ASSOCIATION ACTUARIELLE INTERNATIONALE
INTERNATIONAL ACTUARIAL ASSOCIATION

EXPOSURE DRAFT

MEASUREMENT OF LIABILITIES FOR INSURANCE CONTRACTS: CURRENT ESTIMATES AND RISK MARGINS

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Prepared by the ad hoc Risk Margin Working Group

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1. Executive Summary

1.1 This report was prepared by the ad hoc Risk Margin Working Group ("RMWG") of the International Actuarial Association ("IAA") in response to a request of the Solvency and Actuarial Issues Subcommittee ("Solvency Subcommittee") and Insurance Contracts Committee of the International Association of Insurance Supervisors ("IAIS").

1.2 The background leading to the formation of the RMWG is described in Appendix A. The process followed by the RMWG is outlined in Section 3.

1.3 ~~As outlined in Section 2.3~~In response to the Objective and Aims established at its foundation, the RMWG has focused on ~~information~~ research that it hopes will prove useful in the following areas:

~~1.~~• ~~The~~ Methods for determin~~ation of~~ing the current estimates[1] incorporated in the measurement of the liabilities (in some jurisdictions referred to as *technical provisions* or *actuarial reserves*) ~~of~~ for insurance contracts (without risk margins) in general purpose and regulatory financial reports;

~~2.~~• Possible methods for the determination of risk margins above current estimates appropriate for the measurement of the liabilities for insurance contracts for regulatory and general purpose financial reports; and

~~3.~~• Commentary on ~~measurable~~ standards for assessing the sufficiency of ~~current estimates and risk margins in the measurement~~ of ~~the~~ liabilities for insurance contracts estimated using the methods described above. [Note, I'm not sure that these three bullets encompass all of the goal and aims. If not bullets should be added.]

1.4 Section 4 ~~describes~~ defines the components of the measurement of the liability of an insurance contract ~~that~~ as ~~include~~ a current estimate of the expected cash flows associated with the obligations and rights generated by a portfolio of insurance contracts (including its outstanding claims), a risk margin and, where appropriate, a service margin. These are measured in terms of their expected present value.

1. 5 Section 4 also includes a review of the risk concepts presented in "A Global Framework for Insurer Solvency Assessment" (2004, the *Blue Book*) on the inter-relationship of risk concepts, including which risks should be reflected

[1] The request of the IAIS referred to "best estimate" rather than "current estimate." Subsequently in its *Second Liabilities Paper* the IAIS adopted the terminology "current estimate," defined as "the expected present value of probability weighted cash flows using current assumptions," and "margin over current estimate" referring to the margin reflecting the level of uncertainty in the calculation of the current estimate. In this report, the RMWG has adopted the term "current estimate" and "margin over current estimate" as standard terminology, although the latter is also referred to as "risk margin."

in liabilities of insurance contracts. Risks have been categorized in the following manner:

- Current (best) estimate: underwriting (insurance) risk; and risk mitigation techniques, including product adjustability features.

- Risk margin: current estimate uncertainty; credit and market risk that cannot be replicated; risk mitigation techniques including product adjustability features; and risk concentration.

- Service margin, where appropriate.

- Capital only: current estimate volatility; credit and market risk that can be replicated; catastrophe risk; operational risk; and ruin over a short period.

Different concepts of risk may be applicable in general purpose and regulatory reporting. The amount incorporated in insurance liabilities for "current estimate uncertainty" under an exit value approach used for General Purpose accounting would defined as~~is~~ the amount that would be required to compensate a transferee for the risk inherent in a transfer of the net obligations of an insurance contract, bearing in mind what is known of the probability distributions of the insured and related risks. For regulatory purposes, emphasis is more on the level of confidence which the current estimate, risk margin and required capital combined provides for the overall solvency assessment of an insurer and not on the levels of the individual pieces. The key objectives of the risk margin under each view are to reflect the uncertainty in the measurement of the current estimate of the liability and to provide information useful in the assessment of the insurer's performance.

Section 6 shows that the general purpose reporting and regulatory objectives of the measurement of risks can be mutually compatible [where does it show this?]. With ~~robust~~ defined, required limits on ~~guidance for the~~the assumptions used by professionals involved, risk margin measurement methodologies derived from the compensation for risk or confidence level concepts ~~can be used to~~will develop risk margins that are consistent between product types and between insurers so that desirable balance sheet comparability in general purpose and regulatory reporting is achieved. Who will set those limits and what they would be is not clear. It should be noted, however, that without such limits the various methods will not generally produce comparable results.

1.6 Section 5 discusses the considerations involved in current estimates based on expected present values of the net obligations generated by an

insurance contract that are appropriate for use in general purpose and regulatory financial reporting.

Our ~~observations~~ proposed principles regarding current estimates include the following:

- All relevant expected cash flows ~~are~~ should be included
- Current estimates ~~are~~ must be consistent with the scope of and context in which the estimate is made; in the case of financial reporting, the context includes applicable financial reporting standards and the reporting entity's accounting policy
- Where pertinent, relevant and reliable information is available from a relevant market, measurement inputs should reflect ~~observed prices or~~that ~~related~~ information
- Where pertinent, relevant and reliable information is not available from a relevant market, model-based estimates [what is a model-based estimate?] are reflected
- ~~Non-market~~All assumptions ~~are~~ should be determined on a portfolio-specific basis
  - The unit of account in the measurement of the liability of an insurance contract is the portfolio of contracts subject to broadly similar risks and managed together as a single portfolio.
- Current estimates of the future are more appropriate than simply using current conditions although there are situations in which the current conditions are the best estimate of the future
- Assumptions used should be consistent with each other
- Any significant asymmetry of expected cash flows should be reflected in the best estimate and risk margin
- An approximation or ~~grouping~~ grouping of risks is reasonable when its effect is small, particularly in relation to the cost of a more refined approach or when the data for a more refined approach is not available
- When the quality of data for a source of relevant experience is inadequate for the purpose, alternative less desirable sources should be used with appropriate adjustments on an as needed basis
- Assumptions should be reviewed regularly and systematically at each measurement date and revised when appropriate.

The measurement of current estimates first requires conformance with applicable financial reporting standards and policies, including whether the cash flows being estimated satisfy the definition of a liability and applicable recognition criteria. Then the measurement takes into account appropriate market and non-market inputs.

A more detailed discussion of the primary measurement inputs (assumptions) is covered in Appendix E.

1.7 Section 6 identifies methods that can be used to determine risk margins in the context of the corresponding current estimates. Particular focus is given to two such methods, the "cost of capital" method and the various statistical methods that reflect the uncertainty of the risks as expressed by the moments of the probability distribution of the risks referred to as the "quantile" methods, e.g., the "conditional tail expectation" method.

Through several examples and relevant information about the risks involved, we demonstrate how the types of model used to determine capital levels that provide for particular risks in the cost of capital method can be used as an input to quantile methods. We also demonstrate how the capital from those models, with assumptions about the cost of capital and duration of the obligation and payment pattern can be used in the application of the cost of capital method.

A comparison between the cost of capital and quantile methods shows that a 4% cost of capital for a AA rated insurer would result in quantiles ranging from 58% to 93%, depending on the term of the liability and the Skewness of the risk distribution. [Considering that it has to be between 50 and 100 this doesn't seem to say much.]

Either method can be used to produce consistent estimates of the liabilities of insurance contracts *provided* ~~robust guidance~~certain key assumptions are defined for the professionals involved is available~~ to reflect the current estimates and the uncertainties involved in their measurement~~. Therefore, the risk margins produced by the methods illustrated here indicate that they can be applied in a manner to satisfy the desirable characteristics of risk margins suggested by the IAIS in its *Second Liabilities Report*, "acceptable methods should reflect the inherent uncertainty in the expected future cash flows and would be expected to exhibit the following characteristics:

1. The less that is known about the current estimate and its trend; the higher the risk margins should be
2. Risks with low frequency and high severity will have higher risk margins than risks with high frequency and low severity
3. For similar risks, contracts that persist over a longer timeframe will have higher risk margins than those of shorter duration
4. Risks with a wide probability distribution will have higher risk margins than those risks with a narrower distribution
5. To the extent that emerging experience reduces uncertainty, risk margins will decrease, and vice versa."

These characteristics are important from a regulatory point of view in that they reflect confidence considerations and they are consistent with the general purpose financial reporting concept of risk margins that would be required to compensate for the level of risk transferred.

In comparing the two methods, the following observations are made:

1. Conceptually, the cost of capital method provides a logical framework for establishing the measurement of the liabilities of insurance contracts in a way that could enable consistent measurement between the liability of insurance and investment contracts, as well as between assets and liabilities in each entity's financial reports and consistency between financial reporting by insurance and other industries. However, to implement this methodology certain rather arbitrary rules must be established concerning the measurement of capital and the cost of capital to avoid significant differences between companies.

2. The theory underlying quantile approaches, i.e., liabilities that are large enough to have a selected probability of being sufficient, is logical. However, as shown in the examples, to achieve consistency between lines and types of business, the level of quantiles can differ significantly, and hence may require ~~robust guidance~~specific rules be set for the professionals involved to use. Also, quantile approaches may not produce consistency between assets and liabilities or between insurance and other industries.

3. The assumption approaches, especially if the risk margins are explicitly determined, can also produce liabilities that meet selected criteria and can be consistent across insurance entities. However, the assumption approach will not necessarily produce consistency between the measurement of assets and liabilities or between insurance and other industries.

4. Based on the examples shown, the cost of capital method results in risk margins with larger quantile levels for longer durations of obligations / payment patterns than?. This may be [is it or not?] as result of the quantile method not being as responsive to future capital needs.

When the probability distribution of the liability is expected to be even more skewed than the hypothetical distributions examined here, confidence level techniques should be replaced by techniques better reflecting the fat tail, such as conditional tail expectation (“CTE” or “TailVaR”) methodologies, to develop more appropriate current estimates and risk margins.

The examples included in Section 6 assume that the capital above the liability is set based on a desired total financial resource objective as outlined in the *Blue Book*. Many insurers (e.g., smaller insurers and those with non-standard or unique risks) may not have the specific probability distributions available that are needed to make these calculations, although the effect of risk mitigation techniques (such as reinsurance) may simplify the necessary calculations. In such cases, ~~robust guidance~~rules for the

professionals involved with respect to the level of capital to hold for insurance contracts with varying characteristics would be needed. In such cases, the cost of capital methodology could use regulatory capital to determine risk margins. In cases where knowledge about the probability distributions is poor, risk margin calculations using the quantile method can be problematic and will also require similar rules.

Other risk margin observations include the following:

1. Application of a risk margin approach requires a decision about whether the analysis is based on the risk to the reporting entity or the risk as taken on by a transferee that is referred to here as the reference entity. If the risk is measured relative to a hypothetical standardized reference entity, then risk margins depend only on the nature of the portfolio and not on the nature of the reporting entity. If the risk is measured relative to the reporting entity, then the same block of business may have different risk margins in different entities.

2. While cost of capital methods are more often seen in "reference entity" methods, quantile methods can also be applied, although in a different manner from the way quantile methods have been applied to date, e.g., in recent experience for non-life insurance in Australia.

3. The approach taken to project future capital needs is important and may have a larger effect than expected on general insurance where methods under discussion often assume for simplicity, but incorrectly, that capital requirements should be proportional to the current estimates throughout the duration of the obligation.

4. Further study into issues of capital, cost of capital, and the projection of future capital needs are required, especially when reference entity methods are used. This is currently being investigated by the Committee of European Insurance and Occupational Pensions Supervisors (CEIOPS) in conjunction with the development of Solvency II.

5. Further study is needed to set ~~robust professional guidance~~rules regarding the appropriate levels of quantiles, possibly varying by line and type of business.

6. The examples included in Section 6 assume that the capital in excess of the liability is set based on a desired total financial resources objective as outlined in the *Blue Book*. Many insurers, e.g., small insurers and for some non-standard or unique risks, may not be able to develop the specific probability distributions needed to make these calculations. In such cases, ~~robust guidance~~rules for the professionals

involved will be needed with respect to the level of capital to hold for insurance contracts with varying characteristics and the cost of that capital may be needed. The cost of capital methodology could then use appropriately determined regulatory capital to determine risk margins. In cases where knowledge about the probability distributions is poor, risk margin calculations using the quantile method can be problematic. The effect of risk mitigation techniques such as reinsurance may simplify the necessary calculations where done net of the effect of these techniques.

Examples of the application of risk margin methods discussed in Section 6 for life insurance and property & casualty insurance contracts are also included in Appendices B and D, respectively.

Based on current evidence, both the quantile and cost of capital methods represent viable measures of risk margins.

1.8 Section 7 discusses the implications of how and where to recognize four approaches to risk mitigation for general purpose and regulatory financial reports. Those addressed here are pooling, reinsurance, risk offsetting, risk diversification and the use of contract adaptability features, including participating and other non-guaranteed features. ~~It is~~We conclude~~d~~ that inter-portfolio diversification is not appropriate to be reflected in risk margins, although it is appropriate to reflect its effect in capital. Also addressed is the related issue of recognition of the effect of risk concentration in risk margins.

1.9 Section 8 includes discussions of several additional issues relating insurance risks and liabilities. The first addresses service margins, a component of the measurement of liabilities proposed by the IASB for inclusion in the measurement of liabilities of insurance contracts, in addition to current estimates and risk margins. These are margins for services other than those relating to insurance risks. Section 8 also discusses the role and measurement of margins in the measurement of the liability of an insurance contract in which a constraint of no profit at issue is incorporated. Another risk here is operational risk, which has historically been reflected in capital only.

1.10 Should the IAIS and IASB adopt measurement objectives consistent with the observations and methodologies described in this report, the actuarial profession, through the IAA (and representatives of its member associations), would be pleased to participate in the process of developing ~~the robust~~ general guidance for the professionals involved envisioned in this report. The specific rules required for each jurisdiction should be developed by the local members of the IAA.

2. Terms of Reference of the ad hoc Risk Margins Working Group

In mid-2005, the International Association of Insurance Supervisors (IAIS) asked the International Actuarial Association (IAA) for assistance in its development of approaches to measurement of the liabilities for insurance contracts (*technical provisions* in a regulatory context). Included prominently was a request for assistance with a key element of these liabilities and provisions, the risk margins. The formal title of the IAIS request is "Approaches to the Determination of Liability Values and Quantitative Benchmarks for Technical Provisions."

In response to this request, the IAA formed its ad hoc Risk Margin Working Group (RMWG). A complete background behind the formation of the RMWG can be found in Appendix A.

2.1 Scope

"Issues related to the determination of best estimate policy obligations and technical provisions, and assessing the adequacy thereof, in the context of an insurer's total balance sheet."

2.2 Objective

"To provide detailed insight into current practice, challenges and solutions in relation to how actuaries determine best estimate policy obligations and technical provisions in a number of major insurance markets, approaches to determining their adequacy, the reliability and robustness of the different methods used and quantitative benchmarks to enable appropriate comparisons across insurers and jurisdictions."

2.3 Aim

"To assist the IAIS in defining

1. the role and purpose of best estimate policy obligations, risk margins and hence technical provisions in the context of both solvency assessment and public financial reporting, and the likely areas of difference between these two contexts;
2. principles and approaches that are appropriate for the determination of best estimate policy obligations, risk margins and hence technical provisions; and
3. measurable standards for assessing the sufficiency of best estimate policy obligations, risk margins and hence technical provisions in a manner that will allow supervisors *to:*

    a. readily assess the prudential risk margin above best estimate policy obligations that is included in the technical provisions of insurers and

the reliability of an insurer's history in making prudent assumptions in determining its risk margins;

b. determine the differences in sufficiency of technical provisions between entities and enable comparison across jurisdictions; and

c. monitor the movement of prudential risk margins against changing market conditions, ensuring that, if pro-cyclical behavior exists, it can be arrested before insurers become vulnerable to failure."

2.4 Note regarding terminology

At the time that the IAA received its reference from the IAIS, the IAIS used the term "best estimate," rather than "current estimate" As used in this report. Subsequently, in *Issues arising as a result of the IASB's Insurance Contracts Project – Phase II* (known as its *Second Liabilities Paper*), the IAIS adopted the terminology "current estimate" to refer to the unbiased estimate of future cash flows reflecting the time value of money, defined as "the expected present value of probability weighted cash flows using current assumptions." Similarly, in the same paper, the IAIS introduced the term "margin over current estimate (MOCE)" to refer to the margin reflecting the level of uncertainty in the calculation of the current estimate. In this report, the RMWG has adopted the use of the term "current estimate" and "margin over current estimate" as standard terminology, although the latter is frequently referred to as a "risk margin" for brevity. Note that, in other professional literature, the "current estimate" concept sometimes includes both concepts (i.e., it represents the combination of the current estimate and the risk margin as used in this report).

2.5 Supervisory reporting objectives

"As part of the common structure and common standards for the assessment of insurer solvency, to support transparency and convergence and enhance the comparability of insurers worldwide, … should support a supervisory reporting regime for technical provisions that will enable, for example:

1. reporting of technical reserves analyzed between best estimate policy obligation and prudential risk margin by line of business, covering life and non-life sub-sectors;
2. reporting of these components for a sufficient period (such as the previous five years) in order that triangulations in both components can be derived and thus assumptions validated; and
3. further analysis as appropriate by geographic location and, for reinsurance, by type of contract."

2.6 Supervisory convergence problem addressed by the RMWG

"The terminology for and definition of best estimate policy obligations, risk margins and technical provisions, and the methods and approaches used to determine them, varies across and within jurisdictions. Further, there are different views regarding the reliability and robustness of the methods used and amounts determined using currently available approaches, techniques and data."

2.7 IAA input requested

"In the context of insurer solvency assessment for supervision purposes, on:

- elements/risks that should be allowed for in the quantitative determination and valuation of best estimate policy obligations; technical provisions and risk margins;
- principles, methods and assumptions that are available for determining these values;
- specific issues or considerations related to any particular products or classes of business; and
- data and other requirements needed to enable the determination of reliable and robust values for supervision purposes."

2.8 Relevant considerations

"The IAIS would anticipate that relevant considerations would include, but not be limited to:

- risks for which quantification/valuation is appropriate and reliable
- techniques, methods and models used and their calibration, reliability and robustness
- allowance for aggregation, correlation and risk interdependency
- detailed line of business discussion of issues and assumptions involved in determining and reporting both best estimate policy obligations and prudential risk margins (including reliability, volatility and availability of data).
- allowances for guarantees, bonuses and other embedded options
- effects of changes to reinsurance buying patterns (gross and net valuation and reporting).
- discount rates
- claim rates, amounts and settlement expenses
- materiality considerations."

3. Process Followed by the RMWG

The RMWG held five face-to-face meetings, in September 2005, and January, March, June and November 2006. It also had frequent exchanges of e-mails and conference calls between meetings.

In addition, selected (co- and vice-) chairpersons of the IAA's Insurance Accounting Committee, Regulation Committee and Solvency Subcommittee attended most of the meetings of the IAIS Insurance Contract Liabilities ("Liabilities") and Solvency and Actuarial Issues ("Solvency") Subcommittees. Similarly, IAIS representatives attended RMWG meetings, as well as IAA's Insurance Accounting, Insurance Regulation and Solvency meetings during this period.

In part due to the lack of IAA paid actuarial staff, the RMWG decided at its first meeting that it would rely upon research that it was aware that:

- had been conducted by the IAA in the past and was capable of modification to help meet the IAIS objectives;
- was conducted, or being conducted, by its member organizations; or
- was conducted, or being conducted, by members of the RMWG.

The initial request from the IAIS was for a preliminary report by the end of 2005 and for a final report by the middle of 2006. It was quickly determined that it would be impossible to produce a preliminary report by the end of 2005. Nevertheless, the IAA representatives to the IAIS Liabilities and Solvency Subcommittees were able to provide input to those subcommittees as they developed the IAIS's *Second Liabilities Paper*, the IAIS's *Roadmap Paper* and the IAIS's *Common Structure for the Assessment of Insurer Solvency* (*Common Structure*) Paper that reflected the developing RMWG research. Much of that input made its way into the work on these projects.

The co-chairs of the RMWG have been Paul McCrossan and Henk van Broekhoven, although after a significant contribution, Paul retired from this service prior to the distribution of this Exposure Draft. Members include Tony Coleman, Philipp Keller, Arne Sandström, Masaaki Shigeraha, Therese Vaughan, and Peter Withey. Members Sam Gutterman and Francis Ruygt (in their capacity as chair and vice-chair of the IAA Insurance Accounting Committee, respectively) made considerable contributions, as did several other interested parties, including but not limited to Ralph Blanchard, Stefan Engeländer, Allan Kaufman, Martin White and Henry Siegel.

4. Liabilities and Risk Concept Inter- relationships

Significant discussions regarding the development of a revised framework for the financial reporting of insurance contracts are underway, both for general and regulatory purposes. As part of that process, the IASB's project on Insurance Contracts – Phase 2 ~~is~~ has, at the time this paper was written, ~~has~~ preliminarily adopted an exit value approach, a prospective view that reflects the amounts required for a transferee to take over the net obligations of the insurance contracts~~;~~ . H~~h~~owever, some of the concepts involved in Phase 2 will likely continue to evolve in the near future as much of the world's industry differs from this perspective in important ways. The IAIS's *Second Liabilities Paper* has potentially moved regulatory reporting on a path toward accepting many, if not all, of the principles underlying liability measurement of a general purpose reporting nature, including its current exit value approach.

This contrasts with current practice. From a regulatory perspective, many jurisdictions historically emphasized the measurement of liabilities (or technical provisions) aimed at the protection of policyholders, often including features that encouraged or required insurers to establish prudent estimates of their obligations, sometimes through the use of implicitly conservative assumptions, to help ensure that the insurer's total financial resources would be sufficient to meet its obligations even under adverse circumstances. This is particularly true for jurisdicitions in which the current liability measurements were introduced before the advent of risk-based capital requirements.

General purpose financial reporting has also differed considerably around the world, resulting in financial reports that some have viewed as being non-comparable and opaque. The current movement is attempting to ~~take this in the opposite directions~~produce financial statements that are consistent, clear and representative of the company's actual results.

According to the IASB, a liability is an amount recognized in a balance sheet to reflect ~~the~~ an obligation arising from past events, the settlement of which is expected to result in an outflow of economic resources. In the context of the type of contract within the scope of this report, it is a prospective measure of the unpaid amounts of the obligations and rights associated with the contract. ~~The~~ One definition of the components of the liability for a portfolio of insurance contracts at a certain date consist of a current estimate of the expected future cash flows associated with an obligation generated by a portfolio of insurance contracts[2], a risk margin and where applicable, a service margin.

The objective of this paper is to identify issues and provide examples to help explain the issues involved in the measurement of liabilities of insurance contracts

[2] The portfolio may include insurance contracts no longer inforce, in the case of unsettled claims.

and their components, in the context of general purpose and regulatory financial reports. The current estimate is discussed in Section 5, with a detailed description of specific current estimate assumptions in Appendix E. The role of and approaches to the measurement of risk margins are discussed in Section 6, with risk margin examples given in Appendices B and D for life insurance and property and casualty insurance, respectively. Section 8.1 includes a brief discussion of service margins.

A discussion of relevant governance issues surrounding the measurement of liabilities for insurance contracts is outside the scope of this paper. This is important, and encompasses controls surrounding every element of the process of development relevant measurements and appropriate validation of the reasonableness of the estimates involved.

The IAIS has expressed the view that:

> "(t)he IAIS believes that it is most desirable that the methodologies for calculating items in general purpose financial reports can be used for, or are substantially consistent with, the methodologies used for regulatory reporting purposes, with as few changes as possible to satisfy regulatory reporting requirements." [IAIS *Second Liabilities Paper*, Executive Summary]

This view was expanded upon in the following:

> "As the international standard setter for insurance supervision, the IAIS is concerned with both general purpose accounting and with solvency issues. The IAIS believes that it is most desirable that the methodologies for calculating items in general purpose financial reports can be used for, or are substantially consistent with, the methodologies used for regulatory reporting purposes, with as few changes as possible to satisfy regulatory reporting requirements. Indeed many, but not all, IAIS jurisdictions currently base their regulatory reporting requirements on general purpose financial statements, or at least on equivalent quantities determined using the same methodologies as for those financial statements. Hence, the IAIS and other international regulatory organisations believe that an open and constructive dialogue between the IASB and prudential standard setters is essential.
>
> "There is widespread support for an effort to achieve a single set of accounts that could be utilised for both general purpose financial reporting and regulatory reporting, notwithstanding the potential differing purposes of such reports. Achievement of this aim is likely to reduce costs and workload for regulated insurance entities.
>
> "Although it is clearly preferable for the insurance contracts measurement model for regulatory reporting to be consistent with that used for general purpose financial reporting, this may not be possible or appropriate in all cases. However, the IAIS believes that it is essential that differences between regulatory reporting requirements and general purpose reporting

> are reconcilable and that these differences are publicly explained. Otherwise there is a risk that public confusion will call into question the credibility of both reporting regimes." [IAIS *Second Liabilities Paper*, Introduction]

As noted above, key members of the RMWG participated in the development of the IAIS's *Second Liabilities Paper*. Other RMWG members were involved in IASB working groups such as the Insurance Working Group and the Financial Instruments Working Group, as were key IAIS subcommittee chairpersons.

Because of the simultaneous evolution of financial reporting, actuarial and regulatory thinking during the RMWG mandate, a key question is whether the direction taken in our work will further (or hinder) the desire for substantial consistency or convergence of general purpose and regulatory methodologies.

In "A Global Framework for Insurer Solvency Assessment" (2004, often called the *Blue Book*), a research report written by the IAA's Insurer Solvency Assessment Working Party, a chart is presented with respect to underlying risk concepts and where they should be reflected in measurement of liabilities of insurance contracts (valuation) purposes and for regulatory purposes. The conclusions as expressed (slightly altered to recognize that underwriting risk involves both insurance and related risks and service risk in general purpose financial reporting parlance, as well as the effects of concentration risk as ameliorated by risk mitigation activities) are still generally viewed as appropriate by the RMWG and are given in Table 4.1. The adoption of these assignments may help to remove many (but not all) of the obstacles that might inhibit the IASB and the IAIS from using the same methodologies for measurement of liability of insurance contracts.

Table 4.1 Reflection of risks

	Where reflected	
Risk concept	**Both liabilities and capital**	**Capital only**
Current estimate:		
Current (best) estimate	√	
Current estimate - uncertainty	√	
Risk margin:		
Credit risk that cannot be replicated	√	
Market risk that cannot be replicated	√	
Risk mitigation techniques	√	
Risk concentration	√	
Product adjustability features[3]	√	
Capital:		
Credit risk that can be replicated[4]		√
Market risk can be replicated[5]		√
Operational risk		√
Current estimate (volatility)		√
Catastrophe (very long tail[6]) risk		√
Ruin over a short period		√

There is a problem with this dichotomy as follows. If one assumes that premiums include provision for all risks associated with a product, then allowing certain risks to be not recognized in liabilities will allow the present value of premiums covering those risks to immediately flow to profits upon issue. This is an unacceptable result in the view of most of the world's insurers since it produces profits before any service has been provided. Accordingly, the risk liabilities developed in this

[3] For example, non-guaranteed elements, policyholder dividends / bonuses, and experience adjustments.

[4] "Credit risk" is used in the same way used in Basel II, i.e. the risk of default, and not in the sense of the "own credit standing" ("OCS") adjustment considered by the IASB in the measurement of fair value in a liability of a financial instrument (IAS 39) that has also been referred to as non-performance risk. Replicating assets are said to exist when assets of the quality implied by the quality of the reference rates (e.g. risk free or swap rates) are available for the expected term of the liability. To the extent that replicating assets of the desired quality are not available, the credit risk is not diversifiable.

[5] "Market risk" is also used in the sense of Basel II, risk from the future change in levels or twisting of the reference yield curve.

[6] As addressed later in this paper, catastrophe risk is sometimes defined to refer to as "extreme event risk," the risk beyond the third standard deviation. Alternative expressions of catastrophe risk have been used, e.g., a one in a given (large) number of year event. In this paper, methods for reflecting extreme event risk in prospective measurement are suggested. This is quite different from the previous accounting approach referred to as "catastrophe reserves" which were, in effect, allocations of surplus which the IASB decided could not be reflected in liabilities.

way should only be considered theoretical initial margins with calibration needed to avoid such initial gains.

A distinction is made in Table 4.1 in credit and market risks based on the extent that they can be replicated, or reproduced in a way that reliable prices can be assigned. Replication in these cases means that risk involved can be replicated or in the market through measurement of prices in a market, which includes current estimates plus risk margins. In the case of credit risk, for example, the replication instrument might be a credit default swap. In fact, this might also be replicated with risk free bonds in combination with corporate bonds, the difference in yield of which would represent the price for the credit risk.

To the extent that it can be reliably measured, catastrophe risk for existing obligations would be reflected in both liability and capital measures; however, catastrophe reserves sometimes used to smooth earnings are inappropriate for reflection in liabilities but might be used for designated regulatory purposes. In all other cases, a provision for catastrophe risk is incorporated in the measurement of (solvency) capital.

At the time the *Blue Book* was published, there was no consensus regarding whether a specific confidence level should be directly reflected only in capital requirements or in liabilities as well, such as by using a quantile method of reflecting confidence such as conditional tail expectation (CTE) to determine risk margins in liabilities, or whether an alternative approach, such as a cost of capital method should be used. Section 6 of this report shows that, with robust guidance[7] for the professionals involved, the use of either quantile methods (that directly reflect confidence levels) or cost of capital methods (that indirectly reflect confidence levels) can be used to determine risk margins in liabilities that are mutually consistent.

While risk margins and capital both relate to providing for risks inherent in insurance contracts and in an insurance entity, it is important to recognize that they do not serve the same objective. Capital aims to ensure that an entity has sufficient financial resources to withstand a significant adverse deviation such that the entity is able to satisfy its obligations to its policyholders. Hence, capital protects the liabilities. In contrast, risk margins provide for a confidence level around the current estimates.

In addition, the allocation of risks between liabilities and capital provide useful information in enabling liabilities to communicate a realistic measurement of performance and to facilitate financial statement comparison among insurers and between insurers and entities in other industries. In view of an increasingly global

[7] In this report, references to “robust guidance for the involved professionals” means that the process is described in detail through a source such as a regulator or actuarial guidance notes.

world of financial services, the IAA encourages the convergence of practice between jurisdictions, as well as between general purpose and regulatory financial reporting.

Solvency issues are outside the scope of this paper, although to properly discuss some of the issues relevant to the measurement of liabilities of insurance contracts, the context of the total balance sheet in which they reside and the inter-relations between the treatment of risk between liabilities and capital are discussed where appropriate.

A key concern expressed by the IASB has been that the assets held by an insurer should not affect the measurement of the liabilities of insurance contracts, unless the obligations underlying the liabilities change as a result of holding those assets. This financial reporting concern is directly addressed by the positioning of the credit risk and market risk factors in Table 4.1. It suggested that only the credit risk and market risk that cannot be replicated in the market (i.e., unhedgeable risk) should be reflected in liabilities. Of course, all such risks must be addressed in a prudent solvency regime through “total balance sheet resources."

Similarly, the proposed treatment of current estimates, their uncertainty and volatility, as well as catastrophes seems consistent with current accounting thinking.

However, the recommended recognition of risk mitigation techniques in the *Blue Book* may not be totally consistent with current accounting thinking. Section 7 deals with risk mitigation and related issues, including the treatment of the effect of pooling and diversification.

The IASB Board’s tentative thinking about product adjustability including policyholder rights also may differ from the recommended technique. This topic is further dealt with in Section 7.5, focusing on participating policyholder dividends / bonuses and non-guaranteed contract features.

5. Current Estimates

The objective of this section is to discuss factors that may be appropriate in the development of current estimates as part of insurance liability measurement[8]. Current estimates have sometimes been referred to as "best estimates[9]," although the latter term has sometimes also been used to represent the estimate of the most likely possible (modal) outcome rather than the estimate of the probability-weighted expected (mean) value that will be discussed here and that most faithfully represents the current assessment of the relevant cash flows. In this report, “current estimate” does not include the margin for risk included in insurance liabilities as discussed in Section 6, in contrast with some uses of the term "best estimate" such as in IAS 37 that includes a risk margin.

