May 25, 2007

To: International Actuarial Association (IAA) ad hoc Risk Margin Working Group
Via e-mail to: katy.martin@actuaries.org.

Re: American Academy of Actuaries[1] Risk Margin Task Force (RMTF) comments on the IAA February 23, 2007 Exposure Draft '*Measurement of Liabilities for Insurance Contracts: Current Estimates and Risk Margins'*

The American Academy of Actuaries (AAA) recognizes the importance of the work being completed by the IAA ad hoc Risk Margin Working Group and, thus, formed a task force in early 2007 to review the papers related to current estimates and risk margins and offer the task force's suggestions and comments. The AAA's Risk Margin Task Force (RMTF) would like to submit the following comments and observations concerning the Feb. 23, 2007 Exposure Draft, "*Measurement of Liabilities for Insurance Contracts: Current Estimates and Risk Margins".*

Due to the complexity of the subject matter, we thank the authors for bringing this first draft to the table. We imagine that it was a difficult task and we find it to be a good beginning to address this difficult and somewhat cutting-edge topic. Especially because of this complexity, the comment in the February 26, 2007 cover letter that accompanied the Exposure Draft, that "after due deliberation regarding the comments received, the Working Group will complete a final version of this paper" causes us some concern. This paper is one of the most important works being produced at the international level and we believe that it needs to be thoroughly vetted and broadly supported by actuarial associations throughout the world. The length of the paper and the subject matter requires significant background and additional learning about international initiatives, so we strongly recommend there ought to be multiple exposures of this document and finalization only after broad support is achieved.

While there is still significant work and guidance that will need to be developed regarding current estimates, especially considering that the current estimates will be the largest components of the technical provisions, we recognize that much of the initial and immediate uses of this paper will be taken from the risk margin research. In that regard, we find it imperative to more completely and clearly document the pros and cons of the methodologies

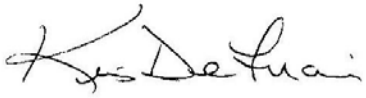
[1] The American Academy of Actuaries is a national organization formed in 1965 to bring together, in a single entity, actuaries of all specializations within the United States. A major purpose of the Academy is to act as a public information organization for the profession. Academy committees, task forces and work groups regularly prepare testimony and provide information to Congress and senior federal policy-makers, comment on proposed federal and state regulations, and work closely with the National Association of Insurance Commissioners and state officials on issues related to insurance, pensions and other forms of risk financing. The Academy establishes qualification standards for the actuarial profession in the United States and supports two independent boards. The Actuarial Standards Board promulgates standards of practice for the profession, and the Actuarial Board for Counseling and Discipline helps to ensure high standards of professional conduct are met. The Academy also supports the Joint Committee for the Code of Professional Conduct, which develops standards of conduct for the U.S. actuarial profession.

that can be used to calculate risk margins. Of particular importance, and especially because it appears that the International Association of Insurance Supervisors (IAIS) wants a recommendation on which methodology should be used to calculate risk margins, we believe that a thorough analysis of the practicality, and even a cost/benefit analysis, of each of those methodologies should be explored. Consideration should also be given as to whether it might be appropriate, especially considering practicality in the implementation, to use a combination of methodologies.

Attached are more detailed responses to the questions posed in the exposure cover letter.

On behalf of the American Academy of Actuaries' Risk Margin Task Force, I wish to thank you for the opportunity to comment. Should you have any questions or need further information on our comments, please feel free to contact us through Tina Getachew at getachew@actuary.org or at (202) 223-8196.

Sincerely,



Kris DeFrain, FCAS, MAAA, CPCU
Chairperson, Risk Margin Task Force
American Academy of Actuaries

The following are responses to the questions asked in your cover letter:

Overall Questions

1. Does this Exposure Draft address the objectives set forth in a satisfactory manner? If not, do you have any specific suggestions regarding how those not fully met could be better addressed?

a. The objectives are not as clearly stated as they should be and are not yet completely met. We offer some suggestions in the following comments.
b. The objectives appear to have evolved over the term of the working group from a narrow focus on solvency to a broader scope that includes general purpose accounting. Either the objective stated in Section 2.2 should be expanded or the various references outside the narrow Section 2.2 scope be eliminated.
c. Assuming that the RMWG chooses to expand the objective, wording such as the following might be appropriate: "*The objective is to present actuarially sound methodologies to establish fair value insurance liability estimates in the absence of deep and liquid markets, where the methodologies produce values that are appropriate for both general accounting and solvency purposes, under the assumption that additional provision for adverse experience will be established from company surplus for solvency purposes."* We note that it is not necessarily clear whether the focus is on fair value, but that makes it all the more apparent that a clearer objective should be stated.
d. Although the proposed methodology that calculates insurance liabilities by incorporating risk margins into the best estimate (referred to as "current estimate" in the paper) calculations is a reasonable and well accepted actuarial practice for some lines of business, it should be noted that market values may not always be easily decomposed into these components. Hence we recommend that the paper explicitly anticipates the use of alternative methodologies that are either observed in markets or have been subjected to appropriate actuarial peer review in actuarial literature. This may be particularly important when similar products are sold by insurers and non-insurers and the non-insurers develop methodologies differing from the current estimate plus risk margin approach. This would result in an open-ended approach versus establishment of a set methodology.
e. As an example of an alternative methodology, risk-neutral valuation methods are commonly used in financial markets to estimate market prices of securities with uncertain cash flows. Those market prices represent transfer prices, since they represent the amount of cash a buyer and seller would exchange upon transfer of ownership of the risky investment. These same valuation methods can be applied to the valuation of projected cash flows from insurance contracts. However, when this is done, one must keep the following in mind:
    i. Such techniques are calibrated to provide a provision for financial market risks only, not insurance risks. They are only suited to valuation of risks that can be replicated, or hedged, in investment markets.
    ii. Since insurance risks cannot generally be replicated in financial markets, other techniques are needed to estimate the risk margin for any insurance risk present in insurance liabilities.

iii. Various techniques can be combined to estimate the transfer value of an insurance contract. However, risk-neutral valuation techniques do not generally facilitate separation of the current estimate from the risk margin.

f. Chapter 6 of the paper presents three methodologies for determining risk margins. The paper would be more valuable if it more thoroughly discussed the pros and cons of each risk margin methodology including indications of the situations or products where each methodology may be most appropriate.

g. A comprehensive view of current practices should be provided and not just focus on advances that are limited to larger or more sophisticated insurance companies. For example, no mention was made that the vast majority of insurance companies currently apply formula-based valuation techniques to calculate some policy liabilities and risk-based capital. Either the Section 2.2 objectives should be narrowed to reflect this limitation (as they were later narrowed in Section 5.1) or broader practices should be included. Expanding the discussion to include all current practices would highlight the magnitude of any changes to the worldwide insurance market from adopting new valuation and solvency standards (to help others understand the impact assessment).

