is unchanged) is still LR(t-1).

However the expected loss ratio is now $LR(t-1)/PD$.

The new units as percentage of total premium, $P(t)$, will be

$$Px(PLR(t)/M) / [Px(PLR(t)/M)+(1-P)] = (PxPLR(t))/[Px(PLR(t))+1-P]xM$$

The expected loss ratio on re-priced dollars, $P(t)$, would be M if the current loss ratio, $LR(t-1)$, was the basis for re-pricing (i.e., equal to $PLR(t)$). The loss ratio on an old dollar is $LR(t-1)$, but we have $(PLR(t)/M)$ dollars per old dollar rewritten, thus the expected Loss ratio on new dollars is $LR(t-1)/(PLR(t)/M) = M \times (LR(t-1)/PLR(t))$.

The new expected loss ratio as a percentage of premium is

$$=(1-P(t))LR(t-1)+P(t)xMxLR(t-1)/PLR(t)$$

$$= LR(t-1)+P(t)LR(t-1)([M/PLR(t)]-1) \quad \text{[prior loss ratio plus phase in amount]}$$

$$= LR(t-1)/PD \quad \text{[prior losses + unchanged dollars]}$$

Thus the phase in adjustment can be thought of as $P(t)LR(t-1)([M/PLR(t)]-1)$

The profit for the period is the PD dollars times the $(TLR + \text{target profit margin} - LR(t))$. The tax rate time the tax recognition factor is applied to the profit and profit less tax are added to the prior surplus total. The aggregate is then divided by PD to put it on a per dollar basis.

If reserve strengthening is considered it is made using an adjustment to surplus. It is made based on PLR being the level of losses in the current block and $RALR$ (reserve adjustment loss ratio) as being the lose ratio above which additional reserves are required. $RALR$ could equal the target loss ratio plus the profit margin. The amount of reserving depends on the phase in factor. A 10% phase in factor would suggest 90% of the margin is lost in the next year, .9² in the second year etc, for a total of $(.9)/(1-.9)=9$. Thus the after tax reserve adjustment to surplus is

Reserve = $9x(PLR-RALR)x(1-\text{Tax Recognition \%} \times \text{TAX Rate})$. The model allows reserve strengthening to be done at other than 100%. The reserve is calculated without interest because interest is implicitly factored into the profit margin and $RALR$ can be set to cover losses after the profit margin.

Depending on how the loss ratios are calculated and how the dynamics are modeled, reserve changes may be implicit in the loss ratio dynamics. The DI loss ratios included normal reserve changes but not basis changes, so no reserve adjustment is required to implicitly model reserve changes.

WORKSHEETS (shown in bold Italics)

1. **Overview:** This worksheet has this model documentation.
2. **Model:** This worksheet has the basic model. It accepts input for scenarios, runs one or many scenarios and saves results.
3. **RunData:** If cell B1 of **Model** has a 1, then minimum surplus over the testing time horizon, the starting loss ratio after the seasoning process, the ending loss ratio and the average annual change in surplus as a percent of premium are saved in columns K through N.

4. **Rnumbers**: This worksheet produces random scenarios adjusted to satisfy certain criteria. This sheet is used in the model only if the random seed in cell B6 of **Model** is negative. The random seed used to generate the random numbers is in cell E1 of **Rnumbers**, it may or may not equal the negative of cell B6 in **Model**.
5. **CalcSTD**: This is an auxiliary worksheet not used in running the model. It calculates a standard deviation given loss ratio data (historic results) and a set of model assumptions on management dynamics.

MODULES

1. Module 1 has a subroutine called *Scenario*. For the number of scenarios in the left most set of input, cell B6 in **Model**, *Scenario* runs scenarios and counts the number of times ruin occurs. While *Scenario* is running the number of scenarios completed and the percentage of ruin scenarios is updated in cells B2 and B3 of **Model**. The *Scenario* subroutine is not accessed directly but is triggered by using the buttons RUNONE or RUN ALL in **Model**.