Such estimates reflect unbiased expectations of the obligation at the report date and are determined on a prospective basis. A current estimate represents the expected present value of the relevant cash flows. In the case where the present value is based on a range of discount rates, it is appropriate to estimate the probability-weighted expected present value of these cash flows.

What follows in this section is a discussion of the key characteristics of current estimates in the context of financial reporting. Appendix E discusses specific inputs to their calculation, including those relating to discount rates, mortality rates for life insurance and annuities, claims expectations, loss (and related expense) development for claims that have already been incurred, non-claims-related expenses, policyholder behavior and contract discontinuance rates. These are often referred to as actuarial assumptions.

As noted below, in developing current estimates there is a decision making hierarchy to be followed. This starts with financial reporting standards (such as IFRS or regulatory) and continues with implications (such as constraints in measuring liabilities) and entity-specific accounting policy implications before reflecting market data and non-market data.

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[8] References to insurance liabilities also include related items such as ceded reinsurance assets. Similar considerations can also be applied to certain financial instruments that do not include significant transfer of insurance risk. However, these considerations do not always apply to these current measurement approaches (e.g., as indicated in IAS 39), either due to current financial reporting standards or to historical practice.

[9] At the time that the IAA received its terms of reference from the IAIS, the IAIS used the term “best estimate” rather than “current estimate." Subsequently, in its Second Liabilities Paper, the IAIS adopted the terminology “current estimate” to refer to the unbiased estimate of future cash flows reflecting the time value of money, defined as "the expected present value of probability weighted cash flows using current assumptions." The RMWG has adopted the use of the term “current estimate” as standard terminology. Note that, in other literature, the “current estimate” phrase sometimes includes both current estimates and risk margins.

5.1 Key observations regarding and characteristics of current estimates

The following discusses recognition and (primarily) measurement issues associated with current estimates. Many of the observations are also applicable to the measurement of any financial item. The observations are not meant to describe current best practice in the measurement of the current estimate component of the estimation of liabilities of insurance contracts, although in some cases observations regarding certain current practices are indicated. Rather, it attempts to describe expected future practice; as such, it should not be taken to represent current best practice or standards.

5.1.1 All relevant cash flows to be included

The financial effect of all relevant contractual rights and obligations, including the expected effect of all contractual options and guarantees should be included in the current estimates in the measurement of the liability of the insurance contracts being measured. Since the contract is recognized once it has been sold, its current estimate should reflect future all of the expected cash flows after the measurement (report) date on a prospective basis. Expected future catastrophic/calamity claims (e.g., exposure to concentration risk) are also reflected, although not in the same manner as was done in some jurisdictions referred to as a "catastrophe reserve" that represented an accumulation of a portion of previously paid premiums. In determining the present value of these cash flows, the probability-weighted expected timing of these cash flows is reflected.

5.1.2 Current estimates are consistent with the scope of and context under which the estimation is made

A current estimate of a set of cash flows has to be made with respect to a specified set of accounting principles, standards or guidance. Certain financial reporting standards require market based inputs when relevant and reliable for use in the calculation of a current estimate (see Section 5.1.3), while another set of accounting standards may require certain inputs to be non-market based.

In addition, before a current estimate is determined, it is important to carefully define or confirm the object or scope of the estimation, i.e., what is being measured. In financial reporting, the initial step is to determine whether a set of possible cash flows must, or might under certain circumstances be recognized. To the extent that it is recognized, a comprehensive set of cash flows can be incorporated. For example, the calculation of current estimates often excludes associated income taxes, as they are recognized in separate calculations. Since all contractual rights

and obligations are reflected, if the obligation is based on a specified set of assets, those assets should affect the current estimate of future cash flows.

5.1.2.1 Influence of financial reporting standards and guidance

In certain cases, financial reporting standards or guidance limit the cash flows that can be included in the measurement of the liabilities or assets for an insurance contract. These standards can affect the measurement of the present value of relevant cash flows and can override what would otherwise be selected characteristics of the measurement of future cash flows. In some cases, different standards applicable for general purpose and regulatory reporting may call for different assumptions.

These standards and resulting constraints might include one or more of the following:

- The measurement objective under which the estimate is made might be based on the expected settlement of the obligation, its transfer value or its "fair value," although in practice there may be little measurement difference.
- The expected values may not include all related expected cash flows. This may in part be due to what a financial reporting standard would recognize as an asset (e.g., due to lack of control by the entity) or a liability (e.g., due to lack of a present obligation).
- Alternative approaches to discounting currently exist. In some accounting systems, the financial reporting standard requires the use of risk free rates, while others use the expected investment earnings rate of a designated set of assets. Some do not permit discounting.
- The measurement of a current estimate might not recognize income tax directly derived from the cash flows resulting from the insurance contracts.
- Certain expected cash flows might not be able to be recognized because the insurer does not have control them or because they relate to a customer relationship rather than the contract, such as certain future renewal premiums that are not required to be paid under the contracts.
- Certain aspects of the measurement of a liability might be fixed at the time of the issue of the contract, being so-called "locked-in" unless an impairment exists.
- Different unit of accounts might be used.
- The estimate of expected cash flows of a contract developed by application of a required liability adequacy test might be substituted for the current estimate.
- The imposition of a cash value floor or prohibition of negative liabilities.
- A requirement that the insurer should not recognize profit at the time of issue.

- Changes in expected cash flows resulting from certain events occurring or expected to occur after the measurement date may not be permitted to be considered in measurement. An example is the expected effect of a future change in law or tax; if these are not to be considered, the measurement is considered based on current law and regulation.

5.1.3 Market and non-market inputs

Measurement standards have differed with respect to their reliance on market-based inputs. For example, fair value standards require inputs to be derived from prices derived from relevant markets and to be reliable; in this case inputs from other sources or models are used only in the absence of such observations. For the large majority of contracts offered by insurers, market-based input is either not available or available only for certain measurement assumptions, normally restricted to financial assumptions.

In some cases, there is no reliable source of measurement inputs other than from prices in a market, while in others there is no reliable market on which to base assumptions. In some circumstances, the relevant financial reporting standards may have to be looked to for guidance in the selection of inputs and calibration sources.

5.1.3.1 Where pertinent and reliable information is available from a relevant market, measurement inputs[10] reflect observed prices or related information

In some cases, financial reporting standards provide rules or guidance regarding which market should be used for this purpose and any constraints or adjustments should be applied in using such information. For example, a standard might require the use of risk-free interest rates from an active market.

Some financial reporting systems establish hierarchies regarding the priority order in which inputs are required to be based. In certain cases, relevant and reliable market-based inputs to current estimates are used, although care may be needed to isolate the current estimates from the risk margin. This means that information about cash flows is distinguished from transaction prices that allow for the risk characteristics of those cash flows. For insurance contracts, these inputs currently relate primarily to financial assumptions and should be generally accepted for this purpose.

[10] "inputs" are sometimes referred to as "assumptions"

5.1.3.2 When pertinent and reliable information is not available from a relevant market

A valuation technique or model is used to measure inputs based on non-market based price inputs reflecting portfolio-specific information regarding the underlying risk characteristics of the portfolio. However, if reliable portfolio-specific information for such a technique or model is not available or sufficient, such as would be the case in a new line of business, similar relevant entity or industry experience is used. This approach is used in pricing a portfolio, augmented where necessary by professional judgment. For instance, although industry or population mortality experience can be used as a basis for a non-market based mortality rate assumption, the observed experience of the portfolio usually provides more relevant information. However, while portfolio mortality experience is more relevant to the development of mortality rate assumptions, it may not be sufficiently credible (i.e., based on a sufficiently large body of data) to stand on its own.

Certain information is simply not available on a publicly observable basis, thus requiring model-based measures. For example, mortality or claim development experience that relates to the risk characteristics of the portfolio being measured is not normally available from a market, e.g., information regarding mortality is non-market based. In some cases, observable prices might be available from sources such as third party administrators (e.g., for claim management costs) or from securitizations, reinsurers or business combinations. However, in most such cases, prices currently available may not relate particularly well to the characteristics of the risks being measured. This may arise from such factors as one-off events or the inability to make an unbiased adjustment to reflect the individual mix and volume of the business or claims involved or to include other factors such as new business. In such cases, the appropriateness of the information available needs to be considered prior to its use.

The following criteria, some of which are referred to in this section as characteristics, may be useful in determining non-market based inputs made in the development of a current estimate, include:

- reflect the characteristics of the underlying portfolio for which the current estimate is made,
- be comprehensive,
- reflect all reasonably possible, relevant and foreseeable cash flows related to the market input; i.e., in cases of assumptions in which optionality or guarantees are involved, representative or stochastically generated relevant scenarios are considered,
- reflect policyholder, producer and insurer behavior, where appropriate,
- apply within the scope of the measurement of what is being measured,
- be internally consistent with other measurement inputs and the measurement approach used,

- be representative of expected experience,
- be explicitly determined, and
- be supportable or verifiable, depending on the reporting requirements, with the basis for the inputs being documented to the extent needed.

5.1.4 Non-market based assumptions should be determined on a portfolio-specific basis

The assumptions relate to the specific portfolio of contracts involved and the characteristics of the obligations involved. Therefore, the preferred source of assumptions is experience observations derived from the portfolio to be measured.

For most insurance contracts, the use of a contract as the source of observable information would not be reliable. For example, if a single contract were used as the unit of account, both a large expense assumption would result and process risk (i.e., statistical deviation and volatility of experience due to the size of the portfolio, discussed in Section 7.1) would be fully recognized. In addition, an industry-wide or even entity-wide basis would not be used, as the resulting assumptions would usually not be relevant to the exposures and risks and obligations of the portfolio of contracts. Thus, the portfolio is the appropriate unit of account to use, as long as it is relevant and reliable for the purpose.

The historical experience of the specific portfolio or even similar risks of the entity may not be of adequate size to produce credible relevant experience ("credibility" as used in actuarial literature usually refers to the extent to which the information can be relied upon, while "reliability" in accounting literature is usually meant to refer to the extent to which a financial item is measurable). When credible, portfolio-specific experience data is generally considered more relevant than that from the industry (or the general population). This is because it is based on the business being valued: its risk characteristics, the coverage and insured mix reflecting the effect of any underwriting selection performed, and other characteristics such as claim management. However, when fully credible portfolio-specific data is not available, industry (or general population) experience data can also be useful, possibly as a supplement or validation of the assumptions made or in the case of a new line of business.

5.1.4.1 What is a portfolio and why is it important

The extent of aggregation of contracts into a relevant portfolio is determined on the basis of the facts and circumstances involved. The portfolio level is usually considered to be the relevant unit of account applied in measuring current values.

This is relevant in part to reflect the effect of pooling on the risk margin and to avoid the otherwise onerous effect of not reflecting any economies of scale on expense levels included in the measurement of the liability. Consistent with these reasons, IFRS 4.18 indicates that a portfolio is an aggregation of contracts that are subject to broadly similar risks and managed together. Although for a mono-line insurer it might include the entire business of an entity, in most entities relevant portfolios would constitute subsets of it. Even in the mono-line case, different portfolios may exist reflecting the use of such factors as different marketing channels or segments. It is not just the type of insurance exposures involved that is important in selecting relevant portfolios, e.g., private passenger automobile and commercial auto may constitute separate portfolios although they are subject to the same types of claim risk. In this case, the method of management of the exposures can also be among the important factors to consider. The relevant concept is that it is the characteristics and management of the insurance contracts that contribute to the determination of the portfolio.

The use of a portfolio-based measure is usually more appropriate than an entire entity basis, as the entity can comprise a wide range of insurance and other contracts that may not be relevant to the portfolio. The liability measurement should generally be related to the portfolio's characteristics rather than those of the entire entity. These characteristics include risk and product mix, contract terms, insurance risk characteristics reflected in their underwriting criteria, as well as the entity's processing and data systems used to manage the portfolio and its claim adjusting policy. In other words, the inputs to the measurement of a liability should reflect the relevant risk characteristics of the portfolio and the business model used to obtain and manage the business.

Nevertheless, certain practical issues may cause a portfolio's expected value to differ depending on the entity that holds it. In particular, this may include operating expense assumptions. Due to the uniqueness of most insurance portfolios and differences between management methods, in practice it is thought by some that portfolio experience and expectations regarding servicing costs will usually be the same in whatever entity it is in. Because most assumption interaction affects the risk margin rather than the current value, this is not discussed further in this section.

In addition, the size of the portfolio can affect the extent that economies of scale are reflected in the expense assumption. If the financial reporting standard under which the current estimates are developed recognizes the hypothetical portfolio of relevant market participants, significant economies of scale can be reflected, possibly larger than that evident for the size of the actual portfolio being evaluated.

5.1.5 Current estimates in contrast with current conditions

The assumptions used to derive a current estimate reflect the current expectation based on all currently available information about the relevant cash flows associated with the financial item being measured. These expectations involve expected probabilities and conditions (scenarios) during the period in which the cash flows are expected to occur. An assessment of expected future conditions is made rather than blindly applying recent historical or current experience. Although historical or current experience is often the best source from which current expectations of future experience can be derived for a particular portfolio, current estimates of cash flows should not automatically consist of a reproduction of recent experience.

In addition, although the observed experience might be relevant to the portfolio as it existed during the observation period, the current portfolio for which estimates are being made may differ in several respects – in many cases, it could be argued that the current portfolio is usually different than the observed portfolio.

While in some cases, recent historical and expected future experience will be identical, in others they will differ, possibly by a material amount. For example, although a change in national macro-economic policy on the day of the valuation might be considered in establishing current conditions, such a change would not have affected historical experience. Also, a recent medical breakthrough and a threat of a global epidemic are also examples of situations in which current conditions have not yet influenced recent experience.

5.1.6 Consistency of assumptions

If two or more current explicitly determined assumptions are related, i.e., they are either positively or negatively correlated, the application of these assumptions should be reflected in current estimates in a consistent manner. For example, mortality experience can be affected by contract continuance rates, as increased discontinuance can lead to anti-selection and thereby to higher mortality than otherwise expected, as the best mortality risks may be able to exchange their contracts for those with lower premiums. As a result, the mortality assumption regarding future mortality experience for a particular portfolio should be consistent with the contract discontinuance rate assumption. If multiple scenarios are used by the valuation technique to measure the expected value of an obligation, the mortality assumption should be consistent with the contract discontinuance rate assumption within each scenario applied, although approximations might be used as long as the approximations are suitably validated and in compliance with the applicable financial reporting standards.

If financial reporting standards or guidance affect the recognition and measurement of the current estimate, the assumptions within a given scenario should be consistent. For example, if interest-rates are assumed to be market-consistent, then it would be appropriate to reflect policyholder behavior that is consistent with these market-consistent rates.

Certain financial reporting constraints on the development of assumptions used can create inherent difficulties in developing estimates of the interrelationships between assumptions. For example, in a given financial reporting system, a liability of a contract may not be permitted to be recorded at less than its cash surrender value, may not recognize non-guaranteed elements, or may be based on a rational expectations model (i.e., the worst case scenario within a probable range of outcomes), even though market observations indicate that those who pay premiums do not act consistently with those assumptions. The result of such constraints would not be a realistic current estimate.

In some cases, the cash flows of a given period depend significantly on the outcome of prior cash flows, while in others they are independent of them. The former might include the use of an assumption regarding the mean reversion in certain types of cash flows such as returns on equity. Such an assumption needs to be validated at each measurement date is necessary. This would be done by means of using observable historical results to help ensure that such a mean reversion assumption faithfully represents the current estimate of expected future cash flows. This type of assumption may not necessarily be market consistent at a current point in time. Another example is the use of contract discontinuance rate assumptions under similar economic and competitive conditions, although this experience is not usually available.

Also, the discount rates for each future period and the distribution of cash flows over the period covered may not be independent. In such a case, the combined effect of the discount rate applied at each duration and the expected cash flow pattern may need special attention.

5.1.7 Determination of the valuation technique (methodology) and considerations regarding its inputs

Once the valuation technique (market-based or non-market-based) is selected, the input parameters (assumptions) are then derived. In certain cases, the use of inputs from multiple valuation techniques can enhance the reasonableness of the current estimates. Depending on the portfolio whose current value is being measured, valuation assumptions for the technique selected can include the incidence, severity, claim development and timing

of claim settlement, mortality, morbidity, policyholder behavior, expenses, and investment returns or discount rates, or their interaction.

Assumptions are applied through the application of a given methodology, often determined by use of one or more actuarial models. For each valuation technique applied, each significant assumption is assessed independently and incorporated as an input to the valuation technique. The effect of other assumptions (e.g., the effect of interest rates in a scenario on discontinuance rates) is also reflected. Although the assumptions need to be reasonable in the aggregate, each significant assumption made is also assessed individually. To the extent practical, each assumption should be made explicitly. In certain cases, the implementation of such an approach may prove impractical.

The process and method used may not be unique and can in some cases be somewhat portfolio-specific, depending on the type of available experience data, and can involve significant judgment. In some cases, many assumptions can be involved, to the point that it may be difficult to isolate a specific assumption. For example, certain assumptions that might provide separate inputs to the estimation of certain cash flows may be difficult to isolate, such as in a separate hypothetical analysis of the frequency and severity of claims if claim counts are not available. In such a case, the use of their combined effect would be more reliable, or it may be more credible to directly estimate the total claim cost rather than to derive separate distribution functions of the number and size of the claims and then to combine them.

5.1.8 Asymmetry of expected costs

Expected cash flows can be influenced by the following factors:

- non-uniform or asymmetric probability distributions
- contractual option use by the policyholders in a way that benefits them
- asymmetric severity, reflecting limits on the distribution of claims or policy size.

In many cases a non-symmetric probability distribution applies, e.g., as a result of a fat or catastrophic tail or a one-sided limit on possible values such as non-negative mortality rates or other contract terminations. Other non-symmetric examples include guarantees (minimum cash value or interest rate credited or maximum cost of insurance charged); limits to values (e.g., reinsurance retention limits or non-negative contract termination assumptions); or asymmetric severity (e.g., relatively few partial losses). In these cases average values of observations not reflecting the asymmetric effect of such assumptions may not produce a reasonable current estimate.

For example, in many cases in which optionality or non-symmetric expected cash flows are involved, the use of stochastic methods is appropriate, although sufficiently validated representative deterministic assumptions might alternatively produce sufficiently similar results. And it may be more precise to consider the overall range of scenarios by applying an actuarial model using probability functions with similar asymmetry. Note that in the derivation of soundly based estimates of expected experience, the use of refined or sophisticated methods is not a substitute for a basic understanding of the experience data used and its context, or for an understanding of the range of probable values.

5.1.9 Approximations

Approximations can be made to individual assumptions or to aggregate estimates that are developed in a relatively simplified manner that produces reasonable estimates. Approximations are often used for minor assumptions or if the current estimate is not sensitive to variations in one or more assumptions, the sensitivity of which can vary by contract. They are usually made for practical reasons, but nevertheless they should be performed in a technically sound manner. For example, in many cases a mid-year assumption for cash flows represents a sufficiently accurate estimate for the purpose of estimating the timing of future annual cash flows, and the average age in a quinquennial age grouping may be appropriate in many situations. Nevertheless, such simplifications may not always be appropriate, depending on the facts and circumstances involved.

The extent of grouping of risk classes in current estimates for a portfolio or contract can be a function of the amount, type and reliability of portfolio or product specific experience, or technology restraints. It is not uncommon that as technology is enhanced (usually with more powerful computers or more efficient software), more refined models, e.g., seriatim modeling, is used. The appropriate extent of grouping may be determined on the basis of the homogeneity of the group with respect to applicable risk characteristics and their size.

If a small entity or unique portfolio is involved, it can be appropriate to use a less refined model or larger groupings. In particular, an extensive data base of portfolio-specific experience is not likely to be available. Nevertheless, even in this case it is necessary to be convinced that the model and assumptions used are sufficiently reliable and could be used to produce an unbiased current estimate.

5.1.10 Quality of data

In some cases, limited or unreliable data may be all that is available to base an assumption on. In such cases, other relevant experience sources must be sought. These sources may be derived from similar products, portfolios or markets, from the entity or, if not available, from industry or population sources. If appropriate, adjustments are made to these alternative sources so that they better match the risk characteristics of the portfolio. If the extent of portfolio-specific data is significant but not sufficient to form the entire input for a model, then a credibility approach might be taken that weights the portfolio-specific experience or data with that from other sources. Often actuarial judgment is necessary to determine the most relevant experience and to derive appropriate adjustments to the most reliable and relevant available source.

The quality and availability of relevant and reliable portfolio-specific data concerning the level, trend and volatility of assumptions may affect the risk margin or the uncertainty surrounding the expected values to a greater extent than the estimate of the present values of expected cash flows. Nevertheless, the lack of a reliable source can create significant difficulties in deriving a current estimate.

Assumed (inward) reinsurance can present a particular challenge when the data made available by the cedants is limited, of poor quality or late (sometimes by one to several quarters). The problems can relate either to experience or to the amount of business which is being reinsured, or both. Reinsurers often develop their assumptions based on experience from similar business from other cedants, pricing assumptions or older than desirable experience.

If sufficiently relevant and reliable experience and data are not available to derive reasonable estimates, the applicable financial reporting standards or guidance may determine the consequences of an inability to provide a reliable measurement. Particularly with respect to a liability, some commentators believe that some estimate is better than none at all (at least to the extent of a lower bound of an estimate), although accounting literature indicates that where no reliable basis exists, no value should be included in the balance sheet, and instead disclosure of the risks and uncertainty involved should be included in the Notes to the financial report. Situations of interest to actuaries where an expected value cannot be derived are relatively rare. More useful financial information may consist of a minimum liability value if it can be determined in a reliable manner, with appropriate disclosure of the source and extent of the uncertainty involved.

5.1.11 Updating assumptions

The following two sections discuss the updating of assumptions, both those based on transaction prices in a market and those that are not.

5.1.11.1 Non-market based assumptions

The derivation of a current estimate of non-market assumptions should be reviewed regularly and systematically at each measurement date. While a review is needed at each measurement date and at least annually, an update of each assumption at each measurement date may not be needed, as significant credible new information to change an estimate may not be available.

Even in a financial reporting system that does not permit the application of updated current estimates but instead requires "locked-in" or non-current assumptions to be applied, current estimates may be required to be updated as a result of a liability adequacy, loss recoverability, or premium deficiency test.

The measurement of the liability of insurance liabilities and reinsurance assets is regularly updated when current expectations differ from those incorporated in the prior estimates. Generally a revision is made at a measurement date when the effect on current estimates from differences between current and prior expectations become significant. In assessing the credibility and relevance of the differences, the same general guidance applies as provided in the previous paragraphs. In some cases, an update to an accounting estimate would have to be significant before it is required. Usually financial reporting requires that it is the effect on the liabilities for which materiality is assessed, rather than on the individual assumption. Except in the case where constrained, an update would always be permitted if the accounting consequence is not material, although such an update would not be required.

These differences can arise for several reasons, including:

- A previous assumption based on incorrect or limited data. Enhanced data or an expanded experience or data source can enhance current estimates.
- The developed experience may not be actuarially credible due to the amount of the available experience data or that the experience resulted from conditions that are not expected to continue.
- An incorrect model of future cash flows. For example, it may have been assumed that future cash flows were distributed according to probability distribution A, when it is subsequently determined, based on additional

information or changed conditions, that they are more consistent with probability distribution B. Or more knowledge is gained regarding cash flow drivers. In addition, a factor contributing to an assumption or the interaction between two assumptions may have been overlooked that will influence the future cash flows.

- Estimates of the assumption of an underlying probability distribution may differ from actual experience. For example, a distribution with a mean of 100 and a standard deviation of 10 may have been estimated, when it is subsequently determined, based on additional information or changed conditions, that the distribution actually has a mean of 120 and a standard deviation of 15.

Another case is the common assumption that the current law remains in effect in the future. In this case, estimation challenges may arise if there are changes to statute or case law, or if any such changes are expected. In any case, the basis of the assumptions used should be reviewed periodically.

It is a best practice to document the basis for and the effect of experience adjustments and changes, and in most cases the basis for not updating assumptions.

Financial reporting standards often distinguish between errors, changes in accounting estimates and changes in accounting policy. IASP No. 8, *Changes in Accounting Policies under IFRS [2005]* describes such differentiation in more detail. Any changes need to be so categorized, as they are treated differently. However, such a determination usually depends on the facts and circumstances involved. For example, a move from decennial age groupings to quinquennial age groupings or a change in development factors are usually considered to be a change in estimates, while the introduction of a mortality trend or a change from a market-based to a non-market based discount assumption are examples of a change in basis or accounting policy.

5.1.11.2 Market based assumptions

Market-based assumptions are also updated on each measurement date, based on a review of observable transaction prices in a relevant market.

5.2 An example of determination of the current estimate for mortality incorporating information about level and trend

One of the co-chairpersons of the RMWG, Henk van Broekhoven, has published a paper (van Broekhoven (2002)) concerning how to use current and past observations about mortality to construct current estimates for levels and trends of mortality. While the mortality risk is just one of the

many risks assumed by certain insurers, the thought process developed in the paper can be applied to many other important insurance risks as well.

The method described in the paper is meant to be a practical one. Although more sophisticated models exist, for practical reasons Henk chose a model that was both easy to use and explain. The future trend he used is based on population mortality development observed during a recent period. Older historical experience also can provide context as to how the trend can change over time. These observed changes are used to measure the trend uncertainty. Entity or portfolio observations regarding trends will normally demonstrate relatively high volatility due to the fact that the number of observations is smaller than that of the overall general population and to the effect of changes made in underwriting criteria over time. These volatile observations give rise to expectations concerning the level of uncertainty. This uncertainty is derived using a statistical method by measuring this volatility.

In the paper, calamity (or "extreme event") risk is based on the only historical observation for which data is available – the Spanish Flu in 1918 - 1919. This pandemic caused a doubling of mortality for the younger ages over a one-year period after which mortality levels returned to trend. The calamity capital for mortality is based on this scenario.

6. Risk Margin Measurement Methods

This section describes the goals of risk margins over current estimates (*MOCE*) and how several approaches might be applied in theory and in practice. The section also compares some of their limitations. Practical examples concerning considerations for risk margin determination are provided for various life insurance and general insurance products in Appendices B and D, respectively. It is hoped that these examples will help clarify the issues involved in risk margin methodologies.

6.1 The goals of risk margins

Insurance obligations are, by their very nature, uncertain. The insurance industry exists to purchase uncertainty from policyholders by transferring at least part of this uncertainty for a price.

Risk Margin as an element of an exit value
Measurement of liabilities for insurance contracts is currently under discussion by the IASB. The current likely measurement direction of the IASB is based on an exit value, i.e., the amount an insurer would expect to pay or receive at the current date if it transferred its outstanding rights and obligations under a contract to another entity.

When deep liquid observable markets exist for financial instruments (such as for many financial assets), the observed exit price already provides an investor with an expected return sufficient for compensation for the risks in that investment relative to alternative investments. In the terminology used in this paper, the market price includes both a current estimate of expected cash flows (see Section 5) and a risk margin in excess of that amount. If there were a deep liquid market for insurance obligations, the observed market price for an insurance obligation would constitute the exit price. However, as no deep liquid market currently exists for insurance obligations, a model must be constructed that can produce exit values.

In putting this methodology into practice, it is assumed that a rational transferee would require something above the current estimate (even if transferor and transferee were to agree perfectly on the level of the current estimate). Otherwise, the transferee would expect to receive nothing for taking on the risk if everything does not work out as expected[11]. This

[11]"The IAIS stresses that any transfer would need to be made to an entity capable of accepting the transfer which, in the case of a regulated industry like insurance, implies that the transferee would also need to be regulated and capable of settling the obligation to the claimant/beneficiary. Accordingly, the IAIS believes that any transfer notion would be strongly influenced by the settlement obligations that the transferee would undertake." [IAIS 2nd Liability Paper, paragraph 11]

amount, the margin over current estimate, can therefore be regarded as an additional amount "for uncertainty". It therefore can also be regarded as a compensation for the transferee for the risk of taking on an obligation to pay uncertain cash flows.

Hence, a reasonably rational methodology for calculating this margin over the current estimate is to put oneself in the position of the transferee. What thought processes might the transferee go through in order to work out what extra amount it might require over the current estimate? Presumably, the answer is as much as possible, but in a market in equilibrium, the margin would be based on a reasonable return reflecting the risk of uncertainty. At market equilibrium, the margin would also reflect how the risks and returns of alternative investments and the manner in which an investor might construct a diversified portfolio of investments. If observable evidence existed that transferees would take on the net obligations at a very low return in view of the uncertainty involved, then the risk margin should reflect this lower return.

Once this is agreed to, the margin over current estimate could potentially be estimated by various different methods. The application of any acceptable method should endeavor to incorporate what a rational market participant may require.

Risk margin as an element of prudence
In addition to serving as an element of the exit price, a risk margin makes it possible to absorb reasonable volatility in experience. If experience is more favorable than that assumed in the current estimate, without risk margins, the release of the excess risk margin creates a “profit” that serves as a reward for the investor that has taken the risk; if experience is worse than expected, the risk margin covers some part of the expected losses, also considering that is also a chance of achieving profits. Normally, a purchaser will not be willing to assume a risky obligation unless its expected reward for doing so not only covers the expected costs, but a margin for risk has been provided as well.

Under an exit value approach, cash flows may be related to risks that can be actively traded (“replicated”) and those that cannot. Risks that can be traded have observable transaction prices that already implicitly include risk margins. For non-financial risks, including insurance, expense and operational risks, and for financial risks not traded in an active market, only the deviation from the current estimate, i.e., the risk margin, will be needed, determined in a manner consistent with what investors require. The use of this approach is consistent with the economic capital described in the *Blue*

Book, as well in more detail in a presentation[12] to the IASB's Insurance Working Group in January 2006.

In certain accounting models, a total margin is applied at issue rather than a separately calculated risk margin. In this case, the risk margin can be used as a measure by which to release this total margin. The effect of this constraint is discussed in Section 8.2.

6.2 Desirable risk margin characteristics

In the *Second Liabilities Paper*, the IAIS takes the position that, "(w)ithout prescribing any one method(ology) at this stage, the IAIS believes that any methodology for calculating the margin over current estimate should share certain characteristics."

The paper continues "(i)rrespective of the particular methodology chosen, acceptable methods should reflect the inherent uncertainty in the expected future cash flows and would be expected to exhibit the following characteristics:

- ~~1.~~ The less that is known about the current estimate and its trend; the higher the risk margins should be
- ~~2.~~ Risks with low frequency and high severity will have higher risk margins than risks with high frequency and low severity
- ~~3.~~ For similar risks, contracts that persist over a longer timeframe will have higher risk margins than those of shorter duration
- ~~4.~~ Risks with a wide probability distribution will have higher risk margins than those risks with a narrower distribution
- ~~5.~~ To the extent that emerging experience reduces uncertainty, risk margins will decrease, and vice versa."

This wording was suggested by observers from the RMWG reflecting its research to the date of preparing the paper. While the characteristics are expressed in a form that is risk oriented, the RMWG believes that the characteristics are also expressed reflecting the way the insurer to insurer (exit value) market works in practice where such markets exist. Given two well informed willing parties, the price demanded (and accepted) for risk transfer would incorporate these characteristics.

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[12] *Cost of capital approach for setting risk margins in market value of liabilities* – a presentation to the IASB Insurance Working Group by Francis Ruygt on 12 January 2006; and *Cost of capital approach for setting risk margins for insurance contracts liabilities – Background paper by presentation on examples to calculate MVL's applying a cost of capital approach for setting risk margins*.

In addition, it is desirable for the risk margin methodology to have the following characteristics:

1. Have a consistent basis at issue and subsequent to issue, i.e., for the entire lifetime of the contract;
2. Use underlying assumptions consistent with those used in the determination of the corresponding current estimates;
3. Have a consistent risk margin methodology with other financial contracts; and
4. Where possible, be determined in a manner consistent with accepted economic and actuarial pricing methodologies.

It is the view of the RMWG that this risk uncertainty should itself reflect knowledge about the risk(s) assumed, including observable information concerning the uncertainty associated with:

- the estimated current level of the risk(s);
- the estimated future level or trend of the risk(s), as applicable;
- the estimated future term of the risk(s); and
- the estimated uncertainty associated with the first three sets of risk[13].