h. Discussion about health insurance and more discussion about property & casualty (P&C) practices would provide valuable additional insights. Since many countries do not have health insurance similar to the U.S. and the U.S. P&C business has longer tails, differing political climate, and different catastrophe exposure than in other countries, the U.S. business should receive some discussion in the paper.

i. Readers of the Exposure Draft have encountered difficulty evaluating it due to its length, organization and reference to external documents. The absence of a stated conceptual framework was particularly daunting since readers had to organize a framework themselves from the entire document.

j. Another impediment to the reader is the observation that the drafters are largely familiar with the background from the IASB, IAIS, and the IAA Blue Book. While there must be reliance on other works since this paper cannot fully detail all relevant background, it would be helpful to provide definitions or an expanded glossary that presents sufficient background information to limit the need for the reader to search through other documents.

2. Are the important issues related to the measurement of the liability for insurance contracts within the scope of the Exposure Draft addressed? Should any additional issues be discussed or issues that are included be deleted in the final paper?

a. The RMTF found many areas where we substantially concurred with the concepts of the Exposure Draft. However, we do not believe that all important issues have been addressed. The RMTF sees a number of areas that require further analysis and development as discussed below.

b. A significant deficiency in the Exposure Draft is the absence of an explicit self-contained actuarial conceptual framework for risk margins in reserves and required capital that would facilitate adoption of new techniques as practices evolve. Without such a framework, any conclusions and recommendations will become dated and outmoded. Such a conceptual foundation permits practices to evolve in response to changing conditions and capabilities. The RMTF would volunteer to assist to further develop this framework.

c. Any valuation technique should be validated, to the extent possible, by external benchmarks such as market values. Strong consideration should be given to including external benchmark values as a fundamental element of the conceptual framework. It should be noted that market values, when they exist, can be observed, but current estimates cannot be observed except as part of a market value. Therefore valuation techniques that involve calibration to benchmarks and provide market value estimates directly, without a split into a current estimate and a risk margin, should be allowed. Risk-neutral valuation is one example of such a technique, and a discussion of it should be included in the paper.
d. In Section 1.5 of the Executive Summary, the statement is made that "Section 6 shows that the general purpose reporting and regulatory objectives of the measurement of risks can be mutually compatible." This conclusion does not appear in the text of Section 6 and additional discussion is needed to support it.
e. The risk margin concept in Chapter 6 is new and needs significant development; however, we also suggest that issues regarding current estimates in Chapter 5 be given more attention, especially since the current estimate amounts will be the majority of the liability value. See answers to Specific Comments Questions 1 and 2 for suggestions.
f. There should be discussion in Chapter 5 about discount rates, margins or conservatism included in current estimates, and how to not double count margins in the current estimates with the risk margins.
g. The measurement of liabilities appears to be limited in scope by focusing on financially-oriented products. For example, in the beginning of Chapter 5 "current estimates" are defined in terms of probability weighted cash flows, which is a not uncommon practice for savings products where financial market performance is a predominant variable. However, risk-related products may not have credible probability distributions, requiring actuaries to rely on more credible model (single point) estimates. Hence, different methods of determining risk margins may be appropriate, depending upon the situation at hand.
h. In Chapter 4, *Liabilities and Risk Concept Inter-relationships* , the paper describes the components of the market consistent liability value. However, it does not clearly describe the inter-relationship between the components of the insurance liability value - the current estimate and the risk margin. We suggest that the section should define more clearly the hedgeable and non-hedgeable risk and illustrate the inter-relationship between the current estimate and the risk margin using the product component example such as claim (death benefit, surrender benefit, etc), expenses, premium/charges, and any option embedded in the liability. In addition, the paper should discuss how to bifurcate hedgeable and non-hedgeable risks. For example, what are the implications for modeling interest rate sensitive lapse risk and related instances where the hedgeable and non-hedgeable portions are not readily separable?
i. There should be significantly more discussion about the practicality of approaches. This discussion is important enough to warrant its own chapter in the paper. The paper addresses the conceptual issues but does not provide sufficient discussion of practical implementation for real products. Some practical considerations include the following:
    i. Will these approaches be practical if a company estimates liabilities monthly or quarterly and not just annually?
    ii. Who will provide information about a reference entity (or reference framework) and how often will that information need to be updated? Would there be different sources and definitions of that reference framework for regulatory financial reporting versus general purpose reporting?

iii. Can the risks that are identified in Table 4.1 as being provided for by capital and/or within liability values be separated in practice? And again, is it possible to separate hedgeable and non-hedgeable risks?

iv. Would approaches differ for small versus large companies? Similarly, how would less developed countries apply this approach, especially if they do not have readily available market information and industry studies?

v. Approximations and practical approaches need to be developed since theoretical precision might not be worth the expense. One example is the suggestion that the mortality assumption vary with contract termination rates when using multiple scenarios. This is particularly true if no internal or public studies have been performed that suggest that this has a significant impact.

j. A revised Appendix D regarding the calculation of risk margins for P&C insurance is attached to this letter. We offer this to make the appendix easier to read and understand, as well as to more simply describe the methodologies. Two methods are added, one is a method described in a UK General Insurance Research Organization's (GIRO) report and the other is one that the current appendix alludes to but did not develop.

k. Throughout the paper, there is reference to the need for further research. We recommend compiling one list at the end of the paper that includes the following:

i. Since the IAIS specified that needed capital would be for nonhedgeable risks only, regulatory capital would differ from economic capital used under the economic capital approach for setting risk margins. The economic capital would normally be expected to be greater than the minimum regulatory capital. There is current literature and models to indicate appropriate levels of economic and regulatory capital, but further work is encouraged and the IAA has volunteered to help to determine the appropriate method for establishing cost of capital for purposes of determining the risk margin.

ii. Further study should be done on future capital needs. It is possible that capital requirements may increase as policies age since late settled claims are larger, with more disputes, and more variability. More study needs to be done on the capital needs over time and whether that should vary by type of business, risk involved, and age of claims.

iii. For insurers without credible internal models, standard tabular factors might be applied to determine risk margins. The development of multi-factor tabular models would require further study.

iv. The IAA encourages continued research and development of practical applications, as well as effective communication of results from this research.