If the seed, cell B6 of **Model**, is greater than or equal to zero, *Scenario* will use the Visual Basic function Rnd to generate random numbers. If the seed number is less than zero, *Scenario* will read the random numbers from **Rnumbers**. Before running *Scenario* using a negative seed, **Rnumbers** has to be set up for the given number of scenarios with a length equal to the years of seasoning plus the time horizon. If the seed in **Model** is negative, the actual random seed used is taken from **Rnumbers**, not from **Model**. To get the full benefit of the adjustments in the random numbers in **Rnumbers**, the years of seasoning and the testing time horizon, Cells B12 and B14 in **Model**, should equal the length of scenarios in **Rnumbers**.

2. Module 3 has one subroutine, *Calcdeviates*. It is accessed directly in **CalcSTD** by clicking the button “Calculate Deviates”. The same management dynamics as found in **Model**, (**Phase In Delay**, **Low Loss Ratio Phase in Factor**, **High Loss Ratio Phase in Factor**, **Low Re-price Ratio**, **High Re-price Ratio**, and **Target Pricing Loss Ratio**) are used as input into *Calcdeviates*. A different set of dynamics can be inputted for each set of data. These are inputted in rows 4 through 9 in consecutive columns starting with column B for up to 99 columns. Given these inputs the deviates required to produce a given set of historic loss ratios are calculated. The historic loss ratios are inputted in rows 18 to 33 under the appropriate management dynamics. The historic loss ratios do not have to be of the same length. The resulting standard deviation of the deviates is a likely candidate for the standard deviation to be used in cell B8 of **Model** with the assumed management dynamics. The same historical experience will produce a different standard deviation given different assumptions on management dynamics.
3. Module 4 has one macro, RUNONE, which is accessed directly in **Model** by clicking the RUN ONE button. The macro uses the sub *Scenario* in module 1 to run the next set of input assumptions found in **Model**. After the run, the input and result is saved in **Model** (the prior output having being shifted over one column to the right). The remaining input scenarios are shifted over one column to the left.

4. Module 5 has one macro, RUNMANY, which is accessed directly in *Model* by clicking the RUN ALL button. The macro repeatedly runs RUNONE until all the input sets have been run.
5. Module 6 has one subroutine, RNFIX, which is accessed directly in the worksheet *Rnumbers* by clicking the button RNFIX. RNFIX uses the seed number in cell E1 of Rnumbers, the number of scenarios in cell C1 and the length of each scenario in cell C2. The scenarios are generated then numbered, with 1 being the scenario with the lowest sum of deviates, 2 the next lowest and so on. The scenarios are then ordered (but not re-numbered) based on the lowest sum of squares. Finally, the scenarios are adjusted.

Each scenario of random numbers, $X(i)$, is adjusted to $aX(i)+b$. Here a and b are chosen so that the sum of the adjusted $X(i)$ and the sum of the $X(i)$ squared match the expected distribution. For example, each scenario has 10 random numbers and the sum of those 10 random numbers is normally distributed with a mean of zero and a standard deviation of $(10)^{1/2}$. The sum of the square of the 10 random numbers will have a chi-square distribution with 10 degrees of freedom. If there are five scenarios (of ten random numbers each) the sum of the ten random numbers of each scenario are adjusted so that the five sums are at 10%, 30%, 50%, 70%, and 90% respectively of the Normal distribution with mean 0 and standard deviation $10^{1/2}$. The sum of the squares are adjusted so the five values equal 10%, 30%, 50%, 70% and 90% for the Chi Square distribution with ten degrees of freedom. Finding a and b to get the target adjustments requires solving a quadratic equation. If the equation has no real roots, a and b are chosen to produce the target sum and minimize the difference between the sum squared and the target sum squared. In these cases the difference is given in column one of *Rnumbers*.

Running the Model

In *Model* input the assumptions for the items listed in A5 to A32 in columns B5 to B32. If you want to run multiple scenarios, input the additional scenarios in columns C, D etc. To run only the first scenario, the one in B5 to B32, click the button "RUN ONE". To run all the scenarios, click the button "RUN ALL". The progress of the run will show in cells B2 and B3. When a scenario is done, the prior output, in rows 47 to 81, will be shifted one column to the right and the most recent scenario will be stored in B47 to B81. If there is another scenario in C5 to C32 all the input scenarios will be shifted over one column to the left.