Regarding this risk uncertainty:

- In order to produce the consistency desired in the Terms of Reference given to the RMWG~~, robust guidance~~rules for the professionals involved concerning the approach to determine current estimates must be available. An ~~major~~ important portion of this report deals with this issue.
- Gaining knowledge about ~~and~~ the uncertainty associated with the current level, trend and probability distributions[14] of the risks can be a resource demanding and time consuming task – a task that might require regulatory encouragement (or regulatory forbearance as the case may be).

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[13] Observable information (or the process) will not always be conducive to reliable probability distribution estimation. While information about the probability density function of the risk is desirable for risk margins to be calculated using the "quantile" approach, it may not need to be explicitly estimated for other approaches to risk margin calculation. Nevertheless, even deterministic (explicit) methods of calculating risk margins should be based on informed professional judgment about these probability distribution functions.

[14] As mentioned above, the degree to which such probability distributions can be reliably estimated will vary by product and jurisdiction, affecting the ability to produce comparable estimates across entities and time. In general, the center of such distributions is usually more readily estimated than the tail. Hence measures that rely on estimates of the center of such distributions will usually be more comparable than those that rely on estimating the tail. Nevertheless, the analysis of the tail remains quite relevant to the measurement and recognition of the risks involved.

- When risk transfer markets exist, they reflect the level of knowledge about the current risk levels, their trends and the probability distributions of their possible outcomes and, to an important degree, the confidence that each of the insurers that are a party to an arm's length risk transfer agreement requires.

Appreciating this latter point might be very important if the IAIS and IASB are to reach consensus about methodologies acceptable to each party that are substantially consistent. Note that at the time this paper was written, the IASB has not described the measurement attributes associated with or guidance with respect to the determination of risk margins. The RMWG has assumed that the characteristics listed above will be deemed appropriate for financial reporting in the future.

Hence, a considerable part of this paper deals with alternate methodologies that might be used for the determination of risk margins, their characteristics and their strengths and weaknesses.

6.3 Possible approaches to risk margins

Three basic approaches (sometimes referred to as methods), or more appropriately, families of approaches, of determining risk margins have been used in the past:

1. **Explicit assumption approaches**. These risk margin methods use "appropriate" margins for adverse deviation on top of realistic "current estimate" assumptions.

   This method might not appear to meet the objectives or either the IASB or the IAIS. However, there may be merit in using an assumption method when an external constraint is imposed so that the measurement of a liability does not reflect a current prospective (such as exit) value. For example, the use of a quantile or cost of capital method might yield a profit at issue, even though the financial reporting standard (or an insurer's accounting policy) might prohibit such a profit at issue. In such a case, in order to ensure that a profit at issue does not arise, the risk margin might need to be increased beyond that normally derived by the risk margin methodology (see Section 6.1.1).

   Explicit assumption methods have been effectively used in some instances, with the risk margins sometimes referred as provisions for adverse deviations (PADs) or margins for adverse deviations (MfADs). One difficulty with this approach is that insufficient assessment is usually made concerning the appropriateness of the combination of separate margins on each major assumption (and in some cases, certain risks are ignored altogether (particularly the persistency risk, in part because the risk of variation can be associated with higher or lower persistency and

because of its interrelationship with other assumptions), with sometimes seemingly arbitrary reductions are made in deriving an aggregate contract risk margin.

Although in some cases the assumption margins are developed on a statistical basis, comparability of these risk margins, except when dictated by a regulator, through explicit disclosure or strong professional discipline, can be relatively weak.

2. **Quantile methods**. These risk margin methods express uncertainty in terms of the excess of a percentile (quantile) for a given confidence level above the expected value for a given period, such as the lifetime of the coverage. They can be determined based on an estimate of a probability of ruin[15] in excess of a given percentile.

   This method could meet the IAIS's primary objective of developing a sound balance sheet and indirectly to meet (after appropriate calibration) the IASB's primary objective of reflecting what a willing buyer would charge a willing seller to assume a contract with insurance risk, as it is sometimes used for pricing purposes.

3. **Cost of capital methods**. These risk margin methods are determined based on the cost of holding the capital needed to support the obligation.

   This method appears to meet the IASB's primary objective of reflecting market charges for assuming risk, as well as that of the IAIS. The cost of capital method directly relates the capital that needs to be held to assume the obligation as part of the insurer's total financial resources. Note that this under some theories, this capital may differ from an insurer's economic capital, which is usually determined on an entity-specific basis. The two measures of capital can be different, as the latter in part includes provision for avoidable risks, for example, to cover the risk of asset/liability mismatch. A buyer of the obligation would not necessarily need to recognize this mismatch although in practice this will often be the case.

   The cost of capital method is based on the explicit assumption that, at each point in time, the risk margin must be sufficient to finance the (solvency) capital otherwise a transferee will be unwilling to pay less

[15] A liability is adequate to a specified degree of confidence if the right hand tail of the expected distribution of the obligation (reflecting losses above the point of ruin) occurs less than the specified confidence level. For example, a liability determined at a one standard deviation level will be adequate to absorb losses up to one standard deviation above the mean and total balance sheet requirement set at the 99.5 percentile level will be adequate to absorb all but 0.5% of the statistically expected losses.

than an amount that would fund future capital requirements. Reflection of the estimated current and future economic capital needs of a potential transferee ensures that the amount paid for the transferee for risk provides for the entire risk that will affect the purchaser. In contrast, the quantile and explicit assumption methods do not explicitly reflect current or future required capital although the methods are reconcilable if the total capital requirement is expressed in quantile terms..

More details on the cost of capital method are discussed in Section 6.9.

3. **Other Approaches.** Not included in this list of possible approaches is the traditional method of incorporating risk that uses conservative assumptions of unspecified amount on an implicit basis, either in aggregate or on an assumption specific basis. This method has been applied in many jurisdictions for regulatory purposes. It has also been applied when it has been assumed that the discount for the time value of money was equivalent to the risk margin, e.g., in the use of undiscounted claim liabilities.

In addition, risks may also be reflected in the discount rates rather than in the cash flows as is the case in the three methods described above. Reflecting risk premiums in discount rates is an approach generally used in embedded value calculations; however, these focus on the value of the future distributable earnings rather than expected cash flows. If such a methodology would be used for the measurement of the liabilities the risk adjustment would have the effect of lowering the discount rate. Such a methodology may lack transparency and implicitly assume that risk runs off evenly over time.

These other approaches do not appear to meet either the IASB's or the IAIS's objectives for a new system of general purpose or regulatory financial reports, as it might not be consistent across jurisdictions, might not be as transparent as the alternative approaches, and would not be consistent between insurance and other industries. They will not be examined further in this report.

There are several other actuarial methods that have been used to measure risk in pricing. Among them are the standard deviation and variance methods (both measures of the second moments of the probability distribution). These approaches are similar to quantile methods, in that they use statistical methods calibrated to a specific level of the moments of the risk distribution. In fact, these measures are often used to assess the reasonableness of the otherwise determined risk margins – for the purpose of this paper, they represent variations of the same theme, the principle difference is in the way that the result is expressed (e.g., confidence, CTE or moments) and are thus discussed in the context of the quantile family of

risk measures. These specific risk metrics will not be examined separately in this report, although many of the comments regarding the quantile methods also apply to these as well.

6.4 Coverage and risk distributions

In order to consider the appropriateness of these approaches to developing risk margins, simple numerical examples have been developed. These examples focus on principle drivers of risk margins, the term of the insurance obligation and the tail of its liability.

Note that risks with highly skewed claim probability distributions beyond those considered in the examples provide challenges to the successful implementation of all both methods. For such risks, it is important that the risk margin methodology reasonably reflect the characteristics of risk margin measurement enumerated in Section 6.2.

6.4.1 Term of the obligation/payment duration

The phrase, term of the obligation, is used here to refer to the number of periods (usually measured in years) that it is expected to take until the obligation is (substantively) extinguished. For unsettled claims, this refers to the period over which the obligation is extinguished. The expected term of an insurance obligation can be very short (as in the example of numerous general insurance coverages such as fire insurance), of medium term (as in the case of ten year term life insurance or well behaved third party liability claims), or very long (as in the case of some whole life insurance or annuities).

To illustrate the differences in risk margins produced by the three methodologies under consideration, three different cash flow patterns associated with insurance coverage were constructed as typical of what are commonly referred to as “short term," “medium term” and “long term” insurance obligations. Three claim runoff patterns were constructed. Table 6.1 shows these with reference to an initial liability of 100 at the end of the first year.

Table 6.1 Coverage and runoff periods

Year	Life insurance			Property & casualty insurance		
	Short	Medium	Long	Short (Property)	Medium (Motor)	Long (Liability)
1	100%	100%	100%	100%	100%	100%
2	50	90	95	50	58	89
3	20	80	90	20	27	77
4	5	70	85	5	6	66
5		65	80	0	2	54
6		59	75		0	43
7		53	70			37
8		47	65			31
9		41	55			26
10		35	50			20
11		0	46			14
12			42			11
13			38			9
14			34			6
15			30			3
16			27			0
17			24			
18			21			
19			18			
20			15			
21			13			
22			11			
23			9			
24			7			
25			5			
26			4			
27			3			
28			2			
29			1			
30			1			

6.5 Tail of the liability

The phrase "tail of the liability" refers to how much of the likely amount of losses are in excess of a specified high confidence level determined based on the shape of the probability density function[16] of the risk exposure resulting from the obligation.

The width of the curve relative to the average value is often of interest, both to the measurement of the risk margin and total financial resource

[16] First order derivative of the probability distribution function.

requirements. As described in the *Blue Book* (page 41), this information can be provided by a standard statistic called the coefficient of variation (CoV) which is the standard deviation divided by the mean. The coefficient of variation varies widely among lines of business. The *Blue Book* (page 50) indicates that for general insurance, the coefficient of variation of unpaid claim liabilities might be expected to be 10% to 20% for short tail lines and 20% to 30% for long tail lines and also observes that the coefficient of variation for unexpired risk liabilities could be 25% to 75% higher than the coefficient of variation for unpaid claim liabilities. For life insurance products, the coefficient of variation for large companies is typically lower.

6.5.1 Normal distribution

The "normal distribution," probably the most widely used family of statistical distributions, is symmetric around its mean in the form of a bell-shaped density curve with a single peak. It is “as good as it can get” in terms of risk, but it is rare in practice for most insurance risks. Nevertheless, since the normal distribution is widely analyzed it is used as a proxy for the probability distribution for an extremely “well behaved” portfolio of insurance contracts or claims.

Key reference points for the normal distribution are shown in Table 6.2.

Table 6.2 Normal distribution
Relationship between the standard deviation and quantiles of the distribution

Standard deviations	Quantiles	Equivalent confidence level
0.67	25.10%	74.90%
1.00	15.80	84.20
1.50	6.68	93.32
2.00	2.28	97.82
2.33	1.00	99.00
2.58	0.50	99.50
3.29	0.05	99.95

These key reference points are often referred to in the literature in the following way. A quantile objective that might be appropriate for a liability under general purpose financial reporting guidance is frequently cited as lying between 2/3 and 1.5 standard deviations above the mean current estimate. If the probability distribution of the underlying insurance risk were normal, such a liability would be expected to be adequate between 75% and 93% of the time.

Similarly, the total financial resource requirement for regulatory purposes is sometimes expressed as meeting the 99%, 99.5%, or (in the case of a AA

rated insurer) 99.95% confidence level. If the probability distribution of the underlying insurance liabilities were consistent with the normal distribution, the total financial resource objective would be set at the 2.33, 2.58 or 3.29 standard deviation levels respectively.

6.5.2 Well behaved insurance distributions

The probability distributions for most insurance current estimates are positively skewed, with higher likelihood of a larger or more extreme loss than a smaller loss (i.e., a fat tail). While the degree of skewness varies by coverage, insurance coverage is often viewed as “well behaved” if its probability distribution is not “long tailed." As noted previously, a third-party liability exposure with a long tailed risk is one in which a significant proportion of the distribution lies beyond the third standard deviation.

There is no generally accepted definition of when a distribution becomes “long tailed." For purposes of the illustrations in this paper, the convenient definition is used that any distribution for which the probability that the liability does not exceed 3 standard deviations is 99.5% or less is considered “well behaved." This 99.5% confidence level is explicitly referred to in the Swiss Solvency Test (SST) and is also found in IAIS discussion papers as a possible regulatory objective for a total financial resource requirement.

If the tail of the liabilities is right hand skewed such that the 99.5% quantile level is at 3 standard deviations, the 99.95% quantile level will be similarly pushed to the right. There are many such probability distributions. For purposes of the examples in this paper, it is assumed that probability distributions are determined using a transformation of the normal distribution using the normal power[17] approximation which results in the 99.95% quantile point at the 4.0 standard deviation point.

[17] The normal power approximation is to solve for the skewness (gamma) that produces a 99.5% confidence level at the desired number of standard deviations. In this case, if the 99.5% confidence level is at 3 standard deviations, the skewness (gamma) is solved for in the equation, 3 = 2.58 + (gamma/6)*(2.58^2 -1) which yields a gamma of 0.42. Then the equivalent 99.95% confidence level is solved for using the same equation, i.e., 4.0 = 3.29 + (0.42/6)*(3.29^2-1). For purposes of illustrating general insurance coverages, this curve is very similar (within 1% at the important quantile points) to the lognormal distribution with a coefficient of variation of 13.9%, which might be associated with a commercial automobile coverage. Section D5.4 provides the formulas needed to convert normal power approximations to log normal distributions.

6.5.3 Long tailed (and fat tailed) distributions

A great deal of insurance is considered to have a long tailed distribution. Examples can include: hurricane / cyclone (and other wind damage) insurance, earthquake insurance, product liability insurance, and many common reinsurance coverages such as excess loss insurance, single event catastrophe insurance, etc.

The nature of these coverages is that there is often a very low frequency and very high severity for the insured risk. The less probable the event and the more severe the economic consequences, the more skewed to the right is the probability distribution of the liability. While this paper uses a single representative long tailed distribution for determination of risk margins, the range of probability distributions for long tailed liabilities varies considerably. However, in general, the more skewed to the right is the probability distribution of the liability, the less relevant the current estimate becomes in its measurement and the more relevant the risk margin becomes.

"Fat tailed" distributions are not just skewed to the right compared to a normal distribution; they are also skewed to the left. A typical example of such a "fat tailed" distribution is that of monthly movements in major stock market indices (such as the Standard & Poor's 500 in the U.S.). To the untrained eye, its probability distribution seems to have the normal shape. But since there are sufficient periods in which "fear" and "greed" are exhibited in the market, the movement in even as broadly based index as the S&P 500 would appear to be remote when measured against the normal curve, so that measurement of insurance coverage against adverse market developments (such as minimum death benefit and minimum maturity benefit coverages) must recognize the "fat tailed" nature of the risk.

6.5.3.1 Well behaved long tail distributions

For illustrative purposes of the comparison of alternative risk margin methods for well behaved long tail distributions, the normal power approximation was used to create a distribution with 3.5 standard deviations for the 99.5% confidence level to arrive at a gamma[18] of 0.95. The use of this 0.95 gamma to solve for the 99.95% confidence level results in it being found at 4.9 standard deviations.

Chart 6.3 shows how the normal, typical insurance and well behaved long tail probability distributions look using the normal power approximation.

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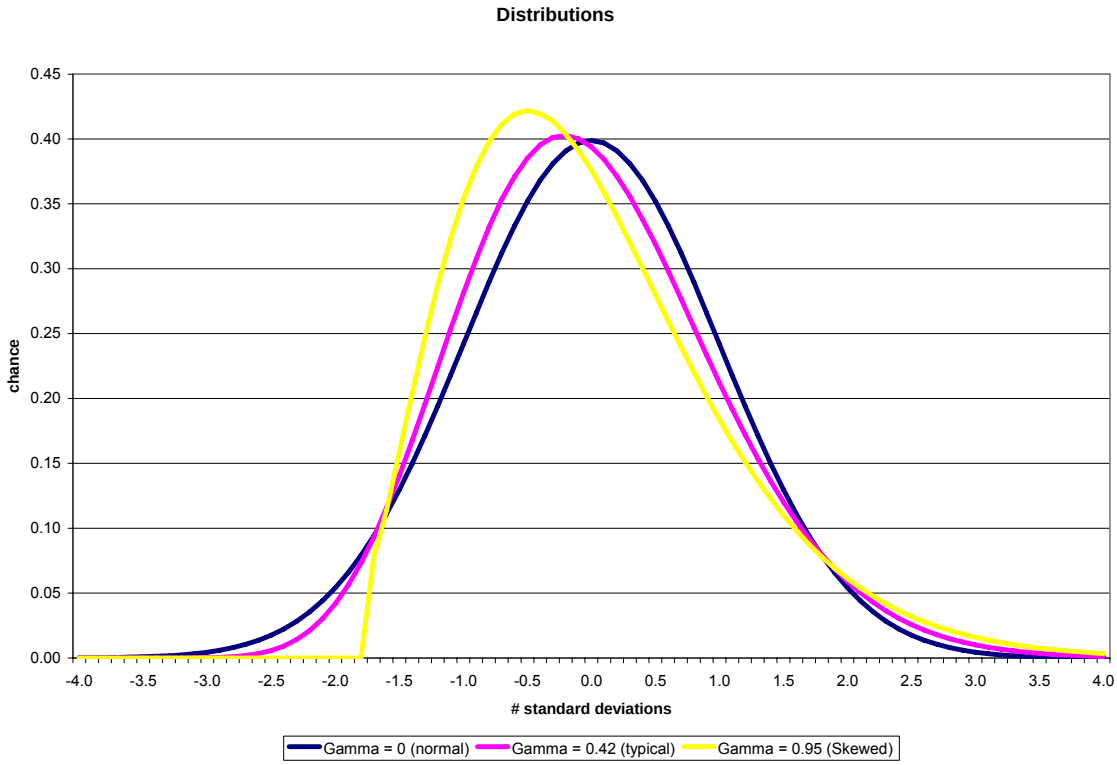
[18] This distribution is very similar to the lognormal distribution with a coefficient of variation of 30.7%, which might be associated with a very long-tail liability coverage or with certain reinsurance covers (see Section D5.2 for comparison of the curves).

Chart 6.3 Representative probability distribution functions derived using the normal power approximation for typical insurance (gamma 0.42) and well behaved long tail (gamma 0.95)



6.5.3.2 Extreme distributions

Some risks, like extreme event risks, can exhibit very high levels of skewness. Examples of extreme event risks are catastrophe risks, like earthquakes, in general insurance and calamity risk like pandemics for life and health insurance. The use of a conditional tail expectation (CTE)[19] is

[19] Conditional Tail Expectation (also known as Tail Value at Risk (TVaR) is the conditional expected value of that part of a probability distribution that lies above a given quantile. The mathematical definition is

$$CTE(p) = E\left\{x \mid x > z(p)\right\} = \frac{\int_{z(p)}^{\infty} x\ f(x)\,\mathrm{d}x}{\int_{z(p)}^{\infty} f(x)\,\mathrm{d}x}$$

where f(x) is the probability density function, p is the selected quantile and z(p) is chosen so that

$$\int_{z(p)}^{\infty} f(x)\,\mathrm{d}x = 1 - p$$

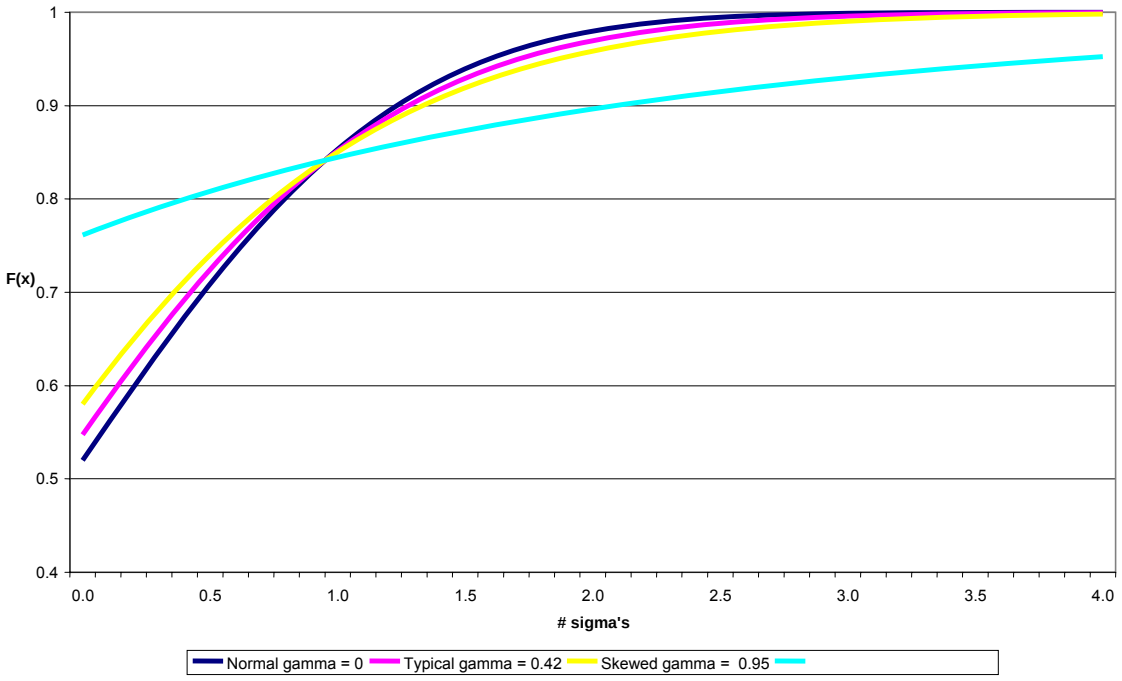
In words, the CTE is the expected value of those outcomes above a given quantile. For example, CTE 80 is the average, excluding the lowest 80% of possible outcomes.

preferable to using quantile approaches for such types of high skewed risk. Compared with other quantile approaches, a CTE type of approach assigns a higher weight on extreme events as market participants should be expected to do, at least because of a higher degree of risk aversion to large losses. Because of the "unusual event" nature of much of the reinsurance business, some product lines for reinsurers will also be much more highly skewed than that written by more "normal" direct writing insurers.

For purposes of illustration of "extreme event" risk, the normal power approximation was used to create an "extreme event" probability distribution in which the 99.95% confidence level was at 10 standard deviations. The distribution had a gamma of 8. Under this distribution, the 99.95% confidence point is not reached until 16 standard deviations.

This "extreme event" probability distribution cannot be illustrated with the previous three distributions without losing information due to the increase in horizontal scaling. However, by illustrating the four cumulative probability distributions, the characteristics of their risk functions can be illustrated. Note that the higher the skewness in these distributions, the higher the probability of no event. This is a common characteristic of many "catastrophe" and excess loss reinsurance coverages.

Chart 6.4 Normal, typical insurance, and skewed probability distributions



For both “long tailed” and “fat tailed” distributions that are more skewed than the “well behaved long tail” (skewed) liability shown in Chart 6.4, liability measures such as “conditional tail expectation” (CTE) would seem to be more relevant than “current expectation” plus a quantile risk margin.

A detailed discussion of the appropriate CTE levels for such skewed distributions used to determine liabilities and total financial resources is beyond the scope of the examples in this paper. However, we have observed that in some jurisdictions a liability based on CTE levels of 60% to 80% appears to be generally accepted for death and maturity guarantees associated with variable annuities. There is almost no literature with respect to the appropriate total financial resources objective; but the 99% CTE level could be viewed as being roughly equivalent to the 99.5% quantile level objective as used in the Swiss Solvency Test and certain IAIS literature.

6.6 Skewness

Skewness arises due to the interplay of several variables common to insurance.

The first is the frequency of claims (for some coverages, sometimes referred to as "benefits"). For insurance against living or dying (annuities or

life insurance respectively), a death either occurs or it does not. For general (property and casualty) or health insurance, an insured event can occur multiple times during the life of a contract e.g. multiple automobile accidents in one contract year. Or, in the case, of some insurance coverage of the World Trade Center, multiple airplane crashes in one coverage year.

The second is the severity of claim. For insurance against living or dying, the insured amount is generally known in advance. For general insurance, the amount of an insurance claim is generally not known in advance, although the maximum potential claim amount may be known, depending on the contract/coverage.

Skewness can also arise from interdependencies/concentrations in the frequency/severity of the insured exposures (also see Section 6.7). For example, if certain events trigger claims or affect the value of claims for multiple contracts at the same time, such a key judicial ruling that affects a significant portion of the unsettled claims, the distribution of total losses tends to become more skewed.

Another source of skewness can arise in situations where the structures and assumptions for events around the center of the distribution break down in the tail. An example is demand/surge inflation, where building costs increase significantly for large property catastrophes, as the demand for building products (and "labor") to rebuild the damaged property outstrips the supply, resulting in increased claim values for a given level of damage absent the demand/surge phenomena.

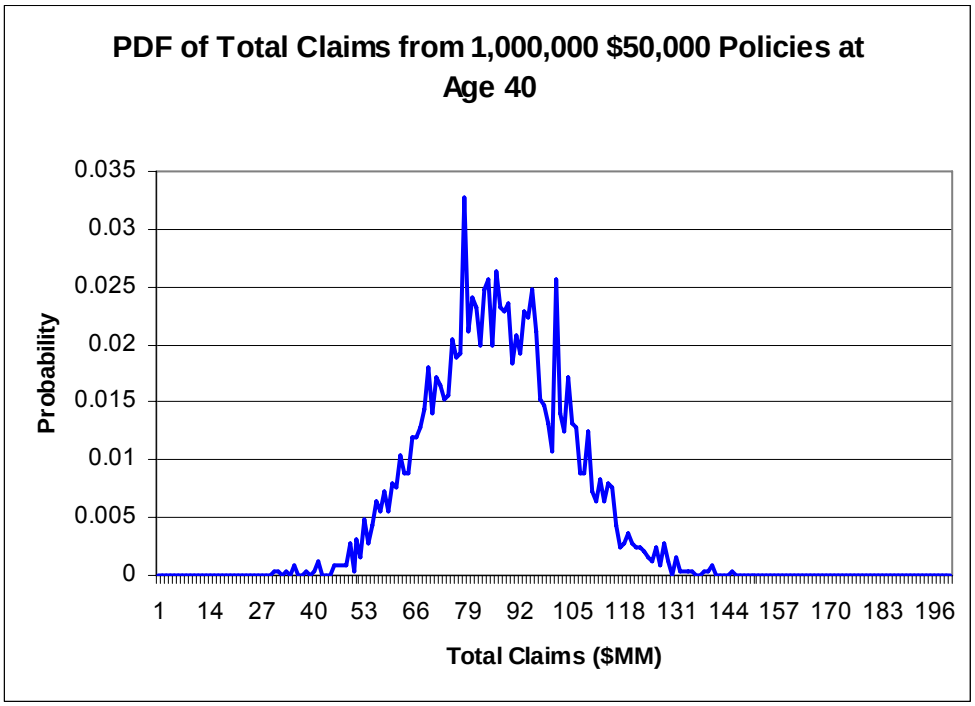
For general insurance, the amount of the insurance claim may frequently not be known when the insured event is reported to the insurer. Instead, the amount may be subject to frequent re-estimation based on a developed history of claim settlement, which itself can be affected by judicial rulings.

In general, when insurance is offered to similar risks for similar amounts, the probability distribution of the liability tends to move towards the normal distribution and have a less skewed probability distribution as more lives are insured and the underlying risk is known. If the risks are uncorrelated, the normal distribution is the limit of this process. Insurance risks, however, are almost always correlated to a greater or lesser degree, so the limiting distribution retains some, and often considerable skewness.

6.7 Examples of skewness and comparison of distributions

Consider a life insurer that only issues term contracts for $50,000 to non-smoking males aged 40 that has 1 million such contracts in force with one year to run. The following graph represents the probability distribution of the remaining liability obtained from 2,500 simulations. Note that the 99.5% confidence level is at 2.6 standard deviations (i.e. only slightly higher than the normal curve 99.5% confidence level of 2.58 standard deviations)

Chart 6.5 PDF of Total Claims from 1,000,000 $50,000 Policies at Age 40



If a similar life insurer were considered that issued only similar contracts for $5,000,000 and had only 2,000 such contracts in force (i.e., one fifth the amount of sum assured as the first insurer), the simulated probability distribution of the liability would tend towards the normal distribution; but the curve would be more "ragged" reflecting a lesser amount of pooling.

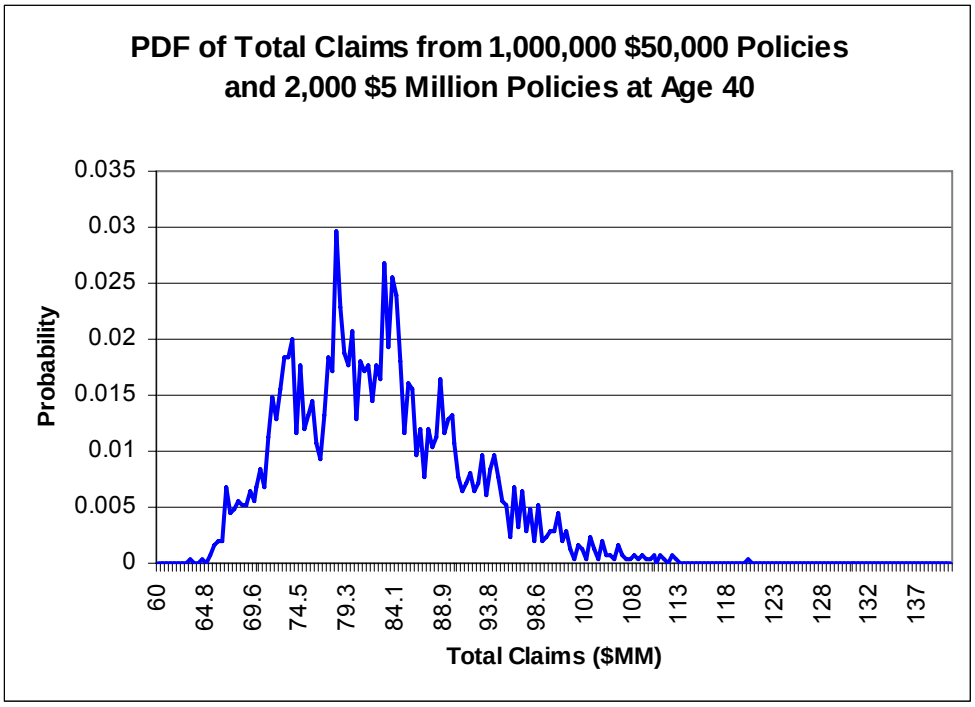
Now, consider the probability distribution of an insurer that has business in force equivalent to the sum of the first two insurers. The probability distribution of the liabilities has become skewed to the right[20] reflecting the fact that a small difference in death claims from the large contracts can "overwhelm" the expected claims from the large number of smaller contracts. Note that even a small increase in granularity, such as by adding

[20] The PDF that results from combining different sized policies to identical insured risk is called a Compound Poisson distribution.

2,000 very large contracts to 1,000,000 small contracts, can cause the 99.5% confidence level to “shift right” to the 3.08 standard deviation level (i.e. close to the “typical insurance” probability example created above).

While the result might not be intuitive, what has happened is a loss of the “pooling” effect (i.e. the predictability from the large pool of small contracts is “overwhelmed” by the unpredictability of the small pool of very large contracts).

Chart 6.6 PDF of Total Claims from 1,000,000 $50,000 Policies and 2,000 $5 Million Policies at Age 40



A life insurer offers many different types of insurance and annuity contracts to insured lives of different risk characteristics for different sums assured. The “granularity” of the risk distribution by items such as age, sum assured and contract type will determine the amount of skewness of the insurer’s probability distribution of its liabilities (before consideration of industry wide systemic risks and exposure concentrations). If increasing homogeneity of risk leads to a probability distribution being close to “normal," increasing granularity leads to a probability distribution being increasingly skewed.