3. Are there areas that require correction or that are not adequately addressed in an objective manner?

a. Section 5.2 is very brief and only provides an example of the determination of the current estimate for mortality incorporating information about level and trend. No examples are provided for property-casualty insurance liabilities and the section only alludes to a paper that appears elsewhere.

b. Section 6.9.3 states that "experience suggests that the assumption of uniform capital requirements as a percentage of the remaining liability will likely understate the capital

requirement". In life insurance, this may not be a correct statement. We believe the future capital needs may not always increase over time. We observed in life insurance many cases where the future capital needs decrease over time.

c. Appendix E 2.1.1 refers to anti-selection effects of "considerable voluntary terminations". Under some circumstances, such terminations might instead result in a shortened select period. We recommend changing the paragraph to read as follows:

E2.1.1 Insured mortality of the portfolio is not the same as population mortality. In general, the mortality of the insured population for life insurance is lower than that of the general population because of the effect of underwriting (selection) at issue. The difference depends on the period since underwriting, through so-called *select mortality*. The period of the select mortality depends on the extent of underwriting and age at time of underwriting. Experience has shown that it can last from 5 to 25 years, with a shorter period if no selection was performed or if lapse rates are generally high for the portfolio. This period should be validated with mortality studies of the particular portfolio or similar insurance portfolios subject to the same underwriting standards, where relevant experience data is available. Mortality after this select period is referred to as *ultimate mortality*. If a portfolio of contracts experiences considerable voluntary terminations at or near a particular time (for example, after a sharp premium increase) or if no underwriting is conducted initially, anti-selection effects (unhealthy lives are less likely to terminate, giving rise to mortality higher than the ultimate level) may be experienced for several years over time.

d. The second from last sentence of Appendix E 2.1.9 refers to the use of "industry tables … with a constant percentage adjustment applied to all the mortality rates" when no observations are available. Significant adjustments of this type generally should not be expected to persist indefinitely. We recommend changing the paragraph to read as follows:

E2.1.9 If an estimation of mortality rates using age-dependent factors cannot be determined because the amount of experience in the estimation cells are too small (e.g., for a niche market), it may be possible for most ages to use age independent factors or theoretical mortality models (e.g., Gompertz or Makeham). In case of observed groups that are too small, products might be broadly grouped into positive risk (e.g., term insurance, universal life insurance, unit-linked life insurance, and whole life) and negative risk (e.g., pure endowment and payout annuities). In case no observations are available, (margin free) industry tables might be used with a constant percentage adjustment applied to all the mortality rates (for example +/- 20%, depending on an assessment of the relative effectiveness of the underwriting screening performed and the market penetrated). Although such an adjustment may be constant for several years, and some adjustment may be appropriate in the ultimate, as a percentage it should normally decline as the portfolio ages. The less accurate the data is, the higher the uncertainty, resulting in a higher risk margin assumption.

e. The last sentence of Appendix E 2.2.8 4, on expert opinion, though true, is inaccurate because it is incomplete. We recommend adding a sentence, "If properly controlled,

such differences can be used to improve the projection." In this respect, we have also offered some additions to the bibliography in our response to Specific Question 4.

4. Are there other areas for which additional educational guidance related to the issues addressed need to be provided? To what extent is the guidance included inappropriate or unnecessary? Please be as specific as possible.

a. A substantial volume of educational guidance will be needed, with particular emphasis on business practices unique to each region or country, as further explained in the subsequent comments
b. Approximations mentioned in Section 5.1.9 and practical approaches deserve much more discussion since theoretically precise results may not be worth the expense for preparing them. In the U.S., there are many small companies as well as immaterial blocks of business within larger companies. This will clearly be an issue for companies in less developed countries, even for subsidiaries of large multi-national companies.
c. Two practical approaches can be taken: (1) safe harbors and (2) periodic testing. Safe harbors would be simple approaches that reflect both the current estimate and risk margins. Periodic testing would permit a company to accurately calculate values once and then use a simpler approach to "roll forward" the values to later accounting periods. The frequency of accurate recalculations would be a function of reasonability and should not have to be performed annually for all elements of a model.
d. The last sentence of the first paragraph in Section 5.1.6 calls for a mortality assumption that varies with contract termination rates if multiple scenarios are used. Although this sounds theoretically correct, it is beyond both the sophistication of experience studies available to date and the capabilities of most projection systems now in use. We are not aware of any experience studies that investigate this issue, but would welcome a footnote reference to such a study.

Specific Questions

1. With respect to Current Estimates, are the considerations given in Chapter 5 the most important ones? Do you disagree with any of them or do you have additional ones that should be reflected in the final paper?

a. Several significant considerations were omitted in Chapter 5 relating to Current Estimates, as further explained in the subsequent comments.
b. The paper does not address in any detail how to handle lapse and other policyholder behavior risks for life insurance products. These are more complex than the mortality risks included in the appendix and might bring attention to additional considerations regarding "data, other requirements to determine reliable, robust values".
c. Section 5.1.1 states that all relevant cash flows be included, yet income taxes were missing from the discussion of liabilities. The timing of such taxes (such as limited tax carry forwards) can impact the appropriate level of reserves required to extinguish policyholder liabilities. This issue is complicated by the fact that such taxes are normally determined at the entity level rather than the policy level and may not be resolvable. Section 5.1.3 addresses situations where market information is unavailable.
d. In situations where neither company nor industry data is available, the appropriate response should be addressed in detail. This can involve small companies or small

e. portfolios of policies in markets where industry studies have not been performed. Consideration may be given to establishing standards requiring companies to conduct actuarial and other studies in such situations or perhaps even countries that wish to comply with international standards. Examples of quality industry studies include Society of Actuaries and LOMA investigations of mortality, persistency, expenses, etc. The discussion in 5.1.2.1 concerning accounting standards may confuse the effort to establish sound international actuarial principles, since these may be viewed as artificial constraints. On the other hand, it would be valuable to discuss how the international actuarial principles being proposed would change financial results published following existing standards.

f. The question of appropriate rates for discounting insurance cash flows is addressed in Section 5.1.3.1, yet is not fully resolved. In particular, there is a significant problem with using risk-free discount rates for "spread" products like general account SPDA's since this conflicts with longstanding business practices. The problem occurs when businesses expect to receive sufficient yields, even after defaults, to fund crediting rates equal to or in excess of risk-free yields. For example, the discount rate could be a default-free rate. The default-free rate can include a spread over what is commonly called the risk-free rate because liquidity is not a requirement of a replicating portfolio for fixed expected cash flows. The risk-free rate is generally measured based on very liquid securities, and the default-free rate can be higher due to a liquidity premium. (Note, when the timing of the cash flows is uncertain then liquidity is required as part of the provision for risk, and elimination of the "liquidity spread" could be involved in the measurement of the provision for risk). Risk-free yields may also be affected by the tax treatment of interest income from government debt in certain jurisdictions.

g. Appendix E 1.3 cites "high quality government bond rates" as a source for discount rates. However, appropriate government bond yields may not be readily available in all countries and some countries have even defaulted on their obligations in the past.

2. Three specific risk margin methods are described in chapter 6, with a focus on the quantile and cost of capital methods. Are they described in an appropriate level of detail and in an objective manner? Are there any other methods either in current use or that should be considered or treated in greater depth? If so, please provide a description of them and the reasons that they should be considered.

a. Additional discussion is needed relative to risk margins. In particular, members have observed numerous methodologies in current practice for valuing insurance companies and could not reach agreement on a particular methodology to recommend over others.

b. The discussion of the "reference entity" can be challenged. This needs to be more carefully defined as it greatly influences the degree to which diversification adjustments are made. For example, as described in Section 6.9.1 the cost of capital approach requires detailed assumptions regarding the reference entity's portfolio of risks in order to calculate the impact of the risk under consideration on the reference entity's quantile. Will companies create their own set of capital assumptions or will some regulatory body provide these estimates? If the latter, who would set these, how often, how much lead time, etc.?

c. Section 6.9.4 refers to the 6% rate in the Swiss Solvency Test (SST) reflecting a cost of capital for a BBB company - is this an equity cost, debt cost or some weighted average cost? The glossary defines cost of capital as "the opportunity cost associated with a

given amount of capital": how will this be estimated? Should the cost of capital rates used in the paper be thought of as spreads over a risk-free rate or as absolute rates? In the same section, on page 65, there is a reference to the market value of the reference entity as a consideration in establishing cost of capital requirements. This reference is unclear and requires additional explanation.

d. In Section 6.11, the statement is made that "in the cost of capital method the determination of probability distributions is not strictly needed." This statement should be clarified, as the cost of capital method described in the paper requires at least assumptions regarding the reference entity's portfolio of risks and probability distribution of liabilities in order to define the capital required and calculate the margin for the risk under consideration. Perhaps it could also reference (and give examples of) simpler cost of capital approaches that support that statement, such as those that rely instead on market leverage norms for determining required capital and market observation for determining the required costs of capital.

e. Section 6.9.1 refers to the concept of a market proxy entity of a large, diverse AA-rated insurer and mentions a capital factor of 99.5% for a BBB company and a 99.95% or 99.97% for AA. While this is apparently in keeping with Solvency II, we believe these are too onerous in some situations. In fact, this is probably beyond the level of precision for any model, as a 99.97% standard translates for property/casualty (general) insurance catastrophe risk into a 3 in 10,000 year event.

f. In certain cases, an insurer may use multiple methods for deriving a risk margin, or different methods for different classes of business. This possibility should be explicitly addressed in the paper. This is a major point for property/casualty (general) insurance.

3. Do you agree with the description of the treatment of risk mitigation approaches described in Section 7? If not, please describe the reasons for your disagreement.

We have not yet delved into this topic, but will do so with the next exposure draft.

4. The bibliography provides several recent references on this subject. Are you aware of any others that should be included?

While there are likely additional ones, we offer the following references related to Current Estimates. Paragraph #4 of Appendix E ends with "a problem usually encountered using this method …" (expert opinion). Leaving this as a problem short-changes the method. There are techniques for effectively addressing this problem to produce better estimates. Possible references:

Allan Mills and Peter Bishop. Society of Actuaries. 2000. *Applied Futurism: An Introduction for Actuaries*

Society of Actuaries. October 6, 2005. *A Study of the Use of the Delphi Method, A Futures Research Technique for Forecasting Selected U.S. Economic Variables and Determining Rationales for Judgments*

Edward Cornish. The World Future Society. 2005. *Futuring: The Exploration of the Future*

James Surowiecki. Anchor Books. 2005. *The Wisdom of Crowds*

APPENDIX D

Derivation of Property/Casualty Cost-of-Capital Risk Margins

This appendix displays several methods for calculating property/casualty risk margins under cost-of-capital methodologies.

The underlying assumption of cost-of-capital methods is that, given a best estimate of the future payment of claim liabilities and a required outlay of capital to protect against adverse development of these liabilities, the risk margin to be included in the loss reserves must produce (along with the supporting capital and the discounted best estimate of the liabilities) a stream of funds released during the course of the runoff that provides a hypothetical insurer assuming these liabilities with an investment yield similar to what it would have achieved if it had instead invested its capital in the general market.

Notations and Assumptions

Let t represent the age of the runoff (i.e. the number of years after the portfolio transfer). We shall denote the best estimate of the stream of future claim payments (discounted at the risk-free rate and evaluated at the end of year t) as DBE_t. We shall use UBE_t to denote undiscounted claim liabilities at the end of year t.

The hypothetical transfer of the portfolio of claims shall occur at the end of year 0. At this time the insurer ceding the portfolio pays the assuming insurer an amount equal to DBE_0 plus a risk margin which we shall denote as RM_0. Upon taking over these liabilities the assumer must set aside from its own resources an amount of capital (determined by regulators or other external sources) to "support" these liabilities. We shall denote this initial outlay of supporting capital as SCR_0.

For ease of exposition we shall assume that all claim payments are made at the end of each year. We shall also assume that the annual risk-free and risk-loaded (i.e. market yield) rates of return remain constant throughout the runoff.

Release of Portfolio Funds

As noted earlier, the total funds held to pay claim liabilities are comprised of the discounted best estimate *plus* the risk margin *plus* the supporting capital, all of which change throughout the runoff. We denote the total funds supporting the claim portfolio at the end of year t as $DBE_t + RM_t + SCR_t$.

The funds that are released (i.e. made available to the assuming insurer for market investment) during any given year of the runoff equal:

Total claim portfolio funds held at the beginning of the year
+ one year of risk-free income earned on those funds
- claim payments made at the end of the year
- total funds required to be held at the end of the year

Hence the funds released to the purchaser during year t can be notated as

$$(DBE_{t-1} + RM_{t-1} + SCR_{t-1})(1+a) - P_t - (DBE_t + RM_t + SCR_t)$$

Method 1: Fixed Ratio of *SCR / DBE*

The simplest situation occurs where a fixed ratio of supporting capital to discounted best estimate is required throughout the runoff. While there is more than one method to produce a cost-of-capital risk margin stream under these conditions, we display here the "Swiss Solvency Test" method used by Swiss regulators. Under this method ,the risk margin is the present value (discounted at the risk-free rate) of the cost in lost investment opportunities for outlaying the stream of capital required to support the runoff.

To illustrate we will use the medium-tailed (i.e. "motor") claim payment pattern shown on page 46 as well as supporting capital SCR_t equal to 30% of DBE_t and risk-free and risk-loaded rates of 4% and 10% respectively. The cost of capital for any given year t equals the cost-of-capital rate (i.e. the difference between the risk-loaded and risk-free rates) times the supporting capital (SCR_{t-1}) held during the year.