Table 6.7 describes some properties of some of the distributions illustrated in this section

Table 6.7 Summary of Standard Deviations at Various Confidence Levels

Curve	Skewness (gamma)	Confidence levels (number of standard deviations required to reach required level of confidence)		
		99%	99.5%	99.95%
Normal	0.00	2.33	2.58	3.29
Well behaved	0.42	2.60	3.00	4.00
Longer tail	0.95	3.00	3.5-	4.80
Extreme event	8.00	8.20	10.1	16.4

6.8 Quantile method

Table 6.8 shows the Quantile levels implied by the same distributions used in Section 6.5 for purposes of setting capital levels. We illustrate the quantile levels of 65%, 75% and 90% because these are levels sometimes considered appropriate for regulatory purpose.

Table 6.8 Quantile levels for various degrees of skewness

Curve	Skewness (gamma)	Quantile level (number of standard deviations required to reach required level of confidence)		
		65%	75%	90%
Normal	0.00	0.39	0.67	1.28
Well behaved	0.42	0.33	0.64	1.33
Longer tail	0.95	0.25	0.59	1.38
Extreme event	8.00	negative	negative	2.13

As with the number of standard deviations used for capital setting, these quantile levels can be converted to percentages of the current estimate if we know the coefficient of variation, and it can be converted to percentages of premium is we know the ratio of liabilities to premiums.

Assuming a coefficient of variation equal to 10%, then the longer tail quantile levels are equivalent to a risk margin of 2%, 5% and 13% of the current estimate for the longer tail distribution.

These results can be illustrated in more detail by considering two general insurance examples:

Table 6.9 Capital and Quantiles as Percentages of Current Estimates

	Item	Medium Tail-- Commercial Auto	Longer Tail- Liability / Reinsurance
a	Skewness	0.42	0.95
b	Equivalent log normal CoV	13.9%	30.7%
c	65th percentile	4.5%	7.7%
d	75th percentile	8.9%	18.1%
e	90th percentile	18.5%	42.4%
	Notes:		
	(b) Appendix D shows conversion from skewness to CV		
	(c), (d), (e) CV times Table 6.8 number of standard deviations		

Table 6.9 provides a sense of scale for the quantile points relative to the current estimates. Note that the quantile levels do not reflect the effect of diversification between lines of business. If diversification effects were to have been considered, the corresponding quantile levels would be lower.

Further research is needed to assess equivalent levels of quantile that are consistent with standards and guidance provided by the IAIS and the IASB.

6.9 Cost of capital method

The cost of capital method has several important elements to consider, including the identity of the entity for which the risk margins are designed to be applied to (remember, the inherent risks of the portfolio are always relevant), the type and method of deriving the amount of capital, the estimated amount of future capital needs over the remaining life time of the obligation and the capital's cost. The following sections discuss these significant factors in this method.

6.9.1 Reference entity

Before a cost of capital method can be applied, the fundamental question of the entity to which the capital should relate to needs to be answered. To be consistent with an exit value approach, it is reasonable to construct a reference entity to which the portfolio would be transferred. As a result, the reference company is preferred to the reporting entity. In addition, the use of a reference would promote increased comparability between preparers' financial statements.

If there were a deep liquid market, there would be no need to understand the nature of buyer of an asset or an obligation. The price would be determined by the market; end of story. However, as we are modeling the price that would be required by the entity to which the net obligations will be transferred, the relevant characteristics of the entity need to be defined.

While the choices to be made are discussed below, a focus will be on a *reference company* that is a large, multi-line, diversified, and highly rated insurer with business similar in nature to the portfolios subject to the valuation.

1. "Large" means large enough that "process risk"[21], fluctuation about the expected value, is as small as practical. For many types of insurance, given that the reference company is large, process risk will be negligible compared to parameter and model risk. Process risk may be significant for some coverages, e.g., property-catastrophe and high-layer excess property or liability coverages. Parameter and model risk for the reference company is not expected to be small.
2. "Multi-line, diversified" means the realistic benefits of risk diversification across portfolios and territories (including within and between countries to the extent that such diversification is observed in the market) are recognized in determining capital, cost of capital, variability in liabilities, margin setting, and other parameters.
3. '"Highly rated" means having resources that equal or exceed that of a typical insurance company, for example, an AA rating, that might depend on the types of business involved. It means a company with "minimum statutory surplus" would not be consistent with this example[22].
4. "Business similar in nature" means that determination of the characteristics of the reference company is based on a review of an appropriate set of companies that are in the same business.

As the use of a reference company that cannot be observed is relatively new, further research and discussion are warranted to refine the concepts outlined here. [I believe that this is an illusion and basing a valuation basis on this concept is not real world and cannot be calibrated to anything in the real world.]

Reference to the financial strength of an insurer is used elsewhere in this paper. For the purpose of this report, we designate the following:

- An entity just meeting (minimum) regulatory requirements has a BBB rating, having a 99.5% capital factor. This is consistent with the

[21] In the IAA *Blue Book* the concepts of "risk" and "uncertainty" are defined. Risk means the variability in outcomes in a process that is fully understood, e.g., the result of rolling a pair of fair dice. "Uncertainty" means the additional variability in outcomes that occurs because the process is not fully understand, the model used might be incorrect to some degree and/or the actual model parameters will vary from the estimated parameters. As the term "risk" is used in other ways, e.g., risk margin" in this report, the term "process risk" is used to refer to risk as defined in the *Blue Book* and "parameter and model risk" refers to uncertainty as it was defined in the *Blue Book*.

[22] The examples suggest that the choice of financial strength level may not be significant if cost of capital is selected on a consistent basis, as cost of capital will increase as financial rating deteriorates.

assignment of a rating as given in the Swiss Solvency Test and the direction that the European Union's Solvency II project appears to be taking.

- An "average strength insurer could be characterized by an A rating, which in a similar manner implies a 99.9% capital factor.
- An "above strength insurer" refers to a AA rated entity, in practice is often currently assigned a 99.95% or 99.97% factor. The former is used to illustrate the high quality company in this paper.

Some important implications of the transfer value approach include the following:

1. The entity's own portfolio should be examined to determine the portfolio risk characteristics, but the amount of capital and the cost of capital needed for this analysis are the capital amount and cost of capital required by the reference entity taking on the obligation. They are not the capital amounts or cost of capital that might be required by the entity for regulatory purposes.
2. If a quantile approach is used to produce a risk margin that is appropriate as an exit value estimate, the way in which the ceding company's portfolio affects the quantile of the reference entity needs to be analyzed, not the quantile of the ceding entity. This perspective on quantiles is different from that applied in, for example, in Australia under APRA. The Australian quantile approach is applied to the entity's own obligations. In the Australian context, a small company would have a larger risk margin than a larger company, even if the small company underwrote exactly the same types of risks.
3. Use of a reference company in either of the cost of capital or quantile methods seems consistent with the current IASB and IAIS directions noting that the measurement of the liability should be independent of the entity that holds the obligation.
4. The experience of the appropriate segments of the industry needs to be analyzed, e.g., large companies, to establish quantile, capital or cost of capital amounts appropriate for modeling the risk margin.
5. Individual company analysis, such as economic capital models, may be relevant if the company is large enough and similar enough to the reference company. But essentially the use of the entity's experience data as a proxy for the proper reference entity analysis does not constitute an improvement, but rather is a practical expedient.
6. Not withstanding the use of reference company information to determine the risk margin, the company's own variability, size and extent of diversification is relevant for regulatory purposes.

In summary, assumptions for the cost of capital model, if applied in the reference entity context, is derived partly from the model of the reference entity and partly from the reporting entity.

The information that should come from the reference entity includes the following:

1. Capital requirements by line of business, reflecting the degree of diversification in the reference entity that has been agreed should be included in the model.
2. Information on line of business variability implied by the reference entity capital levels, so that reporting entity experience can be compared to the reference entity.
3. The cost of capital.

The information that should come from the reporting entity, in addition to current estimates, includes the following:

1. Payment patterns
2. Capital by line of business, before and after adjustment for diversification effects.
3. Variability in line of business results, perhaps measured by coefficient of variation and skewness data

Depending on the treatment of reinsurance, it may be necessary to have two reference entities, one to evaluate liabilities on a net of reinsurance basis and one to evaluate the corresponding portion of the liabilities that are ceded.

It is reasonably clear how the information from the reporting entity could be developed. It is less clear how the necessary information on the reference entity would be obtained. Approximations based on the information collected by regulators for risk-based-capital analyses, including the information that might be collected under the current CEIOPS effort (see CEIOPS (Consultation Paper No. 20 (2006))), may be the most practical source.

Although the reference company does not have to be an insurance company, if it were not structured to meet policyholder obligations in essentially the same way that an insurer is required to meet the obligations, then it would probably not meet regulatory requirements for a transfer.

6.9.2 Capital

The determination of the amount of capital is an important factor in the implementation of the cost of capital method. The IAA has provided

guidance with respect to this factor in its *Blue Book*, with a safety factor as determined by market actions (e.g., an A or AA rating).

Two important items that need to be discussed are what capital is needed and what simplifications can be used for the measurement of the capital:

1. The amount of capital is for nonhedgeable risks only (see Table 4.1, the IAIS *Structures Paper* (2007), Ruygt (2006) and CFO Forum (March 2006) for further details).
2. In case an insurer is unable to assess the capital based on the total financial resources concept referred to in the *Blue* Book that an insurer may have to hold a certain amount of capital as a result of a set of benchmark capital ratios (or factors). An example is the standard capital requirement (SCR) being discussed in the context of Solvency II. Depending on how it is constructed, the benchmark could represent the amount appropriate for a satisfactorily well capitalized entity that might be a representative marketplace purchaser. However, in considering the use of such a ratio or capital based system to derive risk margins, care should be taken to ensure that the ratios or factors reflect what the market does in fact expect. Otherwise, the resulting risk margins will not meet the IASB objective of reflecting what the market charges to assume risk. For example, in Canada, it is observed that the infrequent market transactions that do occur tend to reflect a multiple of the minimum risk based capital where the multiple reflects capital ratios typical of those desired by marketplace purchasers.

In addition to the wide body of literature and models that have been used to indicate appropriate levels of economic and regulatory capital, this is a fertile field of current study. These can be useful indicators or in fact surrogates as appropriately modified. The quality of models available by insurance line has varied considerably, and further work in the area of modeling is encouraged. Section D4 discusses a few property & casualty insurance specific cost of capital issues.

The following current developments suggest that global consistency between internal models used by insurers may be achievable in a relatively short time frame:

- The CRO Forum has undertaken a benchmarking study between its members indicating that there is high level of consistency in the models used by its member companies;
- The IAIS has undertaken to develop a principles based paper on internal models;
- The IAA, at the request of the IAIS, is developing a paper on the assessment of internal models, with a recent draft issued prior to its public exposure; and

- Standard & Poor's has issued a paper in the assessment of internal models in use by companies rated by S&P.

It should be noted that the cost of capital refers to a market consistent amount of capital. Hence this economic capital would normally be expected to be greater than the minimum amount of capital required to be held by an insurance supervisor.

6.9.3 Future capital needs

For the cost of capital method, both the amount of capital at the valuation date and the capital for each applicable time in the future are needed. As a result, an important issue is to project the level of future capital over the remaining term of the obligation.

The Federal Office of Private Insurance (2006) examined the initial experience with the Swiss Solvency Test. With regards to the determination of future capital needs it stated:

> "Determine the SCR for years 1, 2, until the run-off of the portfolio. The SCR takes into account only run-off risks, not current year risks since no new business is assumed. To calculate the future SCR, several possibilities exist:
>
> ~~1.~~a. Do a full SST given the projected assets and liabilities and risks, for each year 1, 2, … Do not take into account any future new business.
> ~~2.~~b. Assume that the run-off risk is proportional to the best estimate of technical provisions and project the insurance risk part of the SCR for year 1, 2, … given the SCR for year 0 and the best estimate of technical provisions at t=0."

In addition, the CRO Forum (2006) discusses the projection of future capital needs in the context of the cost of capital method.

The assumption that future capital needs is a constant percentage of the current estimate or the risk margin may not be appropriate. In particular, this is important for property & casualty claim liabilities, although the underlying concepts also apply to other insurance risks. For property & casualty claim liability, cost of capital examples have tended to assume that the risk level is sufficiently similar by age of claim that capital (or capital plus risk margin) as a constant percentage of current estimate is appropriate. Contrary to that assumption, two factors make it likely that the probability distribution function for “late claims” would have a higher coefficient of variation and skewness than would the probability distribution function of the entire set of claims. First, the late settled claims are different than early

settled claims, e.g., larger, subject to more disputes and more variability. Second, late settled claims will be more subject to uncertain economic effects, e.g., inflation, social inflation, and judicial activity, which increase the uncertainty in the estimate.

The details of how capital requirements change over time in an aging cohort of claims needs further study, but experience suggests that the assumption of uniform capital requirements as a percentage of the remaining liability will likely understate the capital requirement. As a result, the capital needed over time needs careful review on a regular basis and may depend on the type of business and risk involved.

Table 6.10 shows some property & casualty insurance examples of the indicated risk margin as a percentage of the current estimate for various combinations of capital as a percentage of the current estimate, change in the capital percentage (applied to the current estimate), and as an example the cost of capital used in an application of a methodology underlying the Swiss Solvency Test Market Value Margin calculation. Appendix D describes the methodology and shows further details of the calculation.

These examples show that the pattern of future capital needs can significantly affect the risk margin determined by the cost of capital method. Further research will be needed to provide suitable measurements of change in the risk distribution for claims by age. The constant percentage should not be used unless an entity demonstrates that it is appropriate in the particular context applied.

Table 6.10 Effect of alternative ways to project future capital for use with the cost of capital method

		Medium Tail		Longer Tail	
Assumptions		Capital %		Capital %	
Initial Capital %	Cost of Capital	Constant	Increase 10 % per year	Constant	Increase 10 % per year
35.0%	4.0%	2.5%	2.7%	6.9%	9.9%
35.0%	6.0%	3.8%	4.1%	10.3%	14.9%
35.0%	10.0%	6.3%	6.8%	17.2%	24.8%
70.0%	4.0%	5.1%	5.4%	13.7%	19.8%
70.0%	6.0%	7.6%	8.1%	20.6%	29.7%
70.0%	10.0%	12.6%	13.5%	34.4%	49.5%

Notes: Risk free rate = 4%
Payment patterns from Table 6.1
Capital is a constant or uniformly increasing percentage of current estimates regardless of risk margin.
Method shown in more detail in Appendix D

Table 6.10 shows that, assuming a 35% capital level and a 6% cost of capital, the risk margin for the longer term example is 10.3% if capital is a constant percentage of the current estimate and is 14.9% if capital, as a percentage of current estimate, increases 10% per year. For the medium term line the corresponding risk margins using the same assumptions are 3.8% and 4.1%. Thus, with increasing capital percentages over time, the risk is about 40% higher for the longer-term line and 10% higher for the medium term line.

These illustrations assume that either (a) capital is a fixed percentage of the current estimate or (b) capital is a percentage of the current estimate, where the percentage increases at a fixed rate each year. The impact on capital over time could be more complex than that. For example, capital related to the risk of latent injury claims would be related to time elapsed since the exposure date, but would not be related to the current estimate.

As shown in the examples above, the pattern of future capital can significantly affect the risk margin determined from the cost of capital method. Further research is needed to provide suitable measurements of change in the risk distribution over time. The constant percentage should not be used unless an entity demonstrates that it is appropriate in the particular context applied.

6.9.4 Cost of capital

Implementing the cost of capital method requires determination of the cost of capital from the perspective of the transferee. The cost of capital for this purpose is the before-the-event target intended to produce a desired after-

the-event pre-tax return the capital as indicated in 6.9.2 in a market consistent form.

In discussions of the cost of capital method, 4% and 6% have typically been used to illustrate the method. 6% is used in the example provided in the Swiss Solvency Test described as the cost of capital associated with a BBB company and that has sometimes been used in conjunction with the capital level of a BBB rated insurer.

The cost of capital, as used in the cost of capital method, is the pre-tax return required by the transferee applying an assessment of capital on a market consistent basis. It does not refer to the firm's cost of capital, rather to the capital needed for the unhedgeable risks. This might be determined in a number of ways including:

1. Judgment
2. Analysis of historical returns on book value
3. Market value analysis.

Judgements are useful for testing the reasonableness of the results, but not a desirable source of information for calibrating models to be used for financial reporting. Historical return data might be collected, but these would need to be calibrated to current financial conditions.

Market value analysis appears to be what commentators have in mind in discussing a market-based approach to cost of capital analysis. There are two issues here. First, what is the cost of capital required by external markets based on the market value of the reference company? Second, what is the internal return on capital that the reference entity must target in order to achieve the market cost of capital on market value?

There are a number of well-known methods for establishing market cost of capital. The Capital Asset Pricing Methodology (CAPM) is perhaps the best known. Other methods include the Arbitrage Pricing Model (of which the Market Consistent Pricing Model is one variant), multi-factor versions of CAPM of which the Fama-French 3 Factor Method (FF3M) is perhaps the most well-known, and Discounted Cash Flow (DCF) methods.[23] Unfortunately, these methods do not necessarily produce consistent results.

A market based cost of capital then needs to convert the investor expected return on market value into an internal return on capital for the reference company. The issue is discussed in depth in Hitchcox (2006) and Swiss Re (2005). As with the cost of capital analysis, results vary.

This report does not contain a recommendation concerning the proper level of cost. Rather, its examples are for illustrative purpose only, using costs

[23] Cummins, J.D., & Phillips, R.D. (2005)

that have been used by others for this purpose. Observations regarding the cost of capital follow:

1. Sources of information on the value for cost of capital include business judgment, history of returns on book value, and market analysis.
2. The cost of capital is not the same as the after-tax return on market value that is sometimes determined from methods such as the Capital Asset Pricing Method (CAPM). The market cost of capital must be adjusted to produce values relevant to the cost of capital method, which does not reflect the individual firm's cost of capital and its franchise values.
3. Recent literature on market cost of capital includes Sigma (2005), and Cummins and Phillips (2005). Recent literature on converting market cost of capital into pre-tax return on book value that can be required to be used as a starting point for the calculation of the cost of capital method include Feldblum (2006), Hitchcox (2006) and Sigma (2005). Note that these models generally reflect the firm's cost of capital and its franchise value.
4. Whatever the standard for determining cost of capital for a particular insurance company, the appropriate method of converting that for purposes of a reference company used for modeling the risk margin to be used for financial reporting needs to be established.

Various parties, including the IAA, have volunteered to participate in work to help determine an appropriate method for establishing cost of capital for purposes of determining the risk margin.

6.10 Comparison of the three potential risk margin methods for short, medium and long term insurance liabilities associated with four levels of skewness

Consider if the total financial resources were to be determined at the 99.5% (1 year) quantile level as representative of the insurance industry's average quality with a 6% cost of capital (as in the Swiss Solvency Test). Consider, in the alternative, if the total financial resource objective of a AA rated insurer were to be determined at the 99.95% quantile level with a 4% cost of capital. What amount of liabilities would be determined for the illustrative short, medium and long term obligations if the probability distributions of their liabilities were to be that illustrated by the normal, typical insurance, long tailed liability and extreme event probability distributions illustrated above?

6.10.1 Insurance examples – cost of capital and quantile methods compared

Tables 6.11A and 6.11B show how risk margins[24] developed by the cost of capital method compare to corresponding quantile results. Short, medium and long term obligations are examined, with normal, typical insurance, long tail and extreme event probability distributions. Section 6.10.1.1 is for an insurer with resources at the 99.5% level, say a BBB rated insurer. Table 6.11B is for an insurer with resources at the 99.95% level, say AA rated insurer.

6.10.1.1 BBB rated insurer

The first line of Table 6.11A shows the cost of capital result in terms of the number of standard deviations for short, medium and long term obligations that have normal, typical insurance, long tail or extreme event probability distributions. The number of standard deviations is then converted to quantile results.

Table 6.11A* Translation of cost of capital method into quantile method cost of capital based on a 99.5% capital and a 6% cost

[24] As has been often discussed at IAIS committee meetings, the application of the cost of capital method to solve for risk margins involves "circular logic" in that the required capital is itself dependent on the level of risk margin above the current estimate for any given total financial resource objective. However, simple recursion techniques cause rapid convergence in the process of determining the risk margins. In contrast, the capital level used is economic capital associated with a reference entity that is independent of regulatory capital of the entity, then this circularity does not arise.

	Normal	Typical	Long-Tail	Extreme
Short term				
#standard deviations	0.239	0.276	0.322	0.938
Gamma	0.00	0.42	0.95	8.00
Quantile	59%	63%	67%	84%
Medium term				
#standard deviations	0.618	0.713	0.832	2.425
Gamma	0.00	0.42	0.95	8.00
Quantile	73%	77%	81%	91%
Long term				
#standard deviations	0.809	0.934	1.089	3.274
Gamma	0.00	0.42	0.95	8.00
Quantile	79%	83%	86%	94%

*Runoff period
Short term 4 years
Medium term 10 years
Long term 30 years
(Life patterns from Table 6.1)

Degree of uncertainty (probability distribution type)
Normal Based on a normal distribution to indicate the lower limit to volatility (does not exist in the real world)
Typical Distribution for an average to large size insurer with "normal" products
Long-tail Distribution for a smaller insurer or an insurer with a higher risk profile
Extreme Distribution for extreme event risks (not the worst case)

As can be seen in Table 6.11A, in general for insurers with the identical total financial resource objectives, the longer the term of the obligation, the higher the quantile of the liability associated with the resulting risk margin. Similarly, the more volatile the probability distribution, the higher the quantile that the resulting risk margin represents.

We also observe that the cost of capital methodology leads to risk margins that are generally in the 2/3 to 1 standard deviation range of the expected value for medium and long term obligations, which is often discussed as an appropriate range by those who favor the quantile method. On the other hand, the level of risk margins generated by the cost of capital method for the short term obligation expressed in terms of standard deviations is well below the 2/3 to 1 standard deviation range.

This raises the question of whether a fixed quantile or other statistical measure of risk objective is appropriate for all liabilities regardless of term or tail. It might be appropriate to set lower quantile objectives for short term obligations, higher quantile objectives for medium term obligations and still higher objectives for the longest term obligations. In addition, consideration might be given as to whether the quantile objectives should vary to reflect what is known of the volatility of the insurance liability.

Moreover, for an insurer with a mix of business of varying terms and tails, reasonably consistent results could be obtained by applying either the quantile method at an average level (say, the 75% level of confidence) or the cost of capital method across the entire book of business. However,

selectively applying the quantile method to some types of contracts (or lines of business) while applying the cost of capital method to other types of contracts could lead to inconsistent results. For example, applying the cost of capital method to short term obligations and the quantile method to long term obligations could lead to either an understatement or overstatement of the appropriate liabilities for an insurer's entire business in force.

Nevertheless, an assessment should be made of the most appropriate risk margin approach, reflecting the views of a potential transferee for the unit of account, although this would result in inconsistently derived risk margins for the entire entity.

Over time the explicit confidence level implied by the margins in Table 6.11A will change as the term of the obligation reduces, even without a change in the market's appetite for risk. For example, an initial medium term obligation with a typical skewness, with an explicit confidence level of 76% at issue, will after, for example, 5 years, move to a short term obligation where the explicit confidence level (implied by the risk margins as calculated by the cost of capital approach) would be 60%. This effect can be seen (in an indirect way) in the comparison shown in Appendix B, Tables B.1, B.6, and B.10.

Overall, Table 6.11A might be interpreted to suggest that the level of confidence sought by an insurer using the quantile method might be set at (roughly) 60% for short term obligations, 75% for medium term obligations and 85% for long term obligations in this example[25]. Note that the use of three levels would be somewhat problematic for practical and conceptual reasons, particularly with respect to the categorization of risks. As a result, a single average percentile might not be appropriate for its application.

[25] For "fat tailed" liabilities or for "extreme long tailed" obligations (such as may occur in some common reinsurance products), the 80% confidence level may not be appropriate. There are many examples of insurance contracts for which the 80% confidence level is zero. For these contracts, CTE should be considered as the confidence measure – and the longer the tail; the higher the CTE level that might be appropriate e.g. CTE 80 has been used as a benchmark for certain minimum death and maturity benefit coverages for products backed with investments in equities.

6.10.1.2 AA rated insurer

While it might seem to lead to more consistency to require all insurers to establish risk margins using a reference insurer such as the insurer illustrated in Table 6.11A, there might be something to be said for allowing insurers with ratings greater than the BBB level to use internal models based on a AA rating, on the basis that the risk margins so produced might be more "market consistent" and more comparable to a more likely transferor or purchaser.

Table 6.11B illustrates the same information as Table 6.11A for the cost of capital method corresponding to a total financial resources objective at the 99.95% level and a 4% cost of capital.

Table 6.11B* Translation of cost of capital method into quantile method cost of capital based on a 99.95% capital and a 4% cost

	Normal	Typical	Long-Tail	Extreme
Short term				
#standard deviations	0.209	0.253	0.308	1.041
Gamma	0.00	0.42	0.95	8.00
Quantile	58%	62%	67%	84%
Medium term				
#standard deviations	0.594	0.718	0.874	2.959
Gamma	0.00	0.42	0.95	8.00
Quantile	72%	77%	82%	93%
Long term				
#standard deviations	0.829	1.004	1.220	4.130
Gamma	0.00	0.42	0.95	8.00
Quantile	80%	84%	88%	95%

*Runoff period
Short term 4 years
Medium term 10 years
Long term 30 years
(Life patterns from Table 6.1)

Degree of uncertainty (probability distribution type)
Normal Based on a normal distribution to indicate the lower limit to volatility (does not exist in the real world)
Typical Distribution for an average to large size insurer with "normal" products
Long-tail Distribution for a smaller insurer or an insurer with a higher risk profile
Extreme Distribution for extreme event risks (not the worst case)

Compared to those indicated in Table 6.11A, risk margins would be less for short term liabilities with a normal probability distribution or a typical insurance probability distribution, but slightly higher for long tail obligations. For medium term obligations, the risk margins would be about the same as for the BBB rated entity (although higher for long tail liabilities). For long term obligations, the risk margins would be about the same as for the AA level insurer for "well behaved" obligations but higher for typical insurance and long tail obligations.

These calculations tend to lend support to the empirical observation by the co-chairperson of the IAA's Insurance Accounting Committee at the January IAIS Brussels meeting that the results of applying the cost of capital methodology assuming an BBB rated insurer with a 6% cost of capital, are about the same as the risk margins that result from assuming a AA insurer (99.95% confidence) with a 4% cost of capital.

6.10.2 Property & casualty (general) insurance examples – liabilities with risk margins based on the cost of capital and quantile methods compared with undiscounted liabilities

Table 6.12 shows how the current estimates plus risk margins compare in the various approaches. To provide a sense of scale, the current estimate before discount (i.e., the undiscounted liability) is also shown.

Table 6.12 Comparison of risk margin results

Current estimate + specified risk margin	Medium term	Longer-term
1. Skewness	Gamma=0.42	Gamma=0.95
2. Equivalent CV	13.9%	30.7%
3. Discounted current estimate (i.e., without risk margins)	100.0	100.0
4. Liability based on cost of capital with capital % increasing 10% annually	104.1	129.7
5. Liability based on 65th quantile	104.5	107.7
6. Liability based on 75th quantile	108.9	118.1
7. Liability based on 90th quantile	118.5	142.4
8. Undiscounted liability	107.7	123.4

Notes:
Quantile results from Table 6.9.
Cost of capital results from Appendix D3.

The liability for the medium and longer term policy based on the cost of capital results on line 4 corresponds to quantiles of 64% and 84%, respectively. If a constant level of capital were assumed for line 4, the liability would be 103.8% and 120.6% of the current estimate for medium and longer-tail business, respectively. This is not shown in the table, as a different capital assumption would imply a different risk distribution, resulting in different estimates for the liability based on the quantile approach.

The "well behaved" example with skewness of 0.42 corresponds to what might be expected in a commercial automobile third party liability line of business. The "longer tail" example with skewness 0.95 corresponds to

what might be expected from a relatively higher risk liability or relatively low risk reinsurance.[26]

6.11 Qualitative comparison of the three methods

The following qualitative discussion regarding the three methods of determining risk margins can be categorized into practical modeling issues and the theory involved.

Practice
From a practical perspective, the use of either of the quantile method or the cost of capital method has considerable merit when there is sufficient data and resources with which to construct credible (i.e., sufficiently reliable) internal models of the insurance risks to which it is exposed. The examples provided suggest that if the quantile objectives are modified to reflect the term obligation and the tail of the liability, that and the cost of capital methods will produce reasonably consistent results.

A question can be raised about how a new risk margin system could be made to work for those insurers that do not have either the necessary data or the internal models on which to base the quantile or cost of capital calculations that rely on determining appropriate probability distribution. Just as under Basel II, an explicit risk margin methodology might have a place as a default mechanism for those insurers that do not possess such internal models or resources. As can be seen, robust guidance for professionals involved as to the level of risk margins in the default mechanism is possible to ensure that the risk margin calculations of insurers that cannot develop either the data or the internal models are reasonably consistent with, but modestly more conservative than, those developed by insurers whose internal models are acceptable.

The tabular factors that will likely be applied by insurers using a default methodology might be more robust if they were developed reflecting more granularity by using an explicit assumption assessment of risk rather than just a single factor applied to the current estimate, e.g., reflecting separate assumptions about key variables such as claim frequency distribution, claim severity distribution, combined frequency and severity distribution, claim development, policyholder behavior, etc. The more granular models might be expected to be more consistent with the general purpose and regulatory reporting objectives of reflecting both market forces and prudential objectives than single factor systems. The development of such multi-factor

[26] The *Blue Book* identified the level of coefficient of variations that might correspond to certain lines of business. The translation to line of business given above is based on that information and several of the contributors to this paper.

tabular models for determination of risk margins is beyond the scope of this paper.

If risk margins are to be based on characteristics of a reference entity, then industry studies of the reference entity characteristics would be required. Individual companies would still need to consider the characteristics of their own portfolios, but the reference entity information would provide the default information for the smaller entities.

While in theory these comments apply to both quantile and cost of capital methods, the work done with respect to risk-based capital models leads to the conclusion that currently the cost of capital approach with benchmark capital and cost of capital levels may be somewhat more practical than quantile methods.

Theory
Conceptually, the cost of capital method provides a logical framework for establishing the measurement of the liabilities of insurance contracts in a way that theoretically yields consistency between the measurement of the liability of insurance and investment contracts, as well as between assets and liabilities in each entity's financial reports and consistency between financial reporting between insurance and other industries.

In the cost of capital method, the determination of probability distributions is not strictly needed, provided the capital is appropriately calibrated to capture risk, an approach currently being assessed in the Solvency II project.

The theory underlying quantile approaches, i.e., establish liabilities that are large enough to have a selected probability of being sufficient, is logical. However, as shown in the examples, to achieve consistency between lines and types of business, the level of quantiles can differ significantly, and hence may require robust guidance for the professionals involved. Also, quantile approaches may not produce consistency between assets and liabilities or between insurance and other industries.

The assumption approaches, especially if the risk margins are explicitly determined, can also produce liabilities that meet selected criteria and are consistent across insurance entities. However, the assumption approach will not necessarily produce consistency between the measurement of assets and liabilities or between insurance and other industries.

Knowledge regarding and experience with these risk margin approaches differ significantly by jurisdiction. The IAA encourages continued research and development of their practical applications, as well as effective communication of their results.

7. Risk Mitigation Techniques

In paragraphs 30 – 33 of the IAIS *Second Liabilities Paper*, the concept of "Allowance for pooling of risk" is considered. On pages 4 and 5 of its May 19, 2006 letter to the IAIS concerning the then draft *Second Liabilities Paper*, the IAA raised the somewhat broader issues of "offsetting risk," "diversification" and "reinsurance" in addition to "pooling." The IAA noted at that time that how to handle these various risk mitigation techniques in the measurement of liabilities of insurance contracts, as well as in total financial resources should be discussed further.

In the meantime, it has become apparent that the issue of risk concentration (i.e., the opposite of risk diversification) should be considered at the same time and is addressed in Section 7.6. Note that a "pool" and a "portfolio of obligations" are used here synonymously.

Each issue addressed in this section is discussed from the perspective of the reporting entity for the measurement of liabilities the determination of capital levels for solvency purposes that depend on the portfolio characteristics, as well as from the perspective of a reference entity if a reference entity is used to determine risk margins, in whole or in part.

7.1 Pooling

To the extent that pooling refers to similar insurance risks that are similarly managed, its effect should be reflected in both the measurement of liabilities for both general purpose and regulatory purposes, as well as to satisfy total balance sheet requirements.