End of Year t	Claim Payments	DBE_t	SCR_t	Cost of Capital	RM_t	Total Funds Held
0		100,000	30,000		3,250	133,250
1	46,000	58,000	17,400	1,800	1,580	76,980
2	33,320	27,000	8,100	1,044	599	35,699
3	22,080	6,000	1,800	486	137	7,937
4	4,240	2,000	600	108	35	2,635
5	2,080	0	0	36	0	0

The stream of funds released to the portfolio assumer under this method produces, at the end of the runoff, an investment yield of 48,315, which is identical to what it would have achieved if it had invested its capital of 30,000 in market investments rather than in the purchase of this claim portfolio.

End of Year t	*Yield from Claim Portfolio*			*Yield from Market Investment*		
	Funds Released	Years Invested	Value at End of Runoff	Initial Capital Invested	Years Invested	Value at End of Runoff
0				30,000	5	48,315
1	15,600	4	22,840			
2	11,040	3	14,694			
3	7,110	2	8,603			
4	1,380	1	1,518			
5	660	0	660			
		Total:	48,315		Total:	48,315

Diagnostics

Further insights into this method can be gained by examining the following key diagnostic rates and ratios.

End of Year t	SCR_t / DBE_t	RM_t / DBE_t	$(DBE_t + RM_t) / UBE_t$	Implied Discount Rate
0	30.0%	3.2%	95.9%	2.3%
1	30.0%	2.7%	96.5%	2.2%
2	30.0%	2.2%	97.2%	2.2%
3	30.0%	2.3%	97.1%	2.2%
4	30.0%	1.7%	97.8%	2.2%

- ✓ The ratio of SCR_t to DBE_t remains constant throughout the runoff. Whether this ratio should increase or otherwise vary as the portfolio ages is open to debate.
- ✓ The ratio of RM_t to DBE_t generally declines with this method as the portfolio ages. The appropriateness of this is also open to debate.
- ✓ The ratio of "cost of capital" loss reserves (i.e. $DBE_t + RM_t$) to undiscounted loss reserves (UBE_t) is less than 100%, implying that a rational investor would assume this claim portfolio for an amount less than the undiscounted loss reserves. It is worth noting that under this particular method this price discrepancy tends to decrease during the runoff.
- ✓ The "cost of capital" loss reserves produced in this example could also be produced by discounting the claim reserves at a rate of approximately 2.2%, which is roughly half the risk-free rate.

Simplified Formula

Since the risk margins from this method are derived from a present-valued stream of costs of capital, each of which are ultimately derived from a present-valued stream of claim payments, the formula for calculating the risk margin at time t under this method can be simplified as follows:

$$RM_t = \sum_{z=0}^{\infty} CoC_{t+1+z} v_a^{z+1} \quad \text{where } CoC_t = \text{cost of capital at end of year } t$$

$$= (x-a)\sum_{z=0}^{\infty} SCR_{t+z} v_a^{z+1}$$

$$= k(x-a)\sum_{z=0}^{\infty} DBE_{t+z} v_a^{z+1}$$

$$= k(x-a)\sum_{z=0}^{\infty}\left[\sum_{u=1}^{\infty} P_{t+z+u} v_a^{u}\right] v_a^{z+1}$$

$$= k(x-a)v_a \sum_{z=0}^{\infty}\sum_{u=1}^{\infty} P_{t+z+u} v_a^{z+u}$$

$$= k(x-a)v_a \sum_{u=1}^{\infty} u\, P_{t+u} v_a^{u}$$

Hence the risk margin at the time of the portfolio transfer equals $k(x-a)v_a \sum_{u=1}^{\infty} u\, P_u v_a^u$

Method 2: Fixed Ratio of *(SCR + RM) / DBE*

Another method for deriving a cost-of-capital risk margin is to maintain a constant ratio of *combined* capital and risk margin to the discounted best estimate. We shall denote this fixed ratio as f. Unlike the previous method, this method produces a ratio of SCR_t / DBE_t that changes during the runoff, as does the ratio of RM_t / DBE_t.

Another peculiarity of this method is that it requires the calculation of best estimates discounted at the *risk-loaded* rate as well as at the risk-free rate. We shall therefore denote the best estimate discounted at the end of year t at the risk-loaded rate of x as DBE_t^x.

This method's supporting capital at the end of year t equals f times the best estimate discounted at the risk-loaded rate, or $SCR_t = f\, DBE_t^x$. The risk margin required at the end of year t is given as $RM_t = f(DBE_t - DBE_t^x)$.

As an example, if we set f equal to 33.2% and maintain the same claim payment patterns and interest rates of the previous example, we get the following:

End of Year t	Claim Payments	DBE_t	DBE_t^*	SCR_t	RM_t	Total Funds Held
0		100,000	90,132	29,924	3,276	133,200
1	46,000	58,000	53,145	17,644	1,612	77,256
2	33,320	27,000	25,140	8,346	618	35,964
3	22,080	6,000	5,574	1,850	142	7,992
4	4,240	2,000	1,891	628	36	2,664
5	2,080	0	0	0	0	0

Calculating the stream of funds released by this method and comparing investment yields we get the following:

	Yield from Claim Portfolio			*Yield from Market Investment*		
End of Year t	Funds Released	Years Invested	Value at End of Runoff	Initial Capital Invested	Years Invested	Value at End of Runoff
0				29,924	5	48,193
1	15,272	4	22,360			
2	11,062	3	14,724			
3	7,331	2	8,870			
4	1,408	1	1,548			
5	691	0	691			
		Total:	48,193		Total:	48,193

Key diagnostics produced by this method are…

End of Year t	SCR_t / DBE_t	RM_t / DBE_t	$(DBE_t + RM_t) / UBE_t$	Implied Discount Rate
0	29.9%	3.3%	95.9%	2.2%
1	30.4%	2.8%	96.6%	2.2%
2	30.9%	2.3%	97.2%	2.2%
3	30.8%	2.4%	97.2%	2.2%
4	31.4%	1.8%	97.9%	2.2%

from which we note that

- ✓ The ratio of SCR_t / DBE_t increases somewhat during the runoff.
- ✓ As with the previous method, the ratio of RM_t / DBE_t generally declines with this method as the portfolio ages.

- ✓ The ratio of $(DBE_t + RM_t)/UBE_t$ is again less than 100%, implying that a rational investor would assume this claim portfolio for an amount less than the undiscounted claim reserves. Again, this price discrepancy tends to decrease during the runoff.

- ✓ The implied discount rate remains at 2.2% throughout the runoff.