Open questions with respect to pooling include the extent to which a lack of pooling should be reflected and how it should be reflected. This has been the subject of considerable discussion at IAIS committee meetings.

If the objective expressed in the IAIS *Second Liabilities Paper* that "similar obligations with similar risk profiles should result in similar liabilities" is interpreted to mean that a relatively small pool of risks in one insurer should have the same liability value as the same small pool of risks would have inside a larger pool of similar risks in a large insurer, the IAIS may have to consider establishing guidance regarding the reference market to be used for reflect this factor in calculating liabilities. This would mean that any required "excess" total balance sheet assets (risk based capital) would be the level at which the smaller pool would be reflected. Similarly, larger insurers with larger pools would be able to reduce their capital requirements rather than their liabilities.

If the objective expressed in the *Second Liabilities Paper* is interpreted to mean that a similar sized pool of similar obligations with similar risk profiles

would result in similar liabilities, the risk margin for a pool of obligations should be adjusted to reflect the credibility of the actuarial data available from the pool or that are relevant to that pool derived from other sources.

In contrast, the IASB has currently indicated that if a price for risk can be observed, it should be reflected in the value of liabilities. Therefore, to the extent that the market includes a price for a smaller portfolio, this price would be included in the risk margin. If, however, efficient markets did exist, the measurement of a transfer price of a pool of obligations would not be relevant. The use of a common reference entity (see section 6.9.2 for further discussion) eliminates the need to reflect the process risk associated with a small portfolio. Further research and discussion may be warranted in this area.

7.2 Reinsurance

In the current version of IFRS 4, the IASB decided that the appropriate accounting treatment for reinsurance was not to present the liability of insurance contracts net of the related reinsurance asset; but rather to present the liability for the direct written obligations and the corresponding reinsurance asset separately.

In its May 2006 meeting, the IASB Board considered this issue further as recorded in the IASB *Update*.

> "The Board discussed approaches to accounting for reinsurance contracts, and tentatively decided:
> - The measurement attribute for reinsurance assumed (inwards reinsurance) should be current exit value.
> - The measurement attribute for reinsurance assets (outwards reinsurance) should be current exit value.
> - For risks associated with the underlying insurance contract, a risk adjustment typically increases the measurement of the reinsurance asset, and is equal in amount to the risk adjustment for the corresponding portion of the underlying insurance contract. The Board noted that the conclusion on risk adjustments for reinsurance assets may also be relevant when the Board considers policyholder accounting after the Discussion Paper stage of the project.
> - The carrying amount of reinsurance assets should be reduced by the expected (probability-weighted) present value of losses from default or disputes, with a further reduction for the margin that market participants would require to compensate them for bearing the risk that defaults or disputes exceed expected value.
> - Given the Board's preference for using current exit value as the measurement attribute for insurance contracts, there is no need to

restrict the recognition of gains or losses when an insurer buys reinsurance.

- A cedant should recognize at current exit value its contractual right, if any, to obtain reinsurance for contracts that it has not yet issued. In practice, that current exit value may not be material if the cedant's contractual right relates to insurance contracts that will be priced at current exit value."

The issue can be simply illustrated. Consider the simple case of the insurer writing life insurance contracts up to $5,000,000, but only retaining $50,000 which was illustrated above. The block of reinsured insurance contracts will have "well behaved" probability distributions. The block of retained contracts will also have a "well behaved" probability distribution, although slightly less "well behaved". The direct written block of business will have a longer tailed probability distribution. The question is will calculating the risk adjusted reinsurance asset and the risk adjusted direct liability separately produce the "right" balance sheet effect?

Both the IASB and the IAIS appear to have recognized the desirability of incorporating risk margins that directly reflect the term and tail[27] of the risk assumed.

Although it is theoretically possible to determine the pools underlying the direct insurance liabilities and corresponding reinsurance assets independently ignoring any risk mitigation effect, both the IAIS and the IASB are expected to propose that the risk margin for the reinsurance asset be measured in a manner consistent with that of the corresponding direct insurance liability. Such an approach is well suited for the determination of the total financial resource requirement of an insurer. The risk margin can be calculated separately for the gross and net of reinsurance position of the insurer, with the difference representing the risk margin of the reinsurance asset, or for the net and ceded portions. This is more fully discussed in the IAA International Actuarial Standard of Practice, *Accounting for Reinsurance Contracts* (2007).

If not measured consistently, the reference entity might be different for the net or gross of reinsurance portions.

7.3 Offsetting risks

Offsetting risks is a risk mitigation technique that uses the negative correlation of the uncertainty associated with a second set of obligations or

[27] Term and tail are words used throughout this report and not words that have appeared in IASB or IAIS literature in respect of risk margins.

rights to reduce the risk for a first set of obligations or rights. A well known example would be whole life insurance contracts and whole life payout annuity contracts. The level of mortality for life insurance is different from the level of mortality for life annuities, reflecting both selection and anti-selection. However, the trend in mortality for insured and annuitants is highly correlated. An insurer that underwrites both life insurance and life annuities will have less uncertainty and experience less volatility than an insurer that only issues either type of insurance product.

There are two alternatives. The first is to ignore any risk mitigation effects in the measurement of the respective liabilities. The second is to reflect an appropriate reduction of volatility in each set of risk margin calculations for insurance and annuity liabilities. A discussion of the three main methods of risk mitigation (pooling, diversification, and hedging) is included elsewhere in Section 7.

The IASB's current conceptual framework seems to imply that effects at a level greater than the level of similar risks that are similarly managed, should not be reflected in the measurement of the liability, as it is a financial view that the effect of off-setting risks are not reflected in transaction prices by market participants. Thus, it would only be reflected as a reduction in capital requirements. Note that this view is not shared by all observers. This approach is consistent with the objective expressed in its *Second Liabilities Paper* of consistent methodologies for both general purpose and regulatory financial reporting purposes.

If however, it is determined that this off-setting of risks would be expected to occur in market participants, i.e., the reference company, it would then be appropriate to reflect off-setting in the reference entity in the application of the cost of capital method of the determination of risk margins.

7.4 Risk diversification

A risk or portfolio of risks is diversifiable if it is of sufficient size and type for which there are sufficient uncorrelated but dissimilar risks available to reduce the fluctuations caused by the risk or type of risk in a diversified portfolio.

If the decision with respect to off-setting risks is to measure the liabilities of insurance contracts independently, there is no case to be made for considering another option with respect to reflecting diversification benefits in liability measurement.

If the decision with respect to off-setting risks is to reflect their effect in the calculation of the risk margins that demonstrably reduce uncertainty and risk, the issue remains open with respect to reflecting diversification benefits

in liability measurement. This is because the benefits from diversification do not occur with respect to similar contingencies.

The IASB may find it difficult to accept that diversification benefits should spill so far over the "unit of account" when calculating insurance liabilities. This may make it more difficult to obtain consistent general purpose and regulatory financial reporting methodologies.

There is no actuarial reason for excluding diversification benefits in the determination of total financial resource requirements. Nor is there an actuarial reason for excluding diversification benefits in the measurement of liabilities. Note that some reflection of diversification is unavoidable, as no two exposures are perfectly identical. A portfolio of life insurance contracts, for example, may implicitly diversify by including a mix of insureds, occupation or region. As a result, the key issue is the extent of diversification to be recognized and not whether it should be recognized.

7.5 Contract adaptability features

Many insurance contracts, in some markets practically all life insurance contracts, include features that permit the insurer to modify the cash flows otherwise due, including both inflows and outflows after issue, based on subsequent experience. They include policyholder dividends/bonuses, contract charges, and fees, as well as other non-guaranteed features, such as charging current levels or fees or cost of insurance charges less than those guaranteed, crediting interest in excess of that guaranteed, premium and benefit adjustment features that allow insurers to increase premiums or reduce benefits in response to experience and expectations more adverse than previously anticipated, and charging current premium levels for term insurance less than the maximum amount required.

The modifications can be based on a direct contractual relationship to subsequent experience or can be subject to considerable discretion. This discretion can be limited by means of initial or subsequent contract illustrations provided to the policyholder, dividend resolutions by the entity's boards of directors, regulatory approval or competitive pressures. It could be debated whether the amounts not guaranteed can be categorized as a current obligation (due, for example, to being a constructive obligation); this has been a very controversial issue by financial reporting standard setters.

These features can provide the insurer with risk mitigation tools to reduce its contractual risks. In some cases, the original risk transferred to the insurer is re-transferred to a pool of policyholders. As such, they can reduce the risk margin compared with the risk margin for similar contracts without these features, while in some cases the retained risk might, since more concentrated, be more complex and larger on a unit basis.

Since risk margins reflect the risk retained by the insurer (as well as by a reference entity that would be transferred the obligation that would include these features) from a contract or a portfolio of contracts, they are determined based on the volatility of the cash flows remaining after all contractual features are reflected. If risk margins are determined as if there were no mitigation or risk retransfer features in the contracts, reductions to the risk margins would be needed to reflect the expected effectiveness of these risk mitigation tools. Since these techniques are part of the same contract, off-setting of rights and obligations should be allowable.

The complexity and tremendous variety of such features can result in significant recognition issues. While the tentative conclusion of the IASB is that liabilities in general purpose financial reporting ~~are~~ should be based on the amounts an entity ~~is~~ has a legal or constructive ~~currently obligated~~ obligation to pay, the liabilities and total financial resource requirements for regulatory purposes may provide for possible action in financial emergency situations. [I think this is true for gp liab's in stochastic situations as well – dividends can be adjusted based on the experience in a scenario.] Hence, amounts under participation or contract adjustment features that are available to cover losses in the case of financial emergency but otherwise inure to the benefit of policyholders, may be recognized as liabilities in general purpose financial reports, reducing the size of the risk margin, but are capital from a regulatory viewpoint. [I'm not sure I understand this sentence.] To date, agreement has not yet been reached on recognition of the effect of many of these features.

The binding force of these features might result from contract terms, applicable law, regulatory action, fiduciary position or other sources. In some circumstances, the line between an obligation to pay amounts and discretion can become quite blurry. Insurers often act as if required to do so, without testing the extent to which an obligation exists, legal or otherwise, especially if the obligation might be based on views of the regulatory authority. In case of regulatory reporting, such binding force can be easier to identify than in general purpose financial reporting, since the regulator whose existing requirements can be identified and actions anticipated. If the actual obligation forces the entity to forward parts of the surplus generated to policyholders, but grants the insurer the option to charge exorbitant premiums or even to retroactively adjust premiums or benefits, this reduction of the ultimate risk should be considered for measurement for both general purpose and regulatory financial reports.

Features where benefits are less strictly bound to surplus but are still significantly subject to insurer's discretion benefits can be assumed not to be paid in highly adverse situations. Therefore, such future benefits, although expected to be paid in the normal course of business, may not be

seen as part of liabilities. [This discussion is unnecessary and not consistent with how the IASB or the IAIS proposes to handle dividends. I suggest you look at the Second IAIS Liabilities Paper on this.] Past surplus still subject to future discretionary distribution decisions is reflected as overall available resources. Performance-linked features can provide allocated past surplus that might be subject to future performance that is not yet irrevocably allocated. ~~The IASB has not yet decided on the extent of guidance it will provide regarding whether discretionary benefits that are expected to be paid should be recognized as part of liabilities~~The IASB has tentatively concluded that the reporting entity should reflect its best estimate of those benefits it has a legal or constructive obligation to pay. Such benefits cause a conflict between the principal that only present obligations cause a liability and a realistic view of the future. That conflict is also expressed by the economic trigger of such payments, the competitive situation, although other compelling reasons may exist at the same time. Ignoring discretionary but expected benefits in measuring the liability would result in reporting profitability which does not reflect economic reality.

The measurement of such features depends on their nature. They range from obligations expressed as a specified amount determined by a formula regarding an identified set of assets (e.g., unit-linked or variable contract), by reference to an external index (e.g., equity index-linked contract), accumulated surplus (and/or losses) from a group of contracts during their entire lifetime, an amount indicated in a sales illustration as designated by a recent board resolution and expected to continue if current experience continues, or on a completely discretionary basis. In some cases, such as term insurance sold at premium levels far less than that guaranteed as a maximum level (the maximum of which might have been set to avoid holding additional regulatory liabilities), the difference is never expected to be charged in the future; if they were, significant shock voluntary terminations would likely occur, which may significantly affect voluntary termination rates, but franchise value as well.

If an adaptability feature contributes additional risks to contract performance, they would result in an increase in risk margins. However, in most cases, the existence of a contractual right by the insurer to make use of a contract adaptability feature not to pay a policyholder dividend or otherwise might decrease the uncertainty associated with expected net cash flows which in turn would reduce the risk margin.

7.6 Risk concentration

Little attention has been paid to concentration of risks so far in this paper. The IAA believes that, just as diversification of risks should be considered in determining the total financial resources objective, so too should risk concentration.

Geographic concentration of risk can be an easy element to recognize; but potentially a difficult one to reflect. Obvious examples are geographic concentration of hurricane, earthquake, workers compensation, business interruption or life insurance risks.

In effect, the underlying issue is often whether insured events that are normally thought of as independent are not. For example, a tornado may kill many people in one location. A terrorist action may cause significant business interruption claims in a small area (as in the World Trade Center). Similarly, a single judicial ruling may affect a significant portfolio of a non-life insurer's claim liabilities if it is concentrated in the market or jurisdiction affected by the ruling.

In its *Blue Book*, the IAA opined that the purpose of capital and surplus was to absorb “catastrophes," And thus it would be a feature of a capital model, just as would great degrees of uncertainty. However, the question remains as to what is significant enough to qualify as a “catastrophe”?

Multiple deaths from a tornado would not seem to qualify. Indeed, re-insurance against just such a contingency can often be readily obtained. Hurricanes happen every year, although their effect on insurance loss can vary considerably. Is there a threshold at which a hurricane becomes a “catastrophe”?

The IASB has decided that “catastrophe reserves” cannot be recognized as liabilities, in that this provision simply was an accumulation of past premiums and did not bear any particular relation to the future expectation of risks. This amount typically was available to smooth earnings, recognizing a portion of a past premium as a future "smoothing" reserve that could be used to offset the effect of a future catastrophe. However, such a liability directly related to the risks associated with an unexpired term of the insurance obligation for which premiums have been paid yet not earned remains appropriate.

The IAA believes that that reflecting risk diversification in required total financial resource requirements is not independent of the reflection of risk concentration. Risk diversification is a statistical concept of proven validity with respect to risk management. Similarly, risk concentration also is of proven relevance to insurer solvency assessment. The probability distributions considered in both risk margins and capital should reflect the potential for catastrophes, although not necessarily that in different risk pools.

It is the opinion of the IAA that the two issues of risk diversification credits and risk concentration debits to required total balance sheet resources should be examined in tandem.

It has been beyond the scope of the IAA discussions to date to do more than “flag” the issue of consistent treatment of risk diversification and risk concentration.

8. Other Issues

8.1 Service margins

The IASB has proposed that the liability for insurance contracts include a margin for services provided by an insurer not related to insurance risks in addition to the current estimate and risk margins. Such a margin would represent the compensation required to provide such services, such as investment management services, as long as market participants typically require such a margin. This can take the form of a fee for the service provided. Its stated objective is to avoid the front-ending of expected profit for such services. It reflects the difference between the profit portion of the price that would be charged by market participants to provide such services in addition to the already considered current estimate and risk margin.

According to the current proposal of the IASB, if a contract explicitly or implicitly provides a fee for services that market participants typically require, the insurer would recognize an asset and measure it at the amount of the origination cost typically incurred. If market participants require a larger explicit or implicit service fee, the initial measurement of the asset is less than the origination cost that market participants typically incur (in extreme cases this could be negative, in which case it would be a liability).

8.2 Margins under a "no profit at issue constraint"

This section discusses an alternative role for margins in the context of a different measurement objective. At present, both the IASB and the IAIS are leaning toward general purpose and regulatory financial reporting for insurance contracts based upon exit values that permits "profit on issue." However, an entry price basis is still being considered. If "profits at issue" are not recognized, a total margin approach, rather than a standard incorporating risk margins would be appropriate although the total margin might be initially based on the risk margin techniques included in this paper.

If such a constraint is required in either general purpose or regulatory financial reporting standards, how would such a constraint be effected? One relatively "simple" method of implementing that constraint is to "gross up" the risk margin by an amount so as to produce a zero profit at issue.

The following are possible approaches that could be applied after issue:

1. Follow one of the risk margin approaches described elsewhere in Section 6. This might result in the amount withheld as profit at issue flowing immediately back into profits. This would defeat the objective of the constraint.

2.• Calibrate the total margin that would have produced the profit at issue and to maintain that total margin for calibration purposes at subsequent measurement dates until there is reliable statistical evidence that either the current estimate of the liability has decreased significantly or the probability distribution of the insurance liabilities has become "better behaved." The determination of what constitutes reliable statistical evidence is an issue that would require further investigation.

3.• Calibrate the total initial margin to an equivalent confidence level or cost of capital, with subsequent adjustments made only when the price of risk demonstrably changes over time, which is inherent in the current entry approach.

- Calibrate the total initial margin, to be worn off on a release from risk basis, with the risk margin otherwise calculated being grossed-up by a factor equal to the ratio of the initial total break-even margin to the otherwise calculated initial risk margin.

8.3 Operational risk

In the IAA's *Blue Book*, it was assumed that the proper place to reflect operational risk was in the capital and surplus of the insurer rather than in the insurer's liabilities, while the IASB, considering that these risks are faced by any owner of such a portfolio, requires them to be considered in the liability for insurance contracts.

During its deliberations, members of the IAA RMWG have expressed the opinion that at least certain aspects of operational risk should be reflected in the liabilities of insurance contracts.

The IAA's RMWG has not yet discussed this issue sufficiently to take a position. The purpose of mentioning the operational risk issue in this paper is to note that a decision should be made as to where (and how) operational risk should be reflected in order to best achieve the consistency between general purpose and regulatory financial reports as well as to achieve consistency between preparers of these financial reports. Techniques to measure operational risk are currently in an evolutionary state.

APPENDIX A – The IAA ad hoc Risk Margin Working Group Background

The International Actuarial Association (IAA) has, from its earliest days, endeavored to work cooperatively with both the International Accounting Standards Board (IASB – and its predecessor the International Accounting Standards Committee, IASC) and the International Association of Insurance Supervisors (IAIS).

When the IASC launched its project to develop a new international accounting standard for insurance contracts in late 1997, the IAA accepted the IASC's invitation to participate in the IASC Insurance Steering Committee and formed its own IAA Insurance Accounting Committee to liaise with the IASC. Later, the IAIS became involved in the IASC's insurance accounting project and launched its own project to establish Core Principles of insurance regulation and related regulatory standards of practice. The IAA increased the remit of its Insurance Accounting Committee to cover both insurance accounting and insurance regulation issues.

It rapidly became apparent that the amount of activity in the accounting field and in the regulatory field was so large that the IAA would need two separate committees to deal with the two aspects of the rapid international developments in the insurance field. The IAA Insurance Committee was split into the IAA Insurance Accounting Committee and the IAA Insurance Regulation Committee. Bearing in mind the commonality of issues faced by the two IAA committees, the IAA developed the tradition of having a joint session in which the members of the IAA Insurance and Regulation Committees met as a "committee of the whole" during the committee meetings accompanying the biannual IAA Council meetings. One of its purposes was to try to ensure that each of the IAA committees that liaised with the other international organizations involved with insurance, the IASB and the IAIS, was aware of both the emerging issues facing the other relevant IAA committee and the actions of the other relevant IAA committee.

By the time of the International Congress of Actuaries in Cancún in 2002, the IAA Insurance Accounting Committee was faced with the desirability to develop International Actuarial Standards of Practice (IASPs) for use in conjunction with what was to become IFRS 4, the first phase of the IASB's insurance financial reporting standard. Shortly thereafter, the IAA Insurance Accounting Committee formed its Actuarial Standards Subcommittee to deal with the development of these IASPs.

Similarly, the rapid evolution of the IAIS led to the establishment of several new committees including ones focused on insurance financial reporting and insurance solvency issues. The IAA reacted by establishing the IAA Solvency Subcommittee of its Insurance Regulation Committee to assist the IAIS in developing a possible new framework for international insurance regulation by the IAIS. In 2004 the IAA Insurer Solvency Assessment Working Party produced a comprehensive research

report, “A Global Framework for Insurer Solvency Assessment," often called the *Blue Book*, which, in very large part, came to form the conceptual foundation underlying future IAIS solvency developments.

The adoption in March of 2004 by the IASB of IFRS 4, the first phase of its insurance financial reporting standard, caused each of the IAA and the IAIS to reinvigorate their respective efforts to interact with the IASB. The IAIS formed an Accounting Subcommittee to deal with overall insurance issues and an Insurance Contracts Subcommittee to deal with the specific issue of liability measurement for financial reporting purposes, while strengthening the mandate of the IAIS Solvency Subcommittee to develop the strong framework for regulating the solvency of the international insurance industry.

The practice developed that the IAA was represented at the IAIS Contracts Subcommittee by the co-vice-chairpersons of the IAA Insurance Accounting Committee. At the same time, the IAA was represented at the IAIS Solvency Subcommittee by the chairpersons of the IAA Insurance Regulation Committee and its Solvency Subcommittee.

By 2005, the need to coordinate the actions inside the IAA reinforced the need for the IAA Insurance Accounting and Regulation Committees to continue meeting at every biannual IAA Council meeting. Similarly, the IAIS came to see the need for its Solvency, Accounting and Contracts Subcommittees to arrange periodic co-located meetings to coordinate the relevant IAIS developments.

In early 2005, the IAIS Insurance Contract Liabilities Subcommittee (“Liabilities subcommittee”) undertook to develop the IAIS’s First Liabilities Paper in which key issues would be raised with the IASB concerning a possible measurement template from which the IASB could measure liabilities for insurance contracts for general purpose reporting purposes and the IAIS could measure them for regulatory purposes. The co-vice-chairperson of the IAA Insurance Accounting Committee, acting as liaison to the IAIS Insurance Accounting Committee, was an active participant in the development of what became known as the IAIS *First Liabilities* Paper, adopted in Beijing in late May 2005.

In developing this IAIS Liabilities paper and its solvency regime, it quickly became apparent that the key issue, without which a common IASB / IAIS liabilities measurement template could not be developed, was what risk margins above current estimates should be included in the measurement of liabilities. In other words, in the development of an IAIS Solvency regime based on the “total balance sheet” (sometimes called “total financial resources”) concept as proposed in the *Blue Book*, what part of the total financial resources objective should be included in liabilities?

This led the IAIS’s Solvency and Actuarial Issues subcommittee (“Solvency subcommittee”) to discuss how to proceed in its meeting in Tokyo held on May 30

to June 1, 2005, which in turn led to draft Terms of Reference (ToR) as to how the IAA might assist the IAIS in the area of risk margins. The draft ToR were discussed at the joint meeting of the IAA's Insurance Accounting and Regulation Committees in Rome on June 15 2005 attended by key IAIS personnel at which it was agreed that the IAA would form an ad hoc Risk Margin Working Group (RMWG) co-chaired by leaders of the IAA's actuarial standards and solvency subcommittees, Paul McCrossan and Henk van Broekhoven, with its membership initially drawn from the relevant IAA committees and subcommittees while being open to other interested actuaries as well.

The IAIS subcommittees met in Basel at the end of September 2005; followed immediately by the first face to face meeting of the IAA's RMWG to finalize the IAA's terms of reference and the process it would follow.

APPENDIX B – Life Insurance and Annuity Risk Margin Examples

This appendix considers the principle methods of calculating risk margins for various types of life insurance contracts.

B1 Methods to set risk margins

As indicated in Section 6.3, there are several methods that could be used to determine risk margins:

1. Assumption method (implicit and explicit)
2. Quantile method(also referred to as the "percentile" method)
3. Cost of capital method

B1.1 The assumption method

The use of implicit conservative assumptions was industry practice for general purpose and regulatory financial reports for life insurers for a long time. As noted in Section 6.3, implicit assumptions are not generally felt to be a satisfactory basis on which to base liabilities in the future. Explicit assumption methods are not necessarily based on a quantification of the stochastic nature of the uncertainties associated with insurance risks, but in any event they incorporate the experience and judgment of the (actuary) preparer in setting the assumptions. Often in implicit methods the current estimate is not determined separately. The risk margin under this method is set in a safe and prudent manner. However, for certain coverages, the relative prudence (in some cases the risk margin implicitly offsets discounting for the time value of money) included is opaque.

Although the use of the assumption approach has been a long standing practice in part of the life insurance industry, this method should normally not be used by an insurer that has reliable internal models and current credible information about the current estimates and their probability distributions. There are many such situations, particularly in respect to new coverages or coverages where extensive experience is not available and in respect of smaller insurers without internal model building expertise.

Systemic risk across years is a risk that is not generally handled well by this method. As a result, the results of these methods should be prepared with care. In addition, data from, say, ten years ago, can have differing relevance to risk margins.

Explicit assumption methods have been effectively used in some instances, with the margins sometimes referred as provisions for adverse deviations (PADs) or margins for adverse deviations (MfADs). One difficulty with this approach is that normally insufficient assessment is performed on the

combination of these separate margins (and in some cases, certain risks are ignored (e.g., the persistency risk), with sometimes seemingly arbitrary reductions are made in deriving an aggregate contract risk margin. Although in some cases the assumption margins are developed on a statistic basis, comparability of these margins, except when dictated by a regulator or surveyed, can be relatively weak.

B1.2 Quantile method

Often based on stochastic analyses, the uncertainty around the liabilities may be translated into a percentile, for example, 75%. Liabilities based on a 75% percentile basis will thus be set at such a level that we are 75% confident that this level will be sufficient over the lifetime of the coverage.

This method is in use, particularly in certain portions of the industry for setting margins where probability distributions for the risk is available. Also for regulatory purposes this method has been used in several situations, for example by the Australian regulator.

A quantile method provides a good translation of the uncertainty risk in the liabilities where the underlying is robust[28]. However, it is difficult to derive a "market related" level of confidence. The release of the margin over time generates the risk compensation for the investor, but given a certain confidence level, this compensation for risk will depend on the type of product and the duration. A 75% confidence level over two years is very different from a confidence level of 75% over 20 years. Therefore, this type of margin should generally be established based on the expected future lifetime of the risk.

As previously mentioned, the quantile method is dependent on a sufficiently robust data set to derive applicable probability distributions. It can be more easily applied if this type of experience data is available.

B1.3 Cost of capital method

The cost of capital method to determine risk margins has often been used in the insurance market for pricing purposes in setting premium levels. This method is also used (both for life and non-life insurers) in the Swiss Solvency Test. The risk margin is the present value of the cost of capital associated with the obligations over the entire term of the obligation being considered.

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[28] Some risk distributions are not robust, that is, do not react throughout to the same risks. For example, the probability for a reinsurance treaty to protect against a pandemic may indicate that there is no difference between the 50% and 75% confidence levels, despite significant uncertainty in the tail of the distribution.

The cost of capital rate is a necessary input to this method. Although for pricing purposes it will generally depend on the entity that issues the contract, for application to financial reporting standards for which risk margins are to be consistent with what would be charged in a market, a reference entity should be used instead. In contrast with the quantile method, a projection of capital is needed. However, many entities do this routinely as part of their pricing process. Discussion of the reference entity is included in Section 6. In the real world, the real price associated with a transaction may differ from this amount, depending on, among other factors, the risk profile of the entity that would take over the obligations of the contracts, the market situation at that moment, etc.

The benchmark capital as used in this approach is determined on an economic capital basis. However, regulatory capital, by itself or adjusted by a factor to approximate economic capital may provide an adequate surrogate for economic capital in many cases. In addition, regulatory capital may prove to be a good alternative for small companies who are not able to calculate economic capital, as they should be able to calculate regulatory capital using standard models.

B1.4 Further considerations

Independent of the risk margin method chosen, if an entry value accounting system is used, it will be necessary to calibrate the total margin to the price of the contract itself. If this approach is not taken, the methodology will usually create a gain or loss at issue. However, in the end, although the method chosen and the financial reporting standards applied will affect the pattern of expected earnings, they will not affect the ultimate financial performance of the contracts.

B1.5 Which risks should be taken into account?

Table B.1 is based on the IAA risk classification scheme, and is an overview of the incorporation of types of risks into the quantile and cost of capital methods. In the quantile method, nonhedgeable risks are included. In principle, the cost of capital method should take into account all non-financial risks. It is assumed that the financial risks are reflected in economic capital (note that assets are assumed to be based on fair values).

Table B.1 Assignment of types of risk

	Risk type	Percentile	Cost of Capital
1	Mortality trend uncertainty	y	y
2	level uncertainty	y	y
3	volatility	-	y
4	calamity	y	y
5	catastrophe credit risk reinsurance	-	y
6	Expense	y	y
7	Persistency volatility & calamity		y
8	uncertainty	y	y
9	Premium Re-rating Risk	y	y
10	Credit Risk	-	-
11	Transfer Risk	-	-
12	P&C current non-catastrophe uncertainty	y	y
13	current non-catastrophe volatility	-	y
14	current catastrophe risk	y	y
15	catastrophe credit risk reinsurance	-	y
16	claims development risk	y	y
17	Morbidity current uncertainty	y	y
18	current volatility	-	y
19	prior	y	y
20	calamity	y	y
21	Operational Risk Capital	-	y
22	Interest Rate Risk	-	-
23	Currency Risk	-	-
24	Real Estate Risk	-	-
25	Equity Risk	-	-

B2 Example – Risk margins for a singe premium annuity contract (guaranteed for the whole life)

In this example, the risk margins for a single premium annuity whose payout is guaranteed for the whole of life are calculated based on the cost of capital method. The annuities are for a portfolio of only 65 year old males. The calculations are based on a model presented in the *Blue Book* and earlier papers of the IAA Solvency Working Parties and van Broekhoven (2002).

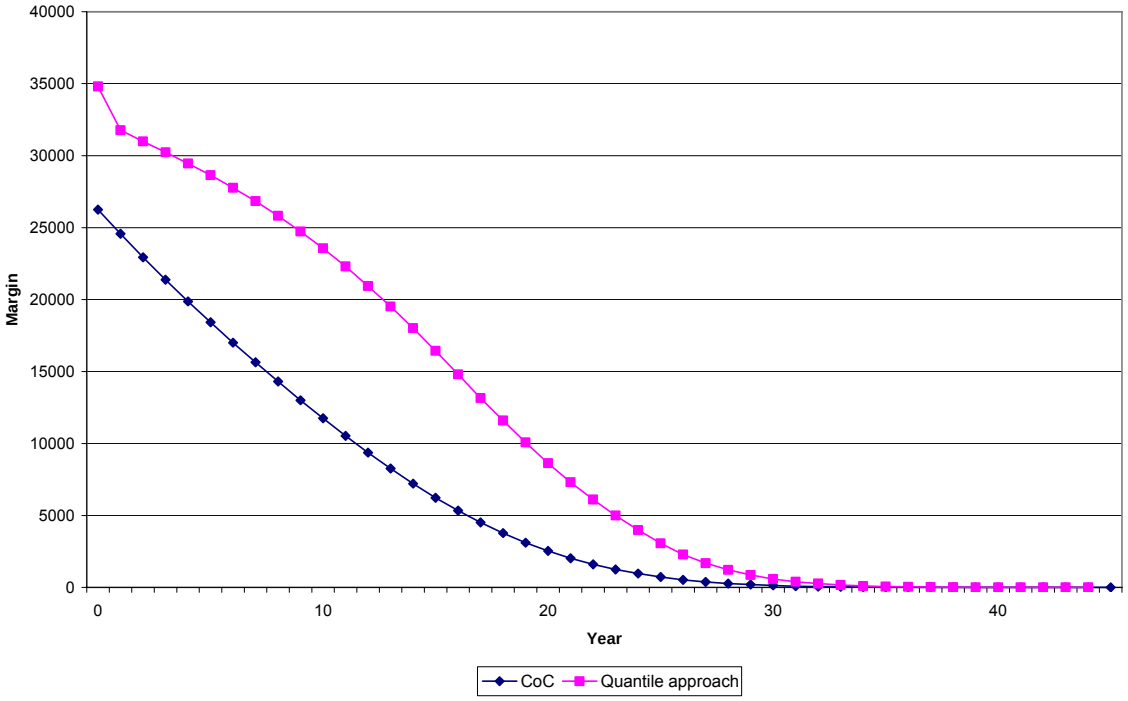
A short overview of how the calculations were prepared is given below.

The calculations themselves are relatively complex, but the results for the annuity show that it is relatively easy to find a simple standard model for the projection of economic capital. It looks as if the pattern of this capital is almost linear. Further investigation is needed to confirm that this pattern applies to other products.

The discount rate used is the risk free yield curve. For this example a constant discount rate of 4% is used.

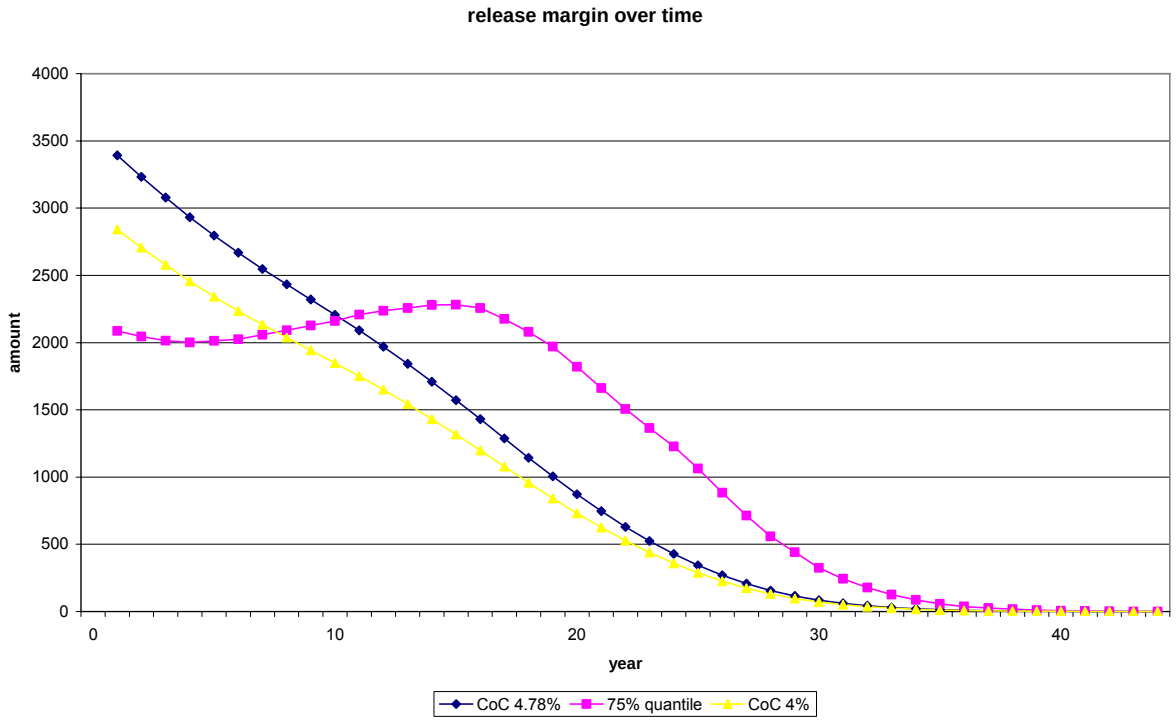
The risk margin for an annuity for a 65 year old male is 1.09% of the current estimate for a AA rated company. The risk margin derived from the 75% quantile method is much higher (1.39%). The primary reason for the difference is the approach needed to determine the parameters. It is useful to examine how the risk margins develop as a percentage of the then current estimate over time, as indicated in Graph B.2.

Graph B.2 Risk margin comparison – single premium annuity



In Graph B.3 the release of the risk margin is shown, starting at the same level of risk margin for ease of comparison. The initial adjusted result is equivalent to the application of the cost of capital method at a 4.78% discount rate rather than at 4%.

Graph B.3 Release of risk margins over time with consistent initial values single premium annuity



As can be seen, for this example the release of the cost of capital method is more linear over time than that of the quantile method. This is logical because the cost is a constant percentage of the economic capital (EC). It is important to note that the relative shape of the risk margin over time does not necessarily follow these patterns. The quantile method also reflects the effect of the release of the capital itself. In this example the application of the cost of capital method generates greater profit in the early contract years and a lower profit later, similar to the original lower cost of capital calculated at 4%.

Detailed results by year for the two methods are presented in Tables B.4 and B.5.

Table B.4 Risk margin based on cost of capital of a AA rated company single premium annuity

				Capital = 0.75% CE	Capital = 1.00% CE				CoC=			
	Current	Stand Alone Capitals				Sum before	Sum after	Div.	4.00%			% CE
Year	Estimate	Trend	Level	Expence	Operational	div.	div.	effect	CoC	PV	Margin	=
0	2500000	53436	107260	18750	25000	204446	68299	136147	0	2627	26246	1.0%
1	2382437	47022	106114	17868	23824	194828	65086	129742	2732	2407	24564	1.0%
2	2263927	41393	104670	16979	22639	185682	61985	123697	2603	2204	22943	1.0%
3	2144704	36682	102969	16085	21447	177183	59041	118142	2479	2019	21381	1.0%
4	2025012	33000	101009	15188	20250	169446	56284	113163	2362	1850	19875	1.0%
5	1905123	30358	98768	14288	19051	162465	53714	108751	2251	1698	18419	1.0%
6	1785356	28642	96205	13390	17854	156091	51297	104794	2149	1559	17007	1.0%
7	1666060	27623	93367	12495	16661	150145	48991	101155	2052	1432	15635	0.9%
8	1547612	27039	90205	11607	15476	144328	46722	97606	1960	1313	14301	0.9%
9	1430428	26622	86758	10728	14304	138412	44437	93975	1869	1201	13004	0.9%
10	1314935	26138	83046	9862	13149	132195	42089	90106	1777	1094	11747	0.9%
11	1201582	25424	79082	9012	12016	125535	39645	85890	1684	990	10533	0.9%
12	1090871	24393	74836	8182	10909	118319	37079	81239	1586	891	9369	0.9%
13	983334	23016	70358	7375	9833	110583	34406	76177	1483	795	8260	0.8%
14	879519	21321	65659	6596	8795	102371	31640	70732	1376	703	7215	0.8%
15	780024	19353	60722	5850	7800	93726	28794	64932	1266	615	6238	0.8%
16	685482	17204	55578	5141	6855	84778	25907	58870	1152	532	5335	0.8%
17	596505	14977	50303	4474	5965	75720	23031	52689	1036	455	4512	0.8%
18	513584	12756	45072	3852	5136	66816	20235	46581	921	384	3772	0.7%
19	437093	10624	39928	3278	4371	58201	17555	40646	809	320	3113	0.7%
20	367350	8633	34918	2755	3673	49980	15021	34959	702	264	2536	0.7%
21	304537	6822	30183	2284	3045	42335	12677	29657	601	214	2036	0.7%
22	248680	5207	25771	1865	2487	35330	10542	24788	507	171	1610	0.6%
23	199734	3830	21683	1498	1997	29009	8625	20384	422	135	1253	0.6%
24	157622	2694	17890	1182	1576	23343	6919	16424	345	104	958	0.6%
25	122220	1807	14390	917	1222	18336	5424	12912	277	78	720	0.6%
26	93203	1158	11293	699	932	14082	4161	9921	217	58	532	0.6%
27	69969	713	8674	525	700	10612	3134	7478	166	42	387	0.6%
28	51742	420	6533	388	517	7858	2320	5538	125	30	277	0.5%
29	37695	233	4843	283	377	5736	1693	4043	93	21	195	0.5%
30	27078	121	3491	203	271	4086	1208	2878	68	14	135	0.5%
31	19196	57	2488	144	192	2882	852	2029	48	10	92	0.5%
32	13416	24	1735	101	134	1993	590	1403	34	6	62	0.5%
33	9248	8	1179	69	92	1349	401	948	24	4	40	0.4%
34	6287	2	782	47	63	894	267	627	16	3	26	0.4%
35	4200	0	511	32	42	584	175	409	11	2	16	0.4%
36	2731	0	332	20	27	380	114	266	7	1	10	0.4%
37	1701	0	212	13	17	242	72	170	5	1	6	0.3%
38	996	0	130	7	10	147	44	103	3	0	3	0.3%
39	536	0	74	4	5	83	24	59	2	0	2	0.3%
40	259	0	38	2	3	42	12	30	1	0	1	0.3%
41	108	0	17	1	1	19	5	13	0	0	0	0.3%
42	37	0	6	0	0	6	2	5	0	0	0	0.2%
43	10	0	1	0	0	1	0	1	0	0	0	0.2%
44	2	0	0	0	0	0	0	0	0	0	0	0.0%
45	0	0	0	0	0	0	0	0	0	0	0	

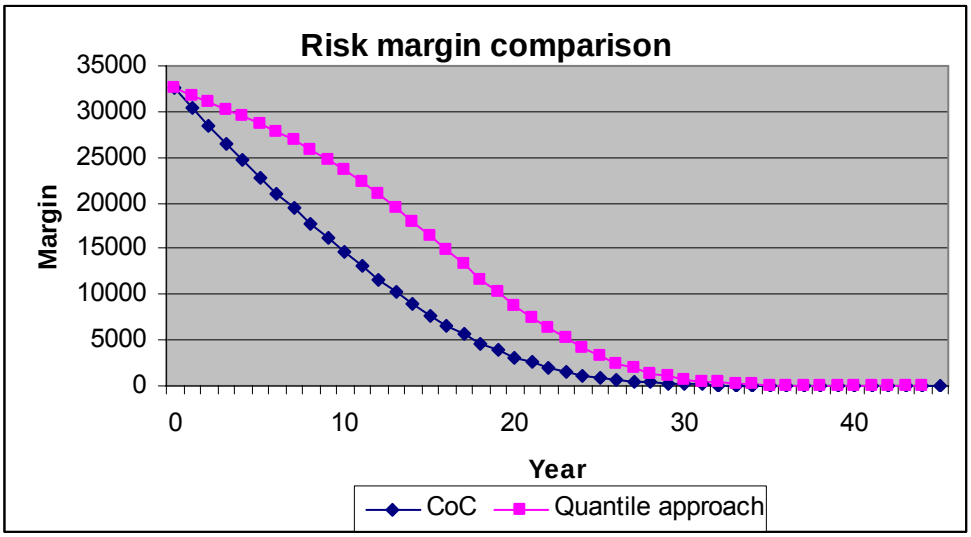
Table B.5 Risk margin based on 75% quantile – single premium annuity

Year	Current Estimate	Trend	Level	Expence	Operational	total	release	margin	Total/CE
0	2500000	11756	32178	5625	2500	34807	0	34807	1.4%
1	2382437	10345	31834	5360	2382	33983	2216	31767	1.4%
2	2263927	9107	31401	5094	2264	33167	2176	30991	1.5%
3	2144704	8070	30891	4826	2145	32361	2132	30229	1.5%
4	2025012	7260	30303	4556	2025	31557	2099	29458	1.6%
5	1905123	6679	29630	4287	1905	30734	2085	28649	1.6%
6	1785356	6301	28861	4017	1785	29867	2097	27770	1.7%
7	1666060	6077	28010	3749	1666	28954	2108	26846	1.7%
8	1547612	5949	27062	3482	1548	27968	2143	25825	1.8%
9	1430428	5857	26027	3218	1430	26910	2178	24732	1.9%
10	1314935	5750	24914	2959	1315	25773	2213	23560	2.0%
11	1201582	5593	23725	2704	1202	24554	2250	22304	2.0%
12	1090871	5366	22451	2454	1091	23239	2297	20942	2.1%
13	983334	5064	21107	2213	983	21841	2328	19513	2.2%
14	879519	4691	19698	1979	880	20364	2351	18013	2.3%
15	780024	4258	18217	1755	780	18806	2373	16433	2.4%
16	685482	3785	16673	1542	685	17181	2378	14803	2.5%
17	596505	3295	15091	1342	597	15516	2352	13165	2.6%
18	513584	2806	13522	1156	514	13867	2269	11598	2.7%
19	437093	2337	11978	983	437	12252	2171	10081	2.8%
20	367350	1899	10475	827	367	10685	2057	8628	2.9%
21	304537	1501	9055	685	305	9209	1903	7306	3.0%
22	248680	1146	7731	560	249	7840	1738	6102	3.2%
23	199734	843	6505	449	200	6578	1575	5002	3.3%
24	157622	593	5367	355	158	5414	1427	3986	3.4%
25	122220	397	4317	275	122	4346	1284	3061	3.6%
26	93203	255	3388	210	93	3405	1114	2291	3.7%
27	69969	157	2602	157	70	2613	929	1684	3.7%
28	51742	92	1960	116	52	1966	751	1215	3.8%
29	37695	51	1453	85	38	1457	588	869	3.9%
30	27078	27	1047	61	27	1050	465	584	3.9%
31	19196	13	746	43	19	748	344	404	3.9%
32	13416	5	520	30	13	521	257	265	3.9%
33	9248	2	354	21	9	354	188	167	3.8%
34	6287	0	235	14	6	235	134	102	3.7%
35	4200	0	153	9	4	154	91	63	3.7%
36	2731	0	100	6	3	100	60	40	3.7%
37	1701	0	64	4	2	64	40	24	3.7%
38	996	0	39	2	1	39	27	12	3.9%
39	536	0	22	1	1	22	18	4	4.1%
40	259	0	11	1	0	11	12	0	4.4%
41	108	0	5	0	0	5	7	-2	4.7%
42	37	0	2	0	0	2	3	-2	4.6%
43	10	0	0	0	0	0	1	-1	3.7%
44	2	0	0	0	0	0	0	0	0.2%
45	0	0	0	0	0	0	0		

A true comparison between the two approaches can not be made. Even in the situation in which both produce the same result, a small change in for example duration, may result in different margins.

The following is another example developed by setting the cost of capital percentage at 4.77% instead of 4% to equate the initial margin. But because of a different release of the capital the margins will differ over time. For ease of comparison, see Graph B.6 for a comparison of the trend in risk margins over time with these equal initial margins.

Graph B.6 Risk margin comparisons with consistent initial values single premium annuity



Note that the use of 4.77% results in a risk margin equal to that produced using a 75% quantile is unique to this special example, so that this equivalence should not be assumed to occur in other situations.

B3 Example – Risk margins for a term life insurance contract

The following term life insurance example is based on the same assumptions and models as described in the immediate annuity example used above. Because the liabilities for a term insurance are less stable than for a payout annuity, the economic capital expenses are expressed as a percentage of the premium. The calamity risk for term insurance is not relevant to the measurement of economic capital for annuities. In determining this capital, we evaluated the possible impact of a pandemic. An extreme scenario can be represented by a rerun of the Spanish Flu from 1918, which was by far the most extreme pandemic over the last 400 years. The impact of this pandemic was age independent and would lead to extra mortality (absolute) of 0.15% to 0.25%, independent of age and gender. In this example, 0.15% is used. Translations to other confidence levels are based on the pareto distribution. The estimated effects of diversification relating to the components of mortality and mortality related risk are given in Table B.7.

Table B.7 Diversification effect

Risk	*Diversification factor*
Trend uncertainty	0.25
Level uncertainty	0.25
Calamity risk	0.50
Expense risk	0.50

For the quantile method, it is assumed that the underlying risks are independent. The results of the two methods to this example are given in Tables B.8 and B.9.

Table B.8 Cost of capital method based on a AA rated company – term life insurance

Year	Premium	Liability	Capital Trend	Capital Level	Capital Calamity	Capital Expense	total cap. before div.	div. effect	After div Total	CoC	CoC/Liab
0	3634	3,634	8,017	5,601	1,495	363	15,475	11,142	4,333	920	25.33%
1	3625	4,727	6,892	5,331	1,489	362	14,074	10,093	3,981	784	16.58%
2	3615	5,634	5,777	5,014	1,484	362	12,636	9,016	3,620	656	11.65%
3	3605	6,312	4,694	4,640	1,479	360	11,173	7,920	3,253	537	8.52%
4	3594	6,709	3,664	4,201	1,473	359	9,698	6,815	2,883	429	6.39%
5	3582	6,861	2,709	3,686	1,468	358	8,221	5,709	2,512	331	4.82%
6	3568	6,779	1,852	3,101	1,463	357	6,773	4,625	2,148	243	3.59%
7	3554	6,442	1,136	2,447	1,458	355	5,396	3,594	1,802	167	2.60%
8	3540	5,794	609	1,719	1,453	354	4,134	2,649	1,485	102	1.76%
9	3524	4,829	337	904	1,447	352	3,041	1,830	1,210	47	0.96%
10	0	-	-	-	-	-			0		

Table B.9 Quantile method based on 75% quantile – term life insurance

Year	Premium	Liability	Trend	Level	Calamity	Expense	Margin before div.	Div. effect	Margin after div.	Margin % liab	release
0	3634	3,634	1283	1176	75	84	2617	873	1,744	47.99%	-
1	3625	4,727	1103	1119	74	83	2380	805	1,575	33.32%	238
2	3615	5,634	924	1053	74	83	2135	729	1,405	24.95%	233
3	3605	6,312	751	974	74	83	1882	647	1,235	19.57%	226
4	3594	6,709	586	882	74	83	1625	560	1,065	15.87%	220
5	3582	6,861	433	774	73	82	1363	469	894	13.03%	214
6	3568	6,779	296	651	73	82	1103	379	724	10.68%	206
7	3554	6,442	182	514	73	82	850	294	556	8.63%	197
8	3540	5,794	97	361	73	81	612	223	389	6.72%	189
9	3524	4,829	54	190	72	81	397	172	225	4.66%	180
10	0	-	0	0	0	0			-		234

As above, the quantile and the cost of capital methods are not completely comparable. To equate the starting level of the cost of capital method to that of the 75% quantile, we had to increase the cost of capital from 4% to 8%. Again, this is only the case in this example. Other age/duration combinations would lead to other percentages. In Graphs B.10 and B.11, the development over time of the "adjusted" cost of capital and the 75% quantile method is shown.

It is clear that the release of the risk margin over time based on these two methods is not the same.

Graph B.10 Risk margin comparison with consistent initial values – term life insurance

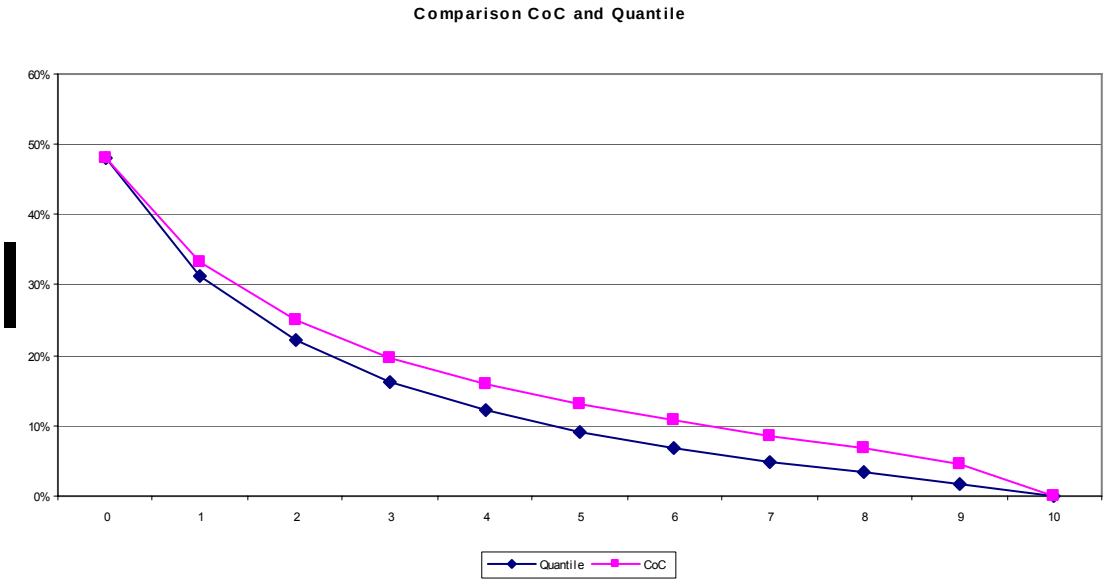
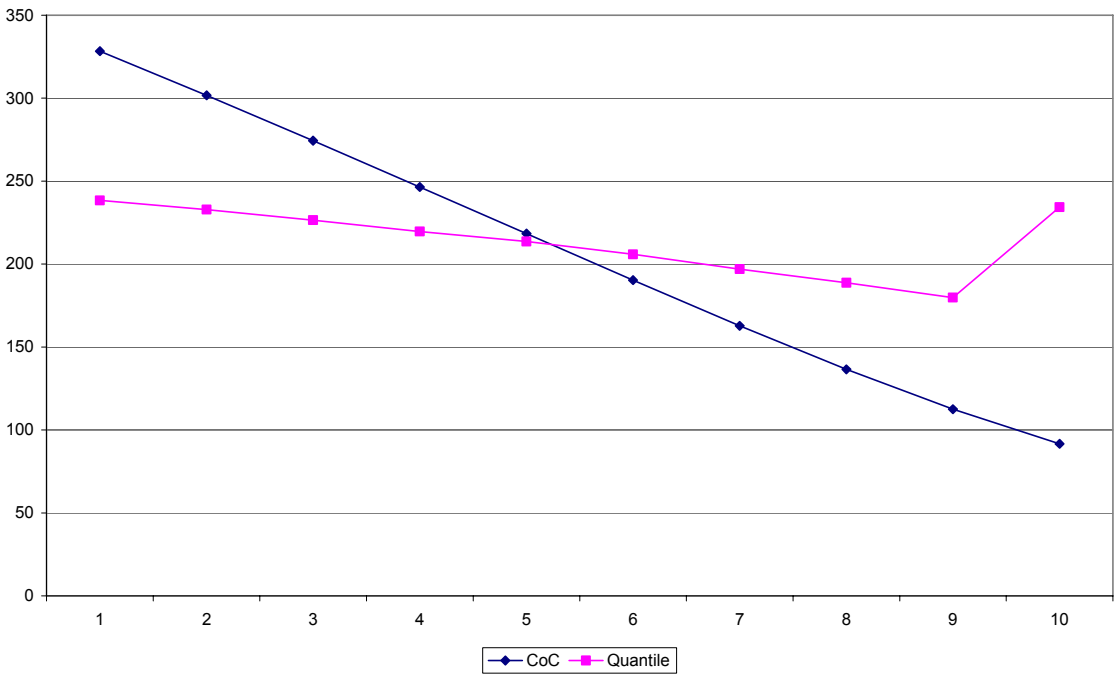


Table B.11 Risk margin release over time with consistent initial values – term life insurance



The release of the risk margins as calculated by the cost of capital method generates higher profits in the early contract years. The "jump" in the last year in the quantile method is because of the release of the total remaining risk margin. In the cost of capital method this would not constitute profit.

B4 Models used

B4.1 Current estimate

The current estimate mortality is based on a projection of Dutch population mortality, adjusted for use as insured mortality, with a factor of 0.80 (times q_x).

B4.2 Mortality trend uncertainty

Suppose the average age of the portfolio of contracts is 12 years and yearly mortality data from 1950 though 1998 is available. In creating the current estimate mortality rates, the current estimate trend is based on the average trend experienced between 1988 and 1995 (In 1988 there was a significant change in trend observed). Within the 48 years of observations 9 separate trends are observed: so there is an average trend between 1950 and 1960 (i=1); 1955 and 1965 (i=2); etc.

Using the same method as was used to calculate the current estimate mortality assumption, nine sets of factors are determined: $f_i(x)$ (i=1 to 9). With each set, $f_i(x)$, a generation mortality table can be calculated using the following formula:

$$q_i(x;t+a) = f_i(x)^a \times q_{be}(x;t)$$

(In case of positive risk it is advisable to limit a in the exponent to 10 years)

Based on each generation table i, a corresponding liability can be calculated. This results in 9 different liabilities: $liab_i$. For these 9 liabilities, a standard deviation can be calculated:

$$s_{trend} = \sqrt{\tfrac{9}{8}\{(\tfrac{1}{9}\sum_i liab_i^2) - (\tfrac{1}{9}\sum_i liab_i)^2\}}$$

The trend uncertainty calculated in this way is a student (t) distribution with 8 degrees of freedom (dof). In the student (t) distribution with dof=8, the 98% confidence interval is based on 2.5 standard deviations. This gives:

$$EC_{trend} = 2.5 \times s_{trend}(dof = 8).$$

At the end of this appendix, a table is given with the necessary factors to calculate the economic capital with the student distribution.

B4.3 When insufficient volume of data is available

Sometimes insufficient data will be available to determine certain historic trends, for example, when new mortality tables are developed only once every 10 years. For these countries, a standard set of trend factors can be created. This standard set can be based on observations in countries where enough data are available. The reason that this is possible is that we only try to measure the possible changes of the trend observed in history. This change should not differ very much between countries. Nevertheless, perhaps these standard sets might differ by region, continent or stage of development.

B4.4 Calculating economic capital using a student distribution

In Table B.12, the factors that can be used to estimate economic capital can be found depending on the degrees of freedom reflecting the number of trends available.

The factors then are multiplied by the standard deviation. The economic capital factor (EC) is based on a 99.95% (1 year time horizon) or 98% (12 year time horizon for a AA rated company) or 94% (12 year time horizon, equivalent with the yearly 99.5%), and for the quantile method at 90% and 75% confidence intervals.

Table B.12 Number of standard deviations needed in a student distribution

Degrees of freedom	EC (99.95%)	EC (98%)	Solvency 94%	Quantile 90%	Quantile 75%
5	6.9	2.8	1.9	1.5	0.7
6	6.0	2.6	1.8	1.4	0.7
7	5.4	2.5	1.8	1.4	0.7
8	5.1	2.5	1.7	1.4	0.7
9	4.8	2.4	1.7	1.4	0.7
10	4.6	2.4	1.7	1.4	0.7

B4.5 Mortality level uncertainty

The following describes an approach that could be used to determine the portion of economic capital for the uncertainty determined with respect to the level of mortality.

A similar analytical approach to estimating the portion of economic capital needed to reflect volatility. This can be done because the level uncertainty

is nothing more than the effect of the possible mistake in estimation. The reason for this possible "mistake" is the volatility in historical observations.

The method is based on the normal power (3) approximation (NP(3)). In this approach, the compound Poisson distribution is expressed in terms of a normal distribution using its first 3 moments. A complexity in using this method for the level uncertainty is that the risk capital can sometimes only be determined in the last year of the period. Assuming that the portfolio is rather stable over time in terms of average age, gender distribution and spread of the sum assured, a reasonable approximation of the NP(3) approach can be made. For relatively new portfolios we have to be careful. Further discussion regarding this situation is given later in this appendix.

The method used is as follows:

Define the ratio between the expected mortality rate for insured persons and the whole population by dividing the observed claims over a certain period by the expected claims over the same period, based on the population mortality or an industry (reference) table:

$$f_{be} = \frac{\mu_{obs}}{\mu_{ref}}$$

In the level uncertainty we reproduce the uncertainty in the observations μ_{obs} by means of an adjustment factor: $f_{ec} = \frac{\mu_{obs} + (-)unc_{ci}}{\mu_{ref}}$

The uncertainty element in the numerator can be calculated using the same type of model as used in volatility.

$$unc_{ci} = \sigma(s_{ci} + t_{ci}\gamma)$$

The factors s and t depend on the time horizon and confidence level, as indicated in Table B.13:

Table B.13 s and t values

		Mortality	
Time horizon	**Confidence level**	**s**	**t**
1 years	99.95%	3.3	1.6
12 years	98	2.1	0.5
12 years	94	1.6	0.2
Quantile	90	1.3	0.1
Quantile	75	0.7	0.0

The standard deviation is:

$$\sigma = \sqrt{\sum_p q_p(x) X_{p_i}^2}$$

And the skewness:

$$\gamma = \frac{1}{\sigma^3} \sum_p q_i(x) X_{p_i}^3$$

This calculation should be performed over the same observations used in calculating f_{be}, preferably over the same period. A problem that can be encountered is that this type of dataset may not be available during this entire period. In that case, only the most recent dataset will be available for use. With a weighting factor h, a correction needs to be made:

$$h = \frac{\sum_j N_j}{N}$$

N = numbers of policies in the available dataset
$\sum_j N_j$ = total number of policies used over the entire observation period.

In this case, the formulas for standard deviation and skewness are:

$$\sigma = \sqrt{h \sum_p q_p(x) X_{p_i}^2}$$

$$\gamma = \frac{h}{\sigma^3} \sum_p q_i(x) X_{p_i}^3$$

The economic capital is estimated by first calculating the liabilities ($liab_{ec}$) based on the q_x's:

$$q_{ec}(x;t) = f_{EC} \times q_{POP}(x;t)$$

Then the economic capital can be expressed as:

$$EC = liab_{EC} - liab_{BE}$$

In the example this risk is set at a 10% decrease of q_x's. The reason for using this assumption is that we don't have real observations to determine the current estimate mortality for this portfolio. The 10% shock is based on experience gained by the application of the models described in this paper.

B5 Other items

Among other risks not explicitly dealt with in these examples include the following:

2.1. **Volatility risk** is not included because it will have no or hardly any impact on the economic capital associated with an annuity

3.2. **Calamity risk** is also set at zero, as it only impacts positive risks.

4.3. **Expense risk** is estimated at 0.75% of the liabilities. This is a crude estimate and needs to be investigated further. The same is true for **operational risk**, which has been set at 1% of liabilities, but will depend on country and entity and possibly product related factors. Further investigation is needed for these factors as well.

5.4. **Diversification risk** (See Section 7.4 for a discussion)

The economic capital components resulting from the use of the models are stand alone levels of capital at a "sub-risk" level. Adding a portfolio to a well diversified AA rated company results in a smaller increase in the total economic capital of that entity than just adding together the sum of the components of capital otherwise determined. Each risk will have its own impact, depending on how well it diversifies into a large portfolio.

In this example, there is a portfolio of payout annuities. Such a portfolio will diversify more effectively in an entity with, on average, a positive risk (e.g., through term insurance or endowments) and less effectively in an entity that has already a maturity of negative mortality risks like annuities. The assumption made is that a "positive risk" entity takes over the portfolio.

The diversification factors are based on experience of a AA rated company with on average a positive risk profile. Diversification effects at a group level are allocated on a marginal basis. The results for the risks we have to deal with are given in Table B.14:

Table B.14 Diversification factors

Risk	*Diversification factor*
Trend uncertainty	0.25
Level uncertainty	0.25
Expense risk	0.50
Operational risk	0.75

For the quantile method, it is assumed that the underlying risks are independent (i.e., no tail correlation adjustment is needed at the 75% level).

For the cost of capital method, the cost of capital is set at a constant 4%. This level may be reasonable, but investigation needs to be conducted to confirm this. If the SCR (Solvency II capital, based on a rating of BBB, or 99.5% based on a one year time horizon) is used instead of the higher economic capital for a AA rated company, this percentage will be higher (for example, 6%).

APPENDIX C – Marginal Allocation of Diversification Effects

In the cost of capital method, an increase of the economic capital or solvency capital is associated with the addition of a portfolio that is taken over. A simple example is included here to illustrate how this might work:

Suppose we have a portfolio with a capital of 1000. We want to add another portfolio with a capital of 100. Suppose this added portfolio is independent from the original one, so that the risks included in the 100 are independent of the risks in the 1000. This means that the total capital will be:

$$\sqrt{1000^2 + 100^2} = 1005 .$$

Adding the new portfolio only increases the capital by 5 (=5% of the original 100). In case the two portfolios were not independent, but there was a correlation factor of 0.25 between them the total capital would have been:

$$\sqrt{1000^2 + 100^2 + 2 \times 0.25 \times 1000 \times 100} = 1030 ,$$

an increase of 30 (=30% of the original 100).

We need to determine these impacts for each of the risk types shown in Table B.1. The question is whether these factors should be combined into a more proportional rule. A problem is that some risk types diversify better than others. Therefore a compromise approach is chosen: the use of risk “Buckets." We split the risk types into groups with several levels of diversification.