Derivation of Formulas

The formulas which were referenced earlier for the supporting capital and the risk margin under this method are derived as follows.

Since $f = (SCR_t + RM_t)/DBE_t^a$, the funds released to the assuming insurer during year t simplify as follows:

$$(DBE_{t-1} + RM_{t-1} + SCR_{t-1})(1+a) - P_t - (DBE_t + RM_t + SCR_t)$$

$$= (1+f)DBE_{t-1}(1+a) - P_t - (1+f)DBE_t$$

$$= (1+f)[v_a(DBE_t + P_t)](1+a) - P_t - (1+f)DBE_t$$

$$= (1+f)DBE_t + (1+f)P_t - P_t - (1+f)DBE_t$$

$$= f\,P_t$$

Under cost-of-capital requirements SCR_t must equal the sum of all future released funds, present-valued to the end of year t at the risk-loaded rate.

Hence $SCR_t = \sum_{u=1}^{\infty} v_x^u f\,P_{t+u}$

$$= f\sum_{u=1}^{\infty} v_x^u P_{t+u}$$

$$= f\,DBE_t^x$$

Since $f = (SCR_t + RM_t)/DBE_t$

Then $RM_t = f\,DBE_t - SCR_t$

$$= f\,DBE_t - f\,DBE_t^x$$

$$= f(DBE_t - DBE_t^x)$$

Method 3: Fixed Ratios of *SCR / DBE* and of *RM / DBE*

The British General Insurance Research Organizing (GIRO) Committee has proposed a method for maintaining fixed ratios of both SCR_t/DBE_t and RM_t/DBE_t during the runoff.

Under this method we let $k = SCR_t/DBE_t$ and $m = RM_t/DBE_t$. Hence the funds released during year t can be written as

$$(1+m+k)DBE_{t-1}(1+a)-P_t-(1+m+k)DBE_t$$

$$=(1+m+k)\left[v_a(DBE_t+P_t)\right](1+a)-P_t-(1+m+k)DBE_t$$

$$=(1+m+k)DBE_t+(1+m+k)P_t-P_t-(1+m+k)DBE_t$$

$$=(m+k)P_t$$

Again, under cost-of-capital requirements, supporting capital at the time of the portfolio transfer must equal the sum of all future released funds, present-valued at the risk-loaded rate.

Hence $SCR_0=\sum_{t=1}^{\infty}v_x^t(m+k)P_t$

$$=(m+k)\sum_{t=1}^{\infty}v_x^tP_t$$

$$=(m+k)DBE_0^x$$

Solving for m we get

$$m=SCR_0/DBE_0^x-k$$

$$=k\,DBE_0/DBE_0^x-k$$

$$=k(DBE_0/DBE_0^x-1)$$

Using the same claim payment pattern and risk-free and risk-loaded rates as the previous examples and a fixed SCR_t/DBE_t ratio of 30%, the above formula for m produces a fixed RM_t/DBE_t ratio of approximately 3.3%. This produces the following stream of risk margins and supporting capital:

End of Year t	Claim Payments	DBE_t	DBE_t^*	SCR_t	RM_t	Total Funds Held
0		100,000	90,132	30,000	3,285	133,285
1	46,000	58,000	53,145	17,400	1,905	77,305
2	33,320	27,000	25,140	8,100	887	35,987
3	22,080	6,000	5,574	1,800	197	7,997
4	4,240	2,000	1,891	600	66	2,666
5	2,080	0	0	0	0	0

with the following cost-of-capital verification…

	Yield from Claim Portfolio			*Yield from Market Investment*		
End of Year t	Funds Released	Years Invested	Value at End of Runoff	Initial Capital Invested	Years Invested	Value at End of Runoff
0				30,000	5	48,315
1	15,311	4	22,417			
2	11,090	3	14,761			
3	7,349	2	8,893			
4	1,411	1	1,552			
5	692	0	692			
		Total:	48,315		Total:	48,315

and the following diagnostics…

End of Year t	SCR_t / DBE_t	RM_t / DBE_t	$(DBE_t + RM_t) / UBE_t$	Implied Discount Rate
0	30.0%	3.3%	95.9%	2.2%
1	30.0%	3.3%	97.1%	1.9%
2	30.0%	3.3%	98.2%	1.4%
3	30.0%	3.3%	98.1%	1.5%
4	30.0%	3.3%	99.3%	0.7%

Note that as the portfolio ages this method produces more reserve protection than Method 1 and brings the reserves closer to their undiscounted value.

Method 4: Ratio of *SCR / DBE* Steadily Increases During Runoff

The fixed ratio methods described above all assume that the amount of supporting capital (or capital plus risk margin) relative to the discounted best estimate need not change during the runoff. However, it can be argued that a portfolio's potential for adverse development increases or otherwise changes over time and that the ratio of SCR_t/DBE_t should also increase (or otherwise change) as the claim portfolio matures.

We therefore explore the simplest such situation, where the ratio of SCR_t/DBE_t grows at a steady annual rate during the runoff. If the initial ratio of SCR_0/DBE_0 at the time of the portfolio transfer is k, then at year t SCR_t/DBE_t equals kw^t, where w is the annual growth rate in k.

The formula for RM_t shown in Method 1 expands as follows:

$$RM_t = k(x-a)\sum_{z=0}^{\infty} w^{t+z} DBE_{t+z} v_a^{z+1}$$

$$= k(x-a)\sum_{z=0}^{\infty} w^{t+z} \left[\sum_{u=1}^{\infty} P_{t+z+u} v_a^{u}\right] v_a^{z+1}$$

$$= k(x-a)v_a \sum_{z=0}^{\infty}\sum_{u=1}^{\infty} w^{t+z} P_{t+z+u} v_a^{z+u}$$

If we apply a 10% annual growth rate to the ratio of SCR_t/DBE_t shown in Method 1, we get the following:

End of Year t	Claim Payments	DBE_t	SCR_t	Cost of Capital	RM_t	Total Funds Held
0		100,000	30,000		3,482	133,482
1	46,000	58,000	19,140	1,800	1,821	78,961
2	33,320	27,000	9,801	1,148	745	37,546
3	22,080	6,000	2,396	588	187	8,583
4	4,240	2,000	878	144	51	2,929
5	2,080	0	0	53	0	0

with the following cost-of-capital verification...