Risk types with marginal diversification effects between 1% and 25% are allocated into the 25% bucket, between 25% and 50% in bucket 50%, etc. This process includes rounding in which some additional margin is created. In case the transferred portfolio creates more diversification for a certain entity, the Bucket system leads to some conservatism in the margins, and the other way around.

The reason for using the Bucket system is that it is difficult to define a unique, well diversified insurer. In the Bucket system, the diversification effects of most of the insurers will satisfied. In the Bucket system it is less important to define the reference entity.

Table C.1 Diversification credits

Level of diversification	Capital after diversification
Full	0%
High	25%
Medium	50
Low	75
No	100

Based on experience and testing the types of risks shown in Table B.1 can be ordered according to the buckets shown in Table C.2 (note that this table includes life, health and property & casualty risks).

Table C.2 Ordering of risk types

Risk type	Life	P&C
Mortality level uncertainty	25%	--
trend uncertainty	25%	--
volatility	0%	--
calamity	50%	--
catastrophe credit risk reinsurance	50%	--
Expense	50%	50%
Persistency volatility & calamity	0%	0%
uncertainty	50%	50%
Premium re-rating risk	25%	25%
Credit risk	75%	75%
Transfer risk	25%	25%
P&C current non-catastrophe uncertainty	--	25%
current non-catastrophe volatility	--	0%
current catastrophe risk	--	75%
catastrophe credit risk reinsurance	--	75%
claims development risk	--	25%
Morbidity uncertainty	25%	25%
volatility	0%	0%
claims development risk	0%	0%
calamity	50%	50%
Operational risk capital	75%	75%
Interest rate risk	--	--
Currency risk	--	--
Real estate risk	--	--
Equity risk	--	--

In the above table all volatility risks are set at 0 (full diversification). Alternatively they could also be assigned a relatively small, e.g., 25% value.

APPENDIX D – Property & Casualty (General) Insurance Risk Margin Examples

This appendix provides examples and considers some of the issues involved in applying a cost of capital method to determine the risk margin in a property & casualty (general) insurance unpaid claim liability context.

D1 Assumptions

We consider two coverage examples. The coverages have the medium term and a longer-term payment patterns shown in Table 6.1, and they have the risk distributions described by the gamma=0.42 and gamma =0.95 normal power distributions discussed in Section 6. These normal power approximations produce quantiles and capital levels very similar to lognormal distributions with coefficients of variation (CV) of 13.9% and 30.7%. While not intended to precisely match any particular type of coverage, the two assumptions are broadly like commercial automobile third party liability coverage and long tail liability or short tail reinsurance coverages respectively.

For cost of capital risk margin calculations, we assume that the coverages have required capital levels equal to 35% and 70% of the current estimates for ongoing business. Setting capital as a percentage of current estimates is a convenience for these illustrations, and makes the percentage comparable to examples by FOPI (2006) and the CRO Forum (2006). To avoid potential misunderstanding, note that capital levels are more complex than simple ratios; Section D4 discusses the relationship between capital level and risk distribution more generally. Also note that the ratios of capital to liabilities (meaning current estimate including risk margin), or capital to premiums, implied by these examples is not 35% and 70%, but lower amounts because those alternative denominators are larger than current estimates.

The examples were constructed with unpaid claim liabilities in mind. The structure could also be applied to pre-claim (unearned) liabilities, but the payment term and risk distribution would be different. Moreover, the work in this Appendix did not consider any issues that might specifically apply to pre-claim liabilities.

Finally, we assume the risk free interest rate is 4% and that the cost of capital is 6%.

D2 Examples – Capital as constant percentage of current estimate

Tables D.1 and D.2 show the determination of risk margins using the cost of capital method, as illustrated by the Swiss Solvency Test (*SST White Paper*. 2004).

Table D.1 "Liability" coverage – constant capital ratio

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Risk Margin Calculation			Diagnostic Information						
Year	Current Estimate-BOY	Risk Margin-BOY	Capital Req'd	Capital - % Col (2)	Risk Margin-% Col (2)	Paid during in Year	Current Estimate before Discount	Discount Factor	Risk Margin vs. Discount	Implied Discount Rate
1	100.0	20.6	70.0	70.0%	20.6%	15.0	123.4	0.810	-2.3%	0.4%
2	89.0	17.2	62.3	70.0%	19.4%	15.6	108.4	0.821	-2.0%	0.4%
3	77.0	14.2	53.9	70.0%	18.4%	14.1	92.9	0.829	-1.8%	0.4%
4	66.0	11.5	46.2	70.0%	17.5%	14.6	78.8	0.838	-1.6%	0.4%
5	54.0	9.2	37.8	70.0%	17.1%	13.2	64.2	0.842	-1.5%	0.3%
6	43.0	7.3	30.1	70.0%	17.0%	7.7	51.0	0.843	-1.4%	0.3%
7	37.0	5.8	25.9	70.0%	15.7%	7.5	43.3	0.855	-1.1%	0.3%
8	31.0	4.5	21.7	70.0%	14.4%	6.2	35.8	0.866	-0.9%	0.3%
9	26.0	3.3	18.2	70.0%	12.9%	7.0	29.6	0.880	-0.7%	0.2%
10	20.0	2.4	14.0	70.0%	12.0%	6.8	22.5	0.888	-0.6%	0.2%
11	14.0	1.6	9.8	70.0%	11.8%	3.6	15.7	0.891	-0.5%	0.2%
12	11.0	1.1	7.7	70.0%	10.2%	2.4	12.2	0.905	-0.3%	0.1%
13	9.0	0.7	6.3	70.0%	7.9%	3.4	9.7	0.926	-0.1%	0.1%
14	6.0	0.4	4.2	70.0%	6.0%	3.2	6.4	0.943	0.0%	0.0%
15	3.0	0.1	2.1	70.0%	4.0%	3.1	3.1	0.962	0.0%	0.0%
16	-	-	-			-				
Total						123.4				

Assumptions		
A	risk free	4.0%
B	cost of capital	6.0%
C	initial capital ratio	70.0%
D	annual growth in capital ratio	0.0%

Column	Notes
2	Assumption. Assume that claims are paid at the end of each year. Discounted with no risk margin.
3	Cost of capital times NPV from final year to valuation year. PV to start of valuation year. At risk free rate.
4	For each year, this is the beginning of year required capital Col (4) = Col (1)*Assumption (C)
5	Col (4)/col (2); Capital as a percent of beginning of year current estimate
6	Col (3)/col (2); risk margin as a percent of beginning of year current estimate
7	Payments in year. Column 2 based on these values. Column 5 can be calculated from column 2. Col 5 = current year current estimate plus on year's interest minus next year current estimate
8	Undiscounted current estimate. The upward sum of Col (7)
9	Average discount factor. Col (2) divided Col (8)
10	Ratio (Col (2) + Col (3)//Col (8) -1.0 as a %, i.e., ratio the current estimate plus risk margin to undiscounted current estimate. This is the discount produced by the combined effect of PV and risk margin-100%.
11	The interest discount rate such that the PV of the payments at that rate equals the current estimate including risk margin. (Approximated assuming the mean payment term in col 8 discount factor is the mean term at implied interest discount rate.)

Note: Payment pattern from Table 6.1

Observations from Table D.1 include the following:

1. Columns 3 and 6. Looking down column (3), we see that the risk margin during the first year is 20.6 and declines to 0.1 in year 15, the final year of expected payments. Looking down column (6), we see that the risk margin as a percentage of current estimate declines from 20.6% in the first year to 4.0% in the final year.

2. Columns 4 and 5. Looking down column (4), we see that capital declines steadily. Looking down column (5), we see that capital is a constant 70% of the current estimate at the start of the year, as assumed.

3. Column 9. The average resulting discount factor is 0.810 at a 4% risk free rate. This implies a coverage that is somewhat longer than the average for U.S. liability business, but not as long as for typical reinsurance coverage.

   The work being conducted by CEIOPS on Solvency II may yield comparative information on average payment patterns for European coverages.

4. Column 10. Provides a sense of scale for the risk margin. This value compares the current estimate plus risk margin, the sum of columns (2) and (3), to the undiscounted current estimate, column 8, the upward sum of column 7. The value of -2.3% in row 1 means that the risk margin is less than the amount of discount, such that the sum of the current estimate (discounted) and risk margin is 2.3% less than the corresponding undiscounted amounts. For jurisdictions in which claim liabilities are presented on an undiscounted basis, e.g., current practice in the U.S. and the U.K. among others, this would mean that the liabilities reflecting the time value of money and a cost of capital risk margin are 2.3% less than estimates on the current undiscounted basis. In a final specification of the cost of capital model, it would be surprising if the liability amount for long term liabilities in those jurisdictions were that much lower than the undiscounted values.

5. Column 11. Another measure of the scale of the risk margin. The implied discount rate shows the cost of capital method is equivalent to discounting liabilities at 0.4% (3.6% below the 4% risk free). This implied interest rate is relatively stable, but does decline as the unpaid claims are settled. Note that from a total balance sheet (solvency) perspective, the sum of the liabilities (including the current estimate and the risk margin) plus the capital is considered when assessing the extent to which total resources are considered sufficient at a desired level of safety.

In the first year, the example shows that the liability is equal to 120.6 (the current estimate plus the risk margin). Total financial resources are equal to

the liability plus the capital of 70, or 190.6. The capital as a percentage of the liability is 70/(100+20.6)=58%..

Table D.2 shows the "motor" example comparable to the "liability" example in Table D.1

Table D.2 "Motor" coverage – constant capital ratio

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Risk Margin Calculation			Diagnostic Information					
Year	Liability-BOY	Capital Required	Risk Margin-BOY	Capital - % Col (2)	Risk Margin-% Col (2)	Paid during in Year	Discount Factor	Risk Margin vs. Discount	Implied Discount Rate
1	100.0	35.0	3.8	35.0%	3.8%	46.00	0.928	-3.6%	2.0%
2	58.0	20.3	1.8	35.0%	3.2%	33.32	0.940	-3.0%	2.0%
3	27.0	9.5	0.7	35.0%	2.6%	22.08	0.951	-2.5%	2.0%
4	6.0	2.1	0.2	35.0%	2.7%	4.24	0.949	-2.5%	2.0%
5	2.0	0.7	0.0	35.0%	2.0%	2.08	0.962	-1.9%	1.9%
6	-	-	-						
Total						107.72			

Assumptions		
A	risk free	4.0%
B	cost of capital	6.0%
C	initial capital ratio	35.0%
D	annual growth in capital ratio	0.0%

Note: Payment pattern from Table 6.1

Observations from Table D.2 include the following:

1. Columns 3 and 6. Looking down column 3, we see that the risk margin the first year is 3.8 and it declines to 0.04, rounded to 0.0, in year 5, the last year of expected payments. Looking down column 6, we see that the risk margin as a percentage of current estimate decreases from 3.8% to 2.0%.
2. Columns 4 and 5. Looking down column 4, we see that capital decreases steadily from 35.0 to 0.7. In column 5, we see that capital is a constant 35% of the current estimate at the start of the year, as assumed.
3. Column 9. The average discount factor is 0.928 at 4% risk free rate. This implies a coverage that is somewhat longer than the average for U.S. personal lines automobile and slightly longer than U.S. personal lines automobile liability and shorter than U.S. commercial automobile liability.[29]
4. Column 10. The line value is -3.6%. This means that the risk margin is less than the amount of discount such that the current estimate (discounted) plus risk margin is 3.6% less than the undiscounted

[29] Based on discount factors in the U.S. NAIC Risk Based Capital formula

amounts. For jurisdictions in which liabilities are currently presented on an undiscounted basis, e.g., in the U.S. and the U.K., this would mean the liabilities would be 3.6% less than estimates on the current basis.

5. Column 11. The implied interest rate shows the cost of capital method is equivalent to discounting liabilities at 2.0% (2.0% below the 4% risk free).

D3 Projection of future capital needs – Examples with capital as varying percentage of current estimates

As the examples above show, the cost of capital method uses the amount of capital at the valuation date and the capital for each applicable time in the future. As a result, an important issue is to project the level of future capital over the remaining term of the obligation.

In the examples above, it is assumed that the risk level is sufficiently similar by age of claim that a constant percentage of capital (or capital plus risk margin) is appropriate. Contrary to that assumption, two factors make it likely that the probability distributions for "late claims" have a higher coefficient of variation and skewness than would the probability distribution of the entire set of claims. First, the late settled claims are different from the early settled claims, e.g., larger and more variable. Second, the late settled claims will be more subject to uncertain economic effects, e.g., inflation, social inflation, judicial activity, which increase the uncertainty in the estimate.

The details of how capital requirement change over time in an aging cohort of claims needs further study, but experience suggests that the assumption of uniform capital requirements as a percentage of the remaining liability will understate the capital requirement. As can be seen, the capital needs over time require careful consideration and clearly may depend on the type of business.

Tables D.3 and D.4 show the longer-term and medium-term results when it is assumed that the percentage of required capital increases 10% per year. Apart from the assumed increase in capital % from year to year, the model is the same as used in the previous examples.

Table D.3 "Liability" – capital increases with age of claim

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Risk Margin Calculation			Diagnostic Information					
Year	Liability-BOY	Capital Required	Risk Margin-BOY	Capital - % Col (2)	Risk Margin- % Col (2)	Paid during in Year	Discount Factor	Risk Margin vs. Discount	Implied Discount Rate
1	100.0	70.0	29.7	70.0%	29.7%	15.0	0.810	5.1%	-0.9%
2	89.0	68.5	26.7	77.0%	30.0%	15.6	0.821	6.7%	-1.3%
3	77.0	65.2	23.7	84.7%	30.7%	14.1	0.829	8.4%	-1.7%
4	66.0	61.5	20.7	93.2%	31.4%	14.6	0.838	10.0%	-2.1%
5	54.0	55.3	17.8	102.5%	33.0%	13.2	0.842	12.0%	-2.5%
6	43.0	48.5	15.2	112.7%	35.4%	7.7	0.843	14.2%	-3.0%
7	37.0	45.9	12.9	124.0%	35.0%	7.5	0.855	15.4%	-3.5%
8	31.0	42.3	10.7	136.4%	34.5%	6.2	0.866	16.5%	-4.1%
9	26.0	39.0	8.6	150.1%	33.0%	7.0	0.880	17.0%	-4.7%
10	20.0	33.0	6.6	165.1%	33.0%	6.8	0.888	18.1%	-5.3%
11	14.0	25.4	4.9	181.6%	34.8%	3.6	0.891	20.1%	-6.0%
12	11.0	22.0	3.5	199.7%	32.2%	2.4	0.905	19.6%	-6.8%
13	9.0	19.8	2.4	219.7%	26.3%	3.4	0.926	17.0%	-7.7%
14	6.0	14.5	1.3	241.7%	21.3%	3.2	0.943	14.4%	-8.7%
15	3.0	8.0	0.5	265.8%	15.3%	3.1	0.962	10.9%	-9.8%
16	-	-	-			-			
Total						123.4			

Assumptions		
A	risk free	4.0%
B	cost of capital	6.0%
C	initial capital ratio	70.0%
D	annual growth in capital ratio	10.0%

See notes in Table D.1.
Column (5) increased 10% (Assumption D) per year.

Observations from Table D.3 including the following:

1. Columns 4 and 5. Looking down column 4, we see that capital starts at 70% of the current estimate at the start of the year. However, in each year the required capital percentage increases 10%. It is 77% for year 2, 84.7% for year three, etc. as shown in column 5.

   Looking down column 4, we see that capital declines steadily, but more slowly than was the case for Table D.1. For example, more than half of the capital (39 units versus 70 units) is required at the beginning of year 9, while in Table D.1, 18.2 units of capital (compared to an initial 70 units, i.e., only about 25% of the initial level) were required. In risk terms, this means that the D3 example implies the variability in claim runoff relates most heavily to those claims that are settled later and very little to the claims settled early.

2. Columns 3 and 6. Looking down column 6, we see that the risk margin as a percentage of current estimates begins at 29.7% and then increases to 33% before declining to 15.3% for the final year of payments. Column 3 shows that the amount of risk margin declines steadily from 29.7 initially to 0.5 in the final year of payments. The

principle that risk should decline over time is satisfied by the decline in column 3, even though the ratio of risk to current estimates increases for a period of time.

3. Column 10. The line 1 value is +5.1%. Since this value is positive, the current estimate (discounted) plus risk is greater than the undiscounted current estimate.
4. Column 11. The implied interest rate is -0.9%. This means that an interest charge, rather than a discount, is necessary to equate the present value of claim payment with the sum of the current estimate plus risk margin. The "interest charge" is consistent with the column 10 result.
5. Column 9. The average discount factor of 0.810 at 4% risk free rate is the same as in Tables D.1 and D.2 because no change in payment pattern or risk free rate has been assumed.

Table D.4 shows the model as applied to the medium term coverage.

Table D.4 "Motor" – capital increases with age of claim

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Risk Margin Calculation			Diagnostic Information					
Year	Liability-BOY	Capital Required	Risk Margin-BOY	Capital - % Col (2)	Risk Margin-% Col (2)	Paid during in Year	Discount Factor	Risk Margin vs. Discount	Implied Discount Rate
1	100.0	35.0	4.1	35.0%	4.1%	46.00	0.928	-3.4%	1.8%
2	58.0	22.3	2.1	38.5%	3.7%	33.32	0.940	-2.6%	1.7%
3	27.0	11.4	0.9	42.4%	3.2%	22.08	0.951	-1.9%	1.5%
4	6.0	2.8	0.2	46.6%	3.6%	4.24	0.949	-1.6%	1.2%
5	2.0	1.0	0.1	51.2%	3.0%	2.08	0.962	-1.0%	1.0%
6	-	-	-						
Total						107.72			

Assumptions		
A	risk free	4.0%
B	cost of capital	6.0%
C	initial capital ratio	35.0%
D	annual growth in capital ratio	10.0%

See notes in Table D.1
Column (5) increased 10% (Assumption D) per year.

Observations from Table D.4 are as follows:

1. Columns 4 and 5. Capital starts at 35% of the current estimate at the start of the year. However, in each year the required capital percentage increases 10%. It is 38.5% for year 2, 42.4% for year three, etc. as shown in column 5.
2. Columns 3 and 6. The risk margin during the first year is 4.1% of the 100 current estimate, compared to 3.8% in Table D.2 where capital was a constant 35% of the current estimate.

3. Note that even though the risk margin % (column 6) increases and decreases by year, the absolute level of risk margin (column 3) decreases steadily, consistent with the expectation that risk decreases as time passes.
4. Column 9. The value of -3.4% for the year 1 estimates is only slightly larger than the -3.6% value shown in the constant capital model, Table D.3.

The material in this section has illustrated the effect on capital of uniform increases in capital as a percentage of current estimates. However, capital, particular capital related to latent injury claims, might depend on time and be independent of the current estimate.

D4 Modelling issues

The general insurance illustrations in this Appendix and in Section 6 are based on first year capital levels equal to 35% and 70% of current estimates for motor and liability respectively. Hypothetically, these initial ratios and their patterns over time could be determined by a model developed along the lines described in the *Blue Book.*

As a practical matter, the capital held by an insurer involves consideration of multiple factors, including:

1. The applicable regulatory standards which establish a minimum level before regulatory action is taken.
2. The desired buffer above the regulatory action levels to avoid the risk that the regulator will become involved in the affairs of the company.
3. The credit rating assigned to the entity.
4. Its strategic interests regarding growth, shareholder risk appetite and the like.[30]

These considerations can become numerical values by a combination of the following approaches:

1. Modeling risks
2. Comparison to peer groups
3. Regulatory formulas

In any of those three approaches, the indicated capital amount might be the calculated value or the calculated value plus a loading. For example, few companies hold capital equal to the regulatory minimum, but companies often target a value equal to more than 100% of the regulatory minimum. For example, in the U.K., general insurance companies develop capital

[30] Hitchcox, page 6-7

models based on modeling, but typically hold capital that is the indicated value times a multiplier greater than one, say 1.5.

Modeling is becoming more central to the process of determining capital as "peer company" capital levels may be determined by models and regulatory formulas are becoming more sophisticated.

Nonetheless, there are issues in having a market calibration of a model for gross and outwards reinsurance liabilities for the run-off of a reference company. Some of these issues are discussed below.

1. Reinsurance

Since observed capital is based on the company's financial position net of reinsurance, a peer group comparison for capital gross of reinsurance should be done with care. Moreover, since regulatory formulas have generally been calibrated to net of reinsurance values, formulas mechanically applied to gross financial positions are not necessarily (and often will not) be appropriate. Modeling (and any loading factors based on peer or regulatory data used) should be conducted and applied on a net or gross financial position in a consistent manner.

2. Capital amounts by line of business

Peer group comparisons usually relate to all lines of business on a combined basis, although it is possible to use statistical techniques to deduce market capital levels by line based on differences between capital levels for companies with different lines of business.

Some current regulatory formulas provide results by line of business, but those results are usually either calibrated for a typical mix of business (e.g., U.K. ECR) or consider each line of business separately, with no credit for risk diversification (in the current U.S. formula, there a separate step in which some diversification credit is applied).

Modeling can produce results by line of business, but any loading factor so developed for use with capital would not reflect variations by line of business.

CEIOPS work in developing models related to Solvency II may provide valuable information in this regard.

3. Ongoing companies and run-off companies

Capital levels from peer groups are for ongoing companies. Although there are some run-off companies whose obligations are similar to the liability for claims, they are few in numbers and their situations usually have unique characteristics that make application to the "normal" claims situation problematic.

Current regulatory formulas often show risk capital requirements separately for liabilities and new business (as well as for market, credit and operational risks). However, since current regulatory formulas are

normally applied with a loading based on judgment rather than by market observation, they may not be appropriate for claims liabilities alone.

Although modeling can handle ongoing and run-off situations, as with regulatory formulas, there are no data to test the convenient assumption that loadings used to convert model results to capital amounts held are independent of whether the company is an ongoing business or a run-off situation.

4. Allocation of capital by claim cohort (general insurance)

There is reason to believe that the risk level of claims changes significantly by age of claim, i.e., the cohort of claims that is unsettled five years after their occurrence or underwriting year has different claim characteristics than the cohort of claims unsettled in the first year after occurrence year or underwriting year.

Current regulatory formulas provide no guidance and peer comparisons provide no direct information on this issue. As with the line of business observation above, but to a more limited degree, it might be possible to obtain insight by testing whether capital levels differ for companies with different mixtures of claims by cohort.

D5 Formulas

D5.1 Risk margin when capital is a percentage (fixed or variable) of current estimate

In this formulation of the capital requirement, the capital itself must remain at the same proportion of the discounted value of claims. To achieve the required return on capital the risk margin at any time must be the present value of the excess return above the risk-free rate required on the capital in each future year. Let the required capital at time t be $f\ DBE_t\ w^k$ where w is the growth in the percentage of capital required and k is the number of years from the initial valuation date, the basis on which f is established. Then the additional cost of capital in the year from t to t+1 is $(x-a)w^k\ f\ DBE_t$.

To provide the required rate of return the risk margin (RM) at time t must be given by the following formula.

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

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

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

$$= f\,(x - a)\, v_a \sum_{k=o} \sum_{u=1} P_{t+k+u}\, v_a^{k+u+1}\, w^k \qquad \text{(Eq 1)}$$

If w=1.0, then

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

At the time of the transaction or valuation, this gives

$$RM = f\,(x-a)\, v_a \sum_{u=1}^{\infty} u\, P_u\, v_a^{u}$$

If w ≠1.0 then the expression is more complex, but the summations in Equation 1 can readily be handled in a spreadsheet.

D5.2 Lognormal distribution and the normal power approximation

The lognormal distribution is various described by its own mean and standard deviation and by the mean of standard deviation of the normal curve produced by the log transform (ln(x)) of its random variable x.

If the transformed variable (ln(x)) has mean zero and standard deviation "sigma", then the mean and standard deviation of the lognormal variable x are:

E(x) = exp ((sigma^2)/2)

Var (x) = (exp(sigma^2 -1)(exp(sigma^2)

For CV = the coefficient of variation of the lognormal curve

CV = sqrt(exp(sigma^2 -1), thus

exp(sigma^2) = CV^2 +1.

With these formulas in mind, we note that the skewness (gamma) of the lognormal distribution is

Gamma = exp (sigma^2 +2) * (sqrt (exp(sigma^2 -1)

= (3 + CV^2) *sqrt (CV^2) = (3 + CV^2) * CV

Given gamma, we can solve for CV using the following cubic equation,

CV^3 + 3*CV – gamma = 0

For gamma = 0.42, CV= 0.139
For gamma = 0.95, CV= 0.307

These values can easily be tested. In general, http://www.1728.com/cubic.htm has formulas and a routine to solve cubic equations.

The normal power approximation is a method to estimate the number of standard deviations needed to reach a certain confidence level and is based on the mean, standard deviation and gamma of the underlying distribution. The fit between the lognormal distribution with these coefficients of variation and the normal power approximation with these gammas is close as shown in Table D.5.

Table D.5 Comparison of a lognormal distribution and the normal power approximation at selected skewness (gammas)

Probability	CV = 0.139; gamma = 0.42			CV = 0.307; gamma = 0.95		
	Excess over mean			Excess over mean		
	Lognormal	Normal power approximation	% Diff	Lognormal	Normal power approximation	% Diff
65.00%	0.322	0.326	1.29%	0.238	0.251	5.12%
90.00	1.314	1.326	0.98	1.317	1.383	5.02
99.50	2.982	2.970	-0.40	3.488	3.468	-0.59
99.90	3.732	3.688	-1.18	4.615	4.444	-3.70
99.95	4.039	3.978	-1.52	5.102	4.846	-5.01

APPENDIX E – Current Estimate Assumptions

This appendix contains a discussion of specific assumptions (measurement inputs) to the calculation of current estimates of insurance liabilities (and reinsurance assets).

E1 Discount rates

E1.1 Current bases for discount rates differ, in some cases dramatically, depending on the financial reporting standard and contract type involved. Discount rate bases used to measure the present value of expected cash flows might consist of risk-free rates, high quality corporate rates, expected entity-specific investment earnings, current or initial credited rates, or imputed interest rates. Often discount rates depend on the duration of the cash flow being discounted, although in some cases they have taken the form of a single average rate.

E1.2 It is expected that in the future, discount rates will,

- if a contract's obligation is not directly linked to actual portfolio or contract specific asset performance, rates relevant to the timing, currency and liquidity of the expected cash flows will be applied, possibly based on a replicating portfolio or
- if a contract's obligation is directly linked to the actual portfolio of assets or contract specific asset performance, the expected future investment return net of expected investment expenses and default costs (linked rates).

E1.3 Three possible sources of unlinked discount rates that might be appropriate are high quality government bond rates, swap rates, or high quality corporate bond rates, possibly with an adjustment for expected default risk if relevant.

E1.4 These discount rates will be matched with the expected timing of the associated expected cash flows (i.e., yield curve specific). In cases in which discount rates have limited influence on current estimates of insurance liabilities or if there is a relatively flat yield curve, a single average discount rate may be used, depending on materiality considerations. If used, such an average discount rate would ordinarily be determined so its application results in a liability similar to what would be obtained by using the complete yield curve and may need to be revisited on a regular basis to assure that its effect remains similar to that of the relevant yield curve.

E1.5 If there are no relevant observable investment return rates, then the most similar available yield curve or interest rates would usually be used. For example, if there are no traded risk-free securities in a jurisdiction from

which to observe yield rates at a particular duration (especially in a jurisdiction where such bonds are not available at a duration as long as the expected insurance cash flows), then the closest available securities are usually used (unless the applicable financial reporting context or standard provides different guidance). For example, for a cash flow expected in 30 years and the maximum available applicable bond is 20 years, the interest rate for the 20 year bond is commonly used.

However, such an approach may result in discount rates that might not be considered to be consistent with market-based transaction prices (market-consistent). Such a deviation from the assumption that interest rates are directly observable should be disclosed and might limit the suitability of the resulting estimates. Note that financial models do exist to extend the bond yield curve, e.g., Hull-White.

E1.6 In situations in which projected investment returns of expected assets are used, an assumption of common stock returns can be important. Possible alternatives in this case include the use long-term bond assumptions or long-term market-based assumptions based on market expectations or long-term experience. In other cases, the expected return on policy loans might be considered. Many financial models have been developed to estimate future equity yields that may incorporate a mean-reversion assumption, a further discussion of which is beyond the scope of this paper, although it should be pointed out that such an assumption needs to be regularly evaluated to ensure that the results remain a current estimate.

E1.7 If the obligation is a function of a specific set of assets, either by contract or practice, the discount rates might be adjusted to reflect the investment return on those assets. The return on these assets still should be market consistent; i.e., an assumption that the return on these assets includes credit spreads would normally not be considered to be market-consistent. Examples of the effect of a contractual linkage include variable (unit-linked) contracts, although care is needed to ensure that the cash flows being discounted relate to the underlying assets and certain participating contracts some jurisdictions. Such an approach would represent an example of best practice. Expected investment returns of these sets of assets might be appropriate as the basis of the discount rates for these contracts if the price cannot be used directly, since the linkage is not sufficiently explicit.

E2 Mortality rates

In this section, the setting of the mortality assumptions for use in the current estimate of death benefits is described. Expected mortality rates can be separately discussed in terms of: (1) its *level* that describes expected mortality during the last observation period and (2) its *trend* that describes the expected changes in mortality over the period of coverage, beginning with the period from which mortality was last observed, to develop current estimates of expected future mortality benefits. Most of this discussion also applies to survival rates.

E2.1 The level

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. 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 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 over time.

E2.1.2 The mortality rates for most payout annuities will be lower than population mortality because healthier (than the general population) individuals usually choose to purchase payout annuities.

E2.1.3 In some countries, mortality tables for certain products, types of underwriting, markets, individuals or types of insurer have been developed for the insured population based on statistics from portfolio, entity, industry insured or general populations. Differences in the market in which an entity operates, the intensity of underwriting and risk classification systems between portfolios and insurers can significantly affect expected mortality. In other cases where relevant insured experience is not available or is not of sufficient size, population tables have been used with adjustments developed from other sources to reflect expected or partially observed differences arising from the underwriting of the entity's target population. As an approximation, these adjustments have been expressed as an adjustment to age (e.g., insured mortality age y = population mortality x-5) or by an adjustment to the mortality rates themselves (q_x) by a multiplicative

factor applied to the mortality rate of an individual age or an age group basis, often reducing by contract year. These adjustments may also vary by gender or other risk classification factor.

E2.1.4 Where relevant experience data is available, the estimation of the current mortality level applicable to the demographic and risk characteristics of a portfolio of insureds should be subject to statistical analysis, including:

- ~~2.~~• The mortality experience analyzed would ideally be based on the reporting entity's own portfolio of insureds with similar risk characteristics that were subject to similar underwriting approaches.
- ~~3.~~• The expected difference between the mortality of an insured population and the population from which the benchmark mortality experience was developed would be reflected, depending on such factors as age, gender, health, and smoking status, as applicable.
- ~~4.~~• The product type, type of sale and market involved: for example mortgage or pensions, term insurance, whole life or annuity.
- ~~5.~~• The issue year (select period).
- ~~6.~~• Underwriting procedures; for example, guaranteed issue, medical exam, or blood tested.
- ~~7.~~• Differences between the risk classification system in effect during the experience period and the business for which current estimates are being developed.
- ~~8.~~• Measurement based on sums (net amount) at risk rather than numbers of policies.
- ~~9.~~• Anti-selection effects caused by available termination options.

E2.1.5 Differentials in the mortality assumption (e.g., by risk class or product type) in the measurement of liabilities may be necessary if not considered in underwriting or pricing, as long as the business is not subject to adverse selection as compared to the entity's competitors. That is, if premiums do not differentiate between a given risk characteristic of the insureds, the resulting experience of a given subcategory may not be the same as if they were individually selected. An example where it might not be reasonable to differentiate among population segments is if no insurer could legally differentiate their premiums between genders. In this case, it may be reasonable not to use gender-specific mortality tables for financial reporting purposes either. However, if applicable experience relativities are available from the portfolio or other portfolios that use similar pricing differentials, the experience relativities would normally be used if they reflect the experience of the actual mix of insureds in the applicable portfolio.

E2.1.6 Reflection of the expected mortality experience of an individual insured is usually not useful, as measurement (unit of account) is usually portfolio-specific. It is common to use the expected mortality experience of the contract with respect to its risk classification category.