End of Year t	*Yield from Claim Portfolio*			*Yield from Market Investment*		
	Funds Released	Years Invested	Value at End of Runoff	Initial Capital Invested	Years Invested	Value at End of Runoff
0				30,000	5	48,315
1	13,860	4	20,292			
2	11,253	3	14,978			
3	8,385	2	10,146			
4	1,757	1	1,933			
5	966	0	966			
		Total:	48,315		Total:	48,315

and the following diagnostics…

End of Year t	SCR_t/DBE_t	RM_t/DBE_t	$(DBE_t+RM_t)/UBE_t$	Implied Discount Rate
0	30.0%	3.5%	96.1%	2.1%
1	33.0%	3.1%	96.9%	2.0%
2	36.3%	2.8%	97.7%	1.8%
3	39.9%	3.1%	97.9%	1.6%
4	43.9%	2.5%	98.6%	1.4%

Note that the RM_t/DBE_t ratio remains relatively stable while the SCR_t/DBE_t ratio increases.

Method 5: Ratio of *(SCR + RM) / DBE* Steadily Increases During Runoff

In similar fashion we can alter Method 2 to allow for a steady increase in the ratio of $(SCR_t+RM_t)/DBE_t$ during the runoff.

In this case $(SCR_t+RM_t)/DBE_t^a = f\,w^t$ and the funds released during year t equal

$$\left[1+f(1+w)^{t-1}\right]DBE_{t-1}(1+a)-P_t-\left[1+f(1+w)^t\right]DBE_t$$

$$=\left[1+f(1+w)^{t-1}\right]\left[v_a(DBE_t+P_t)\right](1+a)-P_t-\left[1+f(1+w)^t\right]DBE_t$$

$$=\left[1+f(1+w)^{t-1}\right]DBE_t+\left[1+f(1+w)^{t-1}\right]P_t-P_t-\left[1+f(1+w)^t\right]DBE_t$$

$$=DBE_t+f(1+w)^{t-1}DBE_t+P_t+f(1+w)^{t-1}P_t-P_t-DBE_t-f(1+w)^t DBE_t$$

$$=f(1+w)^{t-1}DBE_t+f(1+w)^{t-1}P_t-f(1+w)^t DBE_t$$

$$= f(1+w)^{t-1}\left[DBE_t + P_t - (1+w)DBE_t\right]$$

$$= f(1+w)^{t-1}(P_t - w\,DBE_t)$$

Hence $SCR = \sum_{u=1}^{\infty} v_x^u f(1+w)^{t+u-1}(P_{t+u} - w\,DBE_{t+u})$

$$= f\sum_{u=1}^{\infty} v_x^u (1+w)^{t+u-1}(P_{t+u} - w\,DBE_{t+u})$$

Since $(SCR_t + RM_t)/DBE_t = f(1+w)^t$

then $$RM_t = f(1+w)^t\, DBE_t - SCR_t$$

which produces the following table:

End of Year t	Claim Payments	DBE_t	SCR_t	RM_t	Total Funds Held
0		100,000	29,705	3,495	133,200
1	46,000	58,000	19,329	1,853	79,182
2	33,320	27,000	10,080	767	37,846
3	22,080	6,000	2,459	193	8,651
4	4,240	2,000	919	53	2,972
5	2,080	0	0	0	0

and the following cost-of-capital verification...

	Yield from Claim Portfolio			*Yield from Market Investment*		
End of Year t	Funds Released	Years Invested	Value at End of Runoff	Initial Capital Invested	Years Invested	Value at End of Runoff
0				29,705	5	47,840
1	13,346	4	19,540			
2	11,182	3	14,884			
3	8,629	2	10,441			
4	1,785	1	1,964			
5	1,011	0	1,011			
		Total:	47,840		Total:	47,840

and the following diagnostics...

End of Year t	SCR_t / DBE_t	RM_t / DBE_t	$(DBE_t + RM_t) / UBE_t$	Implied Discount Rate
0	29.7%	3.5%	96.1%	2.1%
1	33.3%	3.2%	97.0%	2.0%
2	37.3%	2.8%	97.8%	1.8%
3	41.0%	3.2%	98.0%	1.5%
4	46.0%	2.7%	98.7%	1.3%

Note that as in Method 4 the RM_t / DBE_t ratio remains relatively stable while the SCR_t / DBE_t ratio increases.

The Five Methods Applied to a Long-Tailed Line

In all methods previously described we have used medium-tailed claim payment pattern. We will now examine the effects of using the long-tailed claim payment pattern shown on page 46. We shall otherwise maintain the same rates, ratios and formulas used in each of the five methods. For ease of display we will show only the diagnostic tables.

Method 1: Fixed Ratio of SCR / DBE

End of Year t	*Long Tail* SCR_t/DBE_t	RM_t/DBE_t	$(DBE_t+RM_t)/UBE_t$	Implied Dct Rate	*Medium Tail* SCR_t/DBE_t	RM_t/DBE_t	$(DBE_t+RM_t)/UBE_t$	Implied Dct Rate
0	30.0%	8.8%	88.2%	2.3%	30.0%	3.2%	95.9%	2.3%
1	30.0%	8.3%	88.9%	2.3%	30.0%	2.7%	96.5%	2.2%
2	30.0%	7.9%	89.4%	2.3%	30.0%	2.2%	97.2%	2.2%
3	30.0%	7.5%	90.0%	2.3%	30.0%	2.3%	97.1%	2.2%
4	30.0%	7.3%	90.3%	2.3%	30.0%	1.7%	97.8%	2.2%
5	30.0%	7.3%	90.5%	2.3%				
6	30.0%	6.7%	91.2%	2.3%				
7	30.0%	6.2%	91.9%	2.3%				
8	30.0%	5.5%	92.8%	2.3%				
9	30.0%	5.1%	93.4%	2.3%				
10	30.0%	5.0%	93.6%	2.3%				
11	30.0%	4.4%	94.4%	2.3%				
12	30.0%	3.4%	95.7%	2.3%				
13	30.0%	2.5%	96.7%	2.3%				
14	30.0%	1.7%	97.8%	2.3%				

from which we note that…

- ✓ The RM_t/DBE_t ratio declines substantially during runoff, which might be imprudent.
- ✓ For the long-tail line the RM_t/DBE_t ratio begins high and the $(DBE_t+RM_t)/UBE_t$ ratio begins low but by the end of the runoff these ratios merge to those of the medium tail.
- ✓ Implied discount rates remain stable throughout the runoff.

Method 2: Fixed Ratio of *(SCR + RM) / DBE*

Long Tail

End of Year t	SCR_t / DBE_t	RM_t / DBE_t	$DBE_t + RM_t / UBE_t$	Implied Dct Rate
0	29.7%	9.1%	88.4%	2.3%
1	30.2%	8.6%	89.2%	2.3%
2	30.5%	8.3%	89.8%	2.2%
3	30.9%	7.9%	90.4%	2.2%
4	31.0%	7.8%	90.7%	2.2%
5	31.0%	7.8%	90.9%	2.2%
6	31.5%	7.3%	91.7%	2.2%
7	32.0%	6.8%	92.5%	2.1%
8	32.6%	6.2%	93.4%	2.1%
9	33.0%	5.8%	93.9%	2.1%
10	33.1%	5.7%	94.2%	2.0%
11	33.7%	5.1%	95.1%	2.0%
12	34.8%	4.0%	96.3%	1.9%
13	35.7%	3.1%	97.2%	1.9%
14	36.7%	2.1%	98.2%	1.8%

Medium Tail

SCR_t / DBE_t	RM_t / DBE_t	$DBE_t + RM_t / UBE_t$	Implied Dct Rate
29.9%	3.3%	95.9%	2.2%
30.4%	2.8%	96.6%	2.2%
30.9%	2.3%	97.2%	2.2%
30.8%	2.4%	97.2%	2.2%
31.4%	1.8%	97.9%	2.2%

from which we note that…

- ✓ For both lines the SCR_t / DBE_t ratio increases at a moderate pace during the runoff.
- ✓ Since the ratio of "protection" funds (i.e. *SCR* plus *RM*) to *DBE* does not erode during the runoff, this method may be more preferable to regulators than Method 1.

Method 3: Fixed Ratios of SCR/DBE and of RM/DBE

Long Tail

End of Year t	SCR_t/DBE_t	RM_t/DBE_t	$(DBE_t+RM_t)/UBE_t$	Implied Dct Rate
0	30.0%	9.2%	88.5%	2.3%
1	30.0%	9.2%	89.6%	2.2%
2	30.0%	9.2%	90.5%	2.1%
3	30.0%	9.2%	91.5%	2.0%
4	30.0%	9.2%	91.9%	1.9%
5	30.0%	9.2%	92.1%	1.9%
6	30.0%	9.2%	93.3%	1.7%
7	30.0%	9.2%	94.5%	1.5%
8	30.0%	9.2%	96.0%	1.2%
9	30.0%	9.2%	97.0%	1.0%
10	30.0%	9.2%	97.2%	0.9%
11	30.0%	9.2%	98.8%	0.5%
12	30.0%	9.2%	101.1%	-0.5%
13	30.0%	9.2%	103.0%	-2.0%
14	30.0%	9.2%	105.0%	-4.7%

Medium Tail

SCR_t/DBE_t	RM_t/DBE_t	$(DBE_t+RM_t)/UBE_t$	Implied Dct Rate
30.0%	3.3%	95.9%	2.2%
30.0%	3.3%	97.1%	1.9%
30.0%	3.3%	98.2%	1.4%
30.0%	3.3%	98.1%	1.5%
30.0%	3.3%	99.3%	0.7%

from which we note that…

- ✓ Like Method 2, this method ensures that the ratio of "protection" funds (i.e. *SCR* plus *RM*) to *DBE* does not erode during the runoff.
- ✓ This method produces a much higher RM_t/DBE_t ratio for the long-tail line than for the medium-tail line, which may be appropriate.
- ✓ For both lines the $(DBE_t+RM_t)/UBE_t$ ratios and implied discount rates change substantially during the runoff.
- ✓ (DBE_t+RM_t) exceeds UBE_t by the end of the long-tail runoff.

Method 4: Ratio of SCR / DBE Steadily Increases During Runoff

Long Tail

End of Year t	SCR_t / DBE_t	RM_t / DBE_t	$(DBE_t + RM_t) / UBE_t$	Implied Dct Rate
0	30.0%	12.7%	91.3%	1.7%
1	33.0%	12.9%	92.6%	1.5%
2	36.3%	13.2%	93.8%	1.3%
3	39.9%	13.4%	95.0%	1.1%
4	43.9%	14.2%	96.1%	0.9%
5	48.3%	15.2%	97.1%	0.7%
6	53.1%	15.0%	98.3%	0.4%
7	58.5%	14.8%	99.4%	0.2%
8	64.3%	14.2%	100.4%	-0.1%
9	70.7%	14.1%	101.4%	-0.4%
10	77.8%	14.9%	102.4%	-0.8%
11	85.6%	13.8%	103.0%	-1.1%
12	94.2%	11.3%	103.0%	-1.5%
13	103.6%	9.1%	103.0%	-1.9%
14	113.9%	6.6%	102.5%	-2.4%

Medium Tail

SCR_t / DBE_t	RM_t / DBE_t	$(DBE_t + RM_t) / UBE_t$	Implied Dct Rate
30.0%	3.5%	96.1%	2.1%
33.0%	3.1%	96.9%	2.0%
36.3%	2.8%	97.7%	1.8%
39.9%	3.1%	97.9%	1.6%
43.9%	2.5%	98.6%	1.4%

from which we note that…

- ✓ The SCR_t / DBE_t ratio can increase dramatically, particularly for long-tail lines.
- ✓ For both lines the RM_t / DBE_t ratios stay roughly consistent through most of the runoff before dropping at the final years.
- ✓ The RM_t / DBE_t ratios for the long-tail line are noticeably higher than in Method 1.
- ✓ $(DBE_t + RM_t)$ exceeds UBE_t by the middle of the long-tail runoff.

Method 5: Ratio of *(SCR + RM) / DBE* Steadily Increases During Runoff

Long Tail

End of Year t	SCR_t / DBE_t	RM_t / DBE_t	$DBE_t + RM_t / UBE_t$	Implied Dct Rate
0	26.4%	12.4%	91.1%	1.7%
1	30.0%	12.7%	92.5%	1.5%
2	33.7%	13.2%	93.8%	1.3%
3	38.0%	13.7%	95.2%	1.1%
4	42.2%	14.6%	96.4%	0.8%
5	46.6%	15.9%	97.7%	0.5%
6	52.8%	15.9%	99.1%	0.2%
7	59.6%	16.0%	100.4%	-0.1%
8	67.6%	15.5%	101.6%	-0.5%
9	75.8%	15.7%	102.8%	-0.9%
10	83.8%	16.9%	104.1%	-1.3%
11	94.8%	15.9%	104.9%	-1.8%
12	108.5%	13.3%	104.9%	-2.4%
13	123.0%	11.0%	104.7%	-3.0%
14	139.3%	8.0%	103.9%	-3.8%

Medium Tail

SCR_t / DBE_t	RM_t / DBE_t	$DBE_t + RM_t / UBE_t$	Implied Dct Rate
29.7%	3.5%	96.1%	2.1%
33.3%	3.2%	97.0%	2.0%
37.3%	2.8%	97.8%	1.8%
41.0%	3.2%	98.0%	1.5%
46.0%	2.7%	98.7%	1.3%

Note that, compared to Method 4, the SCR_t / DBE_t and RM_t / DBE_t ratios increase during the second half of the runoff, particularly for the long-tail line.