E2.1.7 Experience of similar groups of insureds is often the most relevant experience available that can be gathered. This may not be available in sufficient size to provide a fully reliable measurement base. To the extent that this experience is credible (that is, of a sufficient size and homogeneity), it should be used.

E2.1.8 In certain cases, statistical relationships between the experience of different insured groups cannot be precisely measured or can only be partly measured. If that is the case, less refined assumptions or sets of relativities may be justifiable, although if possible the reasonableness of such groupings or relativities should be validated in some manner, possibly through credibility techniques measured in terms of number of expected claims or volume of business. Important factors that can be considered include the mortality of the specific portfolio and the insured exposure (e.g., sum assured, face amount or net amount of risk), rather than number of policies or lives.

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). The less accurate the data is, the higher the uncertainty, resulting in a higher risk margin assumption.

E2.2 The trend

E2.2.1 Because expected mortality rates change over time and can significantly affect current estimates, it is important to account for this expected change in setting assumptions for current estimates. For a long time, especially during the last century, life expectancies have increased (mortality rates have decreased). For most insured populations, life expectancies are expected to continue to increase in the future. An important issue is thus how fast the mortality rates will decrease and for how long.

E2.2.2 The historical decrease in mortality rates has been a result of positive and negative forces affecting the health and mortality of humans. The historical

changes in mortality have been mainly caused by a combination of factors, sometimes positive (+) and sometimes negative (-), including:

- Medical and disease developments (+)
- Environmental effects (+ or -)
- Behavioral effects (+ or -)
- New diseases (-)
- For insured populations, changes in underwriting methodologies (+ or -).

E2.2.3 The effect of these trends can differ by population categories. For example, the net effect by age or gender may differ due to the relative effect of these factors, e.g., a new disease may significantly affect the very young but not affect at all those in their middle ages and changes in smoking habits can affect a cohort of insureds over a long period of time.

E2.2.4 Mortality rates for insured lives may also affected by improvement in underwriting methodologies (e.g., blood testing) or deterioration as a result of reduced underwriting screens necessitated because of the cost of the screens compared with their expected value.

E2.2.5 The rate of change in mortality rates was and is not expected to be constant. Several changes in trends have occurred, even in periods of generally increasing mortality rates, such as experienced in some countries for males at some age groups (45-75) between 1955 and 1975. This “hump” was caused by three negative drivers of change: increased frequency of heart disease, lung cancer due to smoking, and traffic accidents.

E2.2.6 The effect of these three drivers of change in the U.S. has been offset since the mid-1970s by medical developments and behavioral changes (e.g., the effect of significantly reduced rates of smoking by males, with effect of the smaller decrease by females expected to emerge shortly and enhanced treatment of blood pressure problems,). Other examples of increased mortality have included the effect of the AIDS epidemic in certain countries for certain ages and genders in the late twentieth century and the increase in alcohol use by Russian men in the late twentieth century.

E2.2.7 These and other potential factors can make it difficult, if not impossible, to reliably predict future mortality over a long period of time. Several methods to predict mortality have been in use, most based on an analysis of historical data over various time periods (e.g., through the application of the Lee-Carter method), sometimes supplemented by expert medical opinions.

E2.2.8 Very detailed models that have been constructed to estimate mortality trends can be classified in the following manner:

1. By cause of death. Problems with this approach include: the lack of knowledge of the effect of new causes of death or new treatments or

medicines, a lack of sufficiently detailed and accurate historical data with possibly misleading historical trends, and the possible lack of correlation between historical and future patterns in these causes.

2. By structure. A mortality table can be partitioned into 3 or 4 age segments:
   - child mortality (decreasing by age);
   - aged portion (exponentially increasing);
   - large middle age segment with relatively constant accident causes (except for certain age groups such as young males); and
   - large middle age segment for sickness causes (gradually increasing by age).

   Effective implementation of this model requires a detailed experience data base.

3. General model. For all causes of death combined, historical experience trends are extrapolated into the future. Future changes in trends can be ignored.

4. Expert opinion. Experts provide their opinions regarding the level and period of future trends in the aggregate or by certain demographic segments or causes. A problem usually encountered using this method is that rarely do two experts arrive with the same conclusions regarding expected trends.

In practice, combinations of these four models are often used. For example, a calculation might be based on a general model, but validated with expert opinions, possibly with differential trends by large age segments.

E2.2.9 Just as is the case with other assumptions, the validation of their reasonableness is important. Do the future levels and relativities in tables look reasonable? A simple application of a statistical formula may not provide reasonable results. The results should be compared with other published projections. If appropriate, it may be important to compare the results from nearby countries in a relatively homogeneous geographical region, as they may not be expected to be significantly different.

E2.2.10 The expected level and changes in policyholder behavior, particularly policyholder persistency, can affect the mortality of a portfolio. This behavior can vary by such factors as premium or bonus/dividend patterns by duration or age, particularly compared to current product design available in the market, or changes in health.

E2.2.11 If sufficient portfolio experience is available, it is usually preferable to evaluate its historical trends rather than those of the aggregate population, as portfolio experience should be more relevant and more homogeneous

over time. However, relevant portfolio experience is often not of sufficient size to permit this trend analysis. In addition, if changes in significant underwriting procedures or criteria have been applied over time, comparisons of general population may be more reliable. Observed and expected differences between these two types of experience sources can exist if portfolio-specific underwriting has selected out specific exposures (e.g., those with a history of cardiovascular disease) which are subject to different trends than other causes of death. In certain circumstances, such differentials can overwhelm or hide relevant underlying trends. Because the insured population may be subject to different influences than the aggregate population, caution is needed to use general trends without adjustment. It may be appropriate for both types of sources of information to be considered.

E2.2.12 The use of smooth tables based on Makeham or Gompertz models to estimate trends is usually not appropriate – these models spread special circumstances only applicable to a certain age group over a major segment or the entire table. Nevertheless, alternative approaches exist where the structure of the mortality table remains intact (see for example *NAAJ* vol. 6 no. 2).

E2.2.13 Depending on the volume of the experience base, it is often desirable to aggregate several years of experience to provide sufficiently credible experience. However, if too many years are used, there is a risk that the experience may be too out-of-date for use without adjustment. If the experience is out-of-date considering the expected trend in mortality during the period between the average period of the experience and current conditions, but is still relevant to the portfolio of risks, a trend factor should be applied to bring the experience to the conditions expected in the applicable future period.

E2.2.14 The time period over which a trend factor is to be applied needs to be determined. Differences of opinion exist regarding their application over different periods, especially regarding whether an expected improvement trend should be decreased after a period of time, such as ten or twenty years. The results of an extrapolation of the same trend factor forever may result in an overstatement of the aggregate effect of the trend over the long term.

E2.2.15 Although most actuaries are comfortable in estimating and applying expected trend in the case of annuities, they feel uncomfortable in the case of life insurance. Although this may affect the risk margin applied, there is no conceptual reason why the expected trend factors would be different for these two types of coverages.

E3 Property & casualty (general) insurance claim development

In this section, the estimation of future cash flows relating to property & casualty (general) insurance claims (and related expenses) for claims that have already been incurred is discussed. This liability includes estimates for reported and unreported claims. In general, these are assessed here in the context of a gross of ceded reinsurance basis of measurement, i.e., it does not reflect the effect of the specific measurement of or credit risk associated with ceded reinsurance assets. This section does not describe all of the many methodologies that have been developed. Rather, it describes some of the major considerations and approaches to the estimation of these cash flows.

E4 discusses estimates for unexpired risk liabilities for a stand-ready obligation, i.e., claims that have not occurred on contracts written or the estimation of potential reinsurance recoveries. Except for cases in which there exist evidence to the contrary, estimates of the stand-ready obligation use early experience (that is, relatively soon after claims are incurred) underlying the estimation of claim development.

Although the following primarily relates to the liability for property & casualty insurance claims, much of it also relates to claim liabilities for other insurance coverages, particularly for many forms of health insurance.

E3.1 Case liabilities, Incurred But Not Reported (IBNR) liabilities, and Incurred But Not Enough Reported (IBNER) liabilities

In the analysis of claim liabilities, expected claims may be separately categorized and separately assessed in the following manner:

- Case liabilities are those liability values assigned to individual claims that have been reported and recorded with an individual estimate at the valuation date, often set by claim adjustors, although for certain coverages, such as disability income, they are set by factors that are a function of the major characteristics of the claimants or claims. In some cases, these are assigned on an average basis depending on the type of claim involved, although this is usually applied when they are expected to be small or prior to insufficient information regarding the claims being obtained, without sufficient information to assess it on an individual basis.

- Incurred but not reported (IBNR) liabilities are for those claims that have not been reported to the insurer at the valuation date. In certain cases this includes cash flows associated with claims that may have been reported to the insurer but have not yet been recorded in the insurer's data base. In neither case has a case liability been assigned (pure

IBNR). In some cases the IBNR refers to the sum of (1) a liability for incurred but not enough reported (IBNER), which the difference between the total expected cash flows for a cohort of claims, less those cash flows that have already been paid, and less any current claim liabilities, and (2) the pure IBNR. This combined liability is also sometimes referred to as the bulk or actuarial liability, in that the amount is not attributable to specific claims.

The claim liability is measured for a specified cohort of claims, often grouped by type of claim and such periods as the year of accident, loss or notice (referred to as the accident or loss year, depending on the coverage and situation). The liability is either estimated on the basis of total losses expressed in terms of currency units or in terms of losses separately evaluated by their expected claim frequency and size, depending on the coverage and data available (these methods are more fully discussed in E3.5).

E3.2 Loss adjustment expense (LAE)

E3.2.1 Expenses associated with the claim liability are usually analyzed in the same manner as losses, although sometimes independent techniques are applied. Although in most cases they are analyzed separately, there are exceptions if LAE is small in relation with the losses, in which case they are estimated on a combined basis. In part, this is due to the options available in managing claims. In some cases, an entity can incur additional expenses to avoid making or to reduce the amount of claims payable; in contrast, if the entity decides to pay all of the claims submitted, there will be little claim expense, but a larger amount of losses – this indicates that losses and a certain amount of their related expenses may be negatively correlated.

E3.2.2 Differences in the definition of LAE categories can be important in any comparison and analysis of trends in these expenses, as they can differ by accounting policy or jurisdiction. Potentially important are expenses associated with coverage disputes (between the policyholder and insurer) that can sometimes be significant but may be accounted for differently between accounting systems and allocation of overhead.

E3.2.3 A common method is to separately analyze the expenses that can be associated with individual claims (allocated, sometimes referred to as allocated loss adjustment expenses) and those that cannot (unallocated, often consisting of claims and legal management and staff and their related costs, sometimes referred to as unallocated loss adjustment expenses). Different methods are usually applied in the estimation of these two types of LAE. In addition to the type and mix of claims and the accuracy of expense allocations, the entity's claim management practice can also contribute to the relative amount of expected LAE in relation to losses, the relative

amount of the two LAE or other types just referred to, as well as the speed of claim closing.

E3.2.4 Another aspect of the level of LAE may be due to relative efficiency of the entity's claim management process. Assuming that LAE is a non-market assumption, it would have to be measured on a portfolio-basis, reflecting the mix of claims and the business infrastructure used for managing the claim function, while if a market-based assumption, then some indication of what the market would charge for this function may be more relevant.

E3.2.5 Although in some areas, third party LAE fees charged might be observable (e.g., from third party administrators or outsourcers), recent historical LAE portfolio-specific development measured with respect to the portfolio or type of insurance coverage usually provides the most relevant and reliable experience from which to estimate future expenses. A review of third party claim administrator fees, although useful as a benchmark measure for this purpose, can provide misleading information, as they often vary widely by the specific claim portfolio's characteristics and volume of expected claims involved.

E3.2.6 Differences in the speed, claim management process and decision making can make a major difference in the overall claim and LAE costs. In addition, the interaction between claim management, LAE and claim severity is important in the analysis of claims, their losses and related LAE.

E3.2.7 Estimates of LAE should consider historical and planned changes in the claim management function. The effect of such changes can sometimes be estimated on the basis of annual expense budgets, but in some cases may vary as a result of changes in mix and volume of claims.

E3.3 Exposure to risk, frequency and severity

E3.3.1 Where available, analysis of experience is performed by exposure to risk, often measured by the premium charged or per contract, with the unit used varying by coverage.

E3.3.2 The frequency of claims is analyzed for coverages with relatively homogeneous claim exposure and claim count definitions, particularly for personal lines (e.g., protection against auto or home property claims), reflecting the ratio of the number of claims divided by the exposure to risk (although premium is sometimes used instead). There are several possible measures of number of claims that differ by coverage, e.g., the number of occurrences, the number of claimants, and the number of claims. This is not as often performed for other coverages, especially where contract exposures and claim counts are not homogeneous. A question could be

raised as to whether a notification is or is not a claim, particularly under claims made and liability policies.

E3.3.3 Severity (average size of claims) is a metric that represents the size of the claims. The expected claim cost per exposure unit is equal to the product of the estimated claim frequency and the corresponding estimated average severity.

E3.3.4 The use of certain exposure metrics may be problematic. For example, the pricing exposure base for commercial automobile liability coverage sold to garages could be the amount of sales or the garage area in square meters/feet, while that for truckers could be the expected driving distance. In such cases, the resulting frequency and severity calculations for each component would not be easily combinable into a single meaningful frequency and severity measure for total commercial automobile liability.

E3.3.5 Loss and LAE payments. To discount expected claims, the expected loss and LAE payment patterns are needed. These are generally applied separately on a coverage-specific basis, reflecting the expected payment pattern measured from the end of the loss year. In many cases, historical payment patterns can be determined for this purpose. In long-tail coverages, this can be more difficult, particularly for claims involving possible mass torts or new or slowly emerging types of claims, e.g., claims due to asbestos or lead paint liability.

E3.4 Relevant experience data

E3.4.1 In most cases, the analysis of claim development is primarily based on portfolio-specific data. Portfolio-specific data, rather than industry data is generally considered more relevant because it is based on the risk characteristics, coverage mix, and types and location of customers covered, as well as other characteristics such as claims handling.

E3.4.2 The measurement of obligations is typically determined separately by coverage or groupings of similar coverages with similar development characteristics and might be further segmented by type of claim, customer, policy, or size of claim, or geographic regions. Grouping of experience data used for measurement of claim development often differs from groupings used for pricing purposes and should reflect recent experience. Among other differences, pricing might reflect jurisdiction or rating territory within jurisdiction, as well as using portfolio-specific data for pricing limited ("basic") coverage, relying on broader groupings or even industry data to estimate the additional cost for the broader set of coverages. In contrast, liability measurement will often be based on a wider grouping of coverage, customers, markets and jurisdictions. As another example, many entities price using "basic limits," while relying on industry advisory factors where

available for the additional cost of higher limits, or utilize models to estimate the additional charge necessary for higher limits.

E3.4.3 Nevertheless, there are many situations in which portfolio-specific experience data does not provide a relevant or reliable indicator of the ultimate loss experience of a cohort of claims. In those cases insurance industry data may be the only credible alternative if, for example, the portfolio is new, small, in the process of undergoing significant management changes or in which claims are expected to be of a low-frequency, high-severity nature. Also, for certain long-tail lines of business, few entities have sufficient historical experience to make coverage or portfolio-specific information reliable or cover the full expected claim settlement period; in this case the entity would usually use industry experience to supplement its own experience data. In many cases, industry data is viewed as a last resort. Entities are more likely to extrapolate the portfolio specific experience, perhaps based partly on industry experience for estimating the tail, even though the tail is very dependent on the portfolio and the claim handling particulars of the portfolio. Also, industry data is generally only available at a high aggregate level that is broader than many categories used to measure claim liabilities by the medium to larger entities.

The selection of the proper balance of portfolio and industry data and the categories for analysis of claim liabilities often requires professional judgment reflecting the facts and circumstances involved.

E3.5 Methodologies

E3.5.1 Experience data should be adjusted for changes, if any, in conditions, including the law or regulations, claim processing procedures, underwriting selection, and claim coding, although in some cases these adjustments are made implicitly. In some cases claim experience is adjusted to a common level of historical rates of inflation, particularly if inflation has varied significantly during the experience period or is expected to be different in the future than in the past. If the benefits are directly affected by inflation, separate estimation of inflation is appropriate. Unusual data points or particularly severe individual claims can be excluded from the analysis and estimated separately. It is important to both avoid double-counting and forgetting about these unusual claims. These factors are usually appropriate if they can be validated by relevant historical experience, with uncertainties in these factors reflected in risk margins.

E3.5.2 For many products, estimated claim liabilities can be based on such methods as paid and incurred chain ladder (also referred to as link ratio, triangulation, or development) methods, cost per claim closed, frequency-severity, Bornhuetter-Ferguson (where a prior expected claim levels based on a relevant exposure base is used for early period of the claim cohort),

Cape Cod, Mack's method, and loss ratio-methods. Some of these only depend on historical claim development experience, while others also reflect estimated claims (using claim frequency and severity), policies, exposures, or premiums. Depending on the method, one or more variables may be used to estimate the expected claim development.

E3.5.3 Usually estimates of liabilities are based on more than one methodology – their results are assessed to determine which appear to produce more reliable and reasonable estimates. In some cases an average of two or more methodologies for the basis of the estimate, sometimes differing by claim cohort often separately by accident, report or underwriting year.

E3.5.4 Statistical modeling approaches can also be applied, albeit they are less common in many jurisdictions. Various refined methods, including those using stochastic simulation methods, are being increasingly used in certain circumstances, especially if confidence intervals or conditional tail expectations are desired as outputs from the methods applied (e.g., if used to measure risk margins).

The validity of these approaches, as with any approach, requires regular assessment, involving periodic validation. The objective is to use the method(s) considered to be the most reliable, given the experience available and appropriate expectations, rather than the blind adherence to the same approach(es) from period-to-period, although it is useful to document the reasons for any changes made.

E3.5.5 Selection of the liability methodologies applied is often based on professional judgment and may vary depending on the individual circumstances of the insurer, jurisdiction, coverage and accident year.

E3.5.6 Often a single “current estimate” scenario is developed, e.g., reflecting a single view of rates of inflation (including the influence of social, medical and general factors), current law affecting liability claims, and no mega-events of the type not already reflected in the experience data reviewed, e.g., no claims related to global warming or EMF radiation. It can exclude unusual data points, as long as the exclusion does not bias the resulting expected values and no change in claim handling compared with that of recent experience is expected.

E3.5.7 Insurance risks are often subject to skewed claim probability distributions, possibly both in terms of incidence more commonly severity, resulting in estimates resulting from a single "most likely" scenario often being less than the estimated mean value of all possible scenarios. For example, assuming a portfolio for which a frequency/severity approach incorporates an explicit inflation assumption would be appropriate if expected inflation might be either 4% with a 75% probability, or 2% or 8% (half or twice the expected

value, respectively) with probabilities 12.5% each, so that a probability weighted average (estimated mean value) of scenarios might result in an effective inflation rate of 4.25%, rather than a most likely scenario estimate of 4%. Usually a one scenario approach is only justified if the effect of the use of the entire frequency, severity or total claim cost probability distribution is not expected to result in a significantly different estimate. Given the above, a test of the sensitivity of the estimate to different assumptions can provide useful insight, through the use of probability distributions or scenario analysis, and through the use of multiple estimation methods.

E3.5.8 Extreme events (e.g., the risk of liability claims due to mass torts, radical changes in law or judicial rulings, or large single events with significant uncertainties or uncertain law/judicial rulings, such as the one or two event uncertainty relative to the 2001 World Trade Center event) can potentially contribute significantly to the estimated expected value of losses of certain coverages and markets, particularly where key data elements are unavailable at the valuation date. In certain situations, disclosure of the uncertainty in financial reporting approach is preferable to the use of insufficiently reliable estimates. Nevertheless, current estimates are usually made, even where they are subject to significant uncertainty, although the uncertainty should be appropriately be reflected in the risk margin and described in the insurer's disclosures. Note that applicable accounting standards or guidance might limit the use of such approaches.

E4 Stand ready obligation for property & casualty and other short-period contract periods

E4.1 In many jurisdictions, an unearned premium liability has been held for pre-claim liabilities. This liability is usually calculated on a pro-rata basis, depending on the time elapsed since the premium was paid (sometimes with a reduction for a pro-rata allocation of acquisition costs). If the exposure is non-linear over the contract period, the expected non-linearity can usually easily be reflected. This latter case can occur in situations with significant seasonal exposures, e.g., accident coverage of students while in school, automobile accidents during vacations/holidays or periods of high incidences of ice and snow, storm or warranty coverages by length of time since sale. In some jurisdictions, an unearned premium liability methodology may only be permissible if it can be demonstrated to be a sufficiently reliable approximation of the expected present value of risk-weighted future cash flows, considering both the uniformity of cash flows during the coverage period and that the period until settlement is similar for all claims.

E4.2 In other cases, the stand-ready (unexpired risk) obligation is determined as the current estimate of the expected value of the present value of risk-

weighted future cash flows for future claims associated with the ultimate settlement of those claims. This reflects the current value of the unexpired risk for the remainder of the contract period, less any applicable expected premiums. Similar to a longer-term insurance contract, it is based on an expected value of the cash flows associated with the contract remainder, also reflecting present values and an adjustment for risk. In some cases, payment of future premiums for the remainder of the contract period may be enforceable in non-life insurance; such enforceable rights relieve any concerns regarding the recognition of the premiums. For most cases in which renewal premiums are not under control of the insurer, an initial asset would be recognized excluding those expected to be uncollectible, although no renewal premium would be recognized, depending on the accounting standard and guidance. In many jurisdictions (as required by IFRS 4), this current value is used in a Liability Adequacy Test (LAT) when the basis for the stand-ready liability is the unearned premium.

E4.3 Many of the same factors as given in Section 4 of this report apply to the determination of the expected values used as a basis of this liability. Some differences may include:

- The expected cost of catastrophes for the unexpired risk period would be reflected for the remainder of the current contract period, while in most cases the emergence of a catastrophic claim is usually recognized at an early point in time as a cohort of claims are incurred.
- A liability adequacy test (LAT) would not be needed, as the calculations involved already inherently incorporate these expected values. However, a LAT would be required if current assumptions are not used.

E5 Expenses (other than loss adjustment expenses)

E5.1 Expense assumptions reflected in the expected value of future cash flows reflect future expenses associated with obligations arising from commitments the entity has made through the valuation date. These might, depending on the financial reporting standards and guidance, include some or all allocated overhead expenses.

E5.2 The extent of expenses included can be a function of the financial reporting standard under which the application applies. Incremental expenses are often used if the unit of account underlying the accounting policy is the contract, for example in as IAS 18 and 39. In contrast, if the portfolio is used as the unit of account, variable expenses (including allocated indirect expenses) would be used, e.g., as in U.S. GAAP SFAS 60. Other standards, including the tentative IASB's preliminary conclusions on phase 2 of its Insurance Contracts project, might only consider those expenses arising if the service provided could have been outsourced, reflecting a service profit margin with respect to the expected cash flows. Using the portfolio as a unit of account in those cases would permit some economies

of scale to be reflected, but not overhead. If an entity-based unit of account is used, e.g., as in many current regulatory reporting standards, all relevant overhead would be allocated and included in current estimates.

E5.3 Since significant differences can exist in the development of expense assumptions in different accounting standards, it is important to understand the accounting basis for which those expense assumptions will be applied. For example, the IASB in its Insurance Contracts Phase 2 project has not yet determined whether portfolio-specific, entity-specific or market-based measurement of expected future expenses is a more appropriate base. Even though portfolio-specific measures are apparently preferable, i.e., expense assumptions reflecting servicing needs of the portfolio measured rather than the service capacity of the entity, most insurance professionals favor entity-specific expense measures, as it is available, and is easier to measure and calibrate. In large part this is because it can be quite difficult to determine what applicable third-party costs would be for the product and service mix of a portfolio or entity and in most cases no reliable or relevant industry-wide inter-company or market-based expense benchmarks are available.

E5.4 If an entity-specific basis is used in setting expense assumptions, it may be useful to take into account:

- The entity's range of products and services provided, including the level of maturity of the portfolio;
- The entity's strategy for determining the level of service provided to policyholders and cost of the entity's infrastructure (and its approach to claim management for LAE, if applicable); and
- The entity's efficiency in providing that level of service (and implementation of its claim management approach, if applicable).

E5.5 An important element in the analysis of entity-specific or portfolio-specific expense experience data is the allocation of expenses. Important allocation categorizations include coverage or line of business, and between first year and renewal (or inforce) expenses, for which the latter is more relevant to long-duration contracts.

E5.6 The level of service and approach to servicing policyholders will usually affect both expense levels and voluntary contract termination and renewal rates. The cost of managing the entity's infrastructure can also be indicative of the entity's efficiency, although it can be argued that it is at least as indicative of the level of service expected in the price charged for a contract. For established entities, sufficient data is usually available for expense assumptions to be determined on a portfolio-specific basis. If practical, when developing a non-portfolio specific assumption, the entity's business strategy to achieve the desired level of service to policyholders (and its approach to claim management) can be taken into account. Its operational

and service-level strategies indicate that whether an entity may be more or less efficient than other market participants, while the expense assumption normally reflects the general level of efficiency in the market.

E5.7 The use of a portfolio- or an entity-specific approach on an expected value basis implies that it is appropriate to reflect, or at least consider, management plans to improve the efficiency of its existing service level and claim management strategy incorporated in the assumptions. Historically, allowance for the effect of projected improvements has usually been taken into account only when there is clear and objective evidence that it is appropriate to do so, that is, only to the extent that management has already developed specific plans and has a track record of being able to carry out such plans. In any case, the expense needed to execute such changes would be considered, as well as expected improved ultimate level of expenses. It is usually difficult to verify in advance that projects will achieve an improvement exceeding its cost, considering the large number of such projects that ultimately do not result in improved expense efficiency.

E5.8 All relevant administrative cost and applicable commissions would be estimated, although depending on the applicable financial reporting standard, only contractually-linked expenses are recognized in the measurement of the liabilities. Depending on the entity's accounting policy, if the unit of account is the portfolio or the entity, variable expenses or even general overhead expenses might be included. Where future deposits or premiums are incorporated into the measurement of insurance liabilities, expenses related to those deposits or premiums would also be taken into consideration. In addition, where appropriate the expenses of administering investments and related expenses could be taken into consideration in the determination of the discount rates.

E5.9 In developing assumptions regarding future cash flows, one-off expenses during the experience period would usually be eliminated. However, such expenses should be reviewed carefully, since many entities can incur similar in size but different in nature one-off expenses on a regular basis. In any event, small one-off expenses should not be adjusted for, as these types of expenses usually will reoccur, even though due to different circumstances. However, it would not be appropriate both to deduct the current investment in a new administrative system while at the same time to reflect the cost savings that are expected from the system’s implementation. Such adjustments from recent historical expense levels can go both ways; for example, a producer convention may not be held every year – in the year that one is not held, such expense may have to be added to that of the experience period.

E5.10 Subject to specific market conditions, expense assumptions for long-duration contract portfolios normally assume that the entity will maintain a

reasonable level of new business and, therefore, the assumptions for the closed book, i.e., the book of policies in-force at the measurement date, would ordinarily be based on the current level of economies of scale.

E5.11 Even when the entity's accounting policy indicates that entity-specific expense assumptions are used, in situations such as a start-up or wind-down of an entity, or where the allocation of expenses is unusual, available expense data may not serve as an appropriate basis for projecting future expenses. Normally in such a case it is appropriate to examine the experience data carefully so that the resulting assumptions provide for a reasonable level of future expenses consistent with the administration of contracts, investments, and claim settlement, and that satisfy the objective of the valuation. If a reliable steady-state expense data base is not available, alternative sources will have to be used or developed, e.g., industry studies if any, reinsurer advice (particularly for start-ups), third-party administrators specializing in run-off books of business in the case of a wind-up operation, or the entity's pricing assumptions.

E5.12 Future inflation-sensitive expense cash flows are usually assumed to vary with the assumed rates of general level of expense inflation in a reasonable manner. The starting point is normally the current level of inflation, with subsequent inflation assumed to reflect the expected relationship between inflation and future interest rates. A factor is then normally be added to reflect the issuer’s level of unit expense trend relative to the market level of price inflation, when justified by the relative nature of the entity’s business relative to that underlying observable market data, often consistent with assumptions of future interest rates. In some jurisdictions, technological efficiencies and market growth have more than offset general inflation in the trend in unit operating expense. However, if the unit metric used is based on the number of contracts, this net productivity improvement has been far more difficult to achieve. As different types of expenses are sensitive to inflation to differing extents (e.g., commission expense that is determined by formula in contrast with wage and benefit costs, which has often increased faster than general inflation), different rates of expense inflation may be associated with different types of expenses, although this applies only if discount rates are based on the entity's expectations.

E5.13 Where external parties provide services, such as for policy administration or asset management, consideration is given to the terms of these agreements, including the possibility of their termination.

E5.14 Relevant expenses of the entity’s holding company or any related entity providing inter-group service would also be reflected, although if a measurement approach that relies on market prices is used, the equivalent cost available from the observable market place of the amounts charged by an independent third-party or transfer costs used for tax purposes might be

appropriate. In the case of consolidated group financial statements, such inter-group charges will not have an effect, and the liability measurement will normally be based on the total actual expenses of the group, not necessarily what is charged.

E5.15 The expenses charged to the entity by a guarantee fund (whose purpose is to provide benefits to policyholders of entities who for financial reasons cannot pay them) in a jurisdiction are a necessary cost to many insurers. This is usually based on an allocation of these costs allocated to the entity, often a function of prior business volumes of an entity. Although not a cost directly associated with the portfolio, it is generally felt that it is a cost of being in business and thus the expected charges, based on expected recent changes in volume of the entity, the cost of recent bankruptcies of other insurers, and expectations regarding future volumes and insurer bankruptcies would be reflected in the aggregate expense assumption.

E6 Policyholder behavior

Especially for certain long duration contracts, the effect of the election of policyholder options is important to reflect in the current estimate. If the measurement of the liability is unconstrained by the applicable financial reporting standard (i.e., some accounting systems do not permit certain policyholder behavior assumptions to be used at all), it would be appropriate to reflect the expected effect of the expected use of these options. See Section 5.1.6 of the paper for further discussion of consistency of assumptions. Special consideration should be given to apparently irrational policyholder behavior, since fundamental economic theory and models are based on the assumption of rational behavior.

Options available to the policyholder can include the termination of a contract (contract discontinuance rates, sometimes referred to as lapse or surrender rates) and use of non-forfeiture benefits where available, payment of scheduled or non-scheduled renewal premiums use of guaranteed insurability features, policy loan utilization, contract exchange, or other contractual options including guaranteed living benefits such as annuitization, guaranteed insurance options, partial withdrawals (partial contract discontinuance, either of a portion of the benefits or account values), and guaranteed income benefits. Their use can be particularly affected by other contract features and external conditions and insurer behavior, including being sensitive to interest rate levels or option costs such as surrender charges.

Some financial reporting standards require, for the purpose of estimating liabilities that rational financial behavior by policyholders that would result in the most disadvantageous effect for the insurer. However, it can be difficult in some cases to determine which the worst case is, considering the

expected effect of anti-selection and moral hazard, particularly when current or future guaranteed insurability is involved. Examples of such situations include lapse-supported products (those in which the insurer can increase its expected profitability if greater voluntary terminations occur, such as long-term care contracts without cash values and with a very steep expected cost curve) or even 100% lapsation in certain cases, which may not be realistic and would be inconsistent with current estimates. The worst case often would arise if all healthy policyholders terminate their contracts and all those with significant physical impairments remain. Realistic current expectations would incorporate at least some policyholder action or inaction that is not within their expected best interest (e.g., due to convenience, forgetfulness or loyalty to a producer). Alternatively, what might appear to be irrational behavior to external parties might be consistent with rational risk preference or personal conditions.

E6.1 Extent of rational behavior

E6.1.1 Based on observation, not all policyholders behave in what appears to be a rational financial manner. Unless constrained, expected assumptions can reflect that the extent of rational behavior is limited. For instance, even if insurance or investment guarantees are significant, certain policyholders will discontinue their contract in any event due to many reasons, including changes in their individual circumstances that the insurer will be unable to observe, or the existing policy will be exchanged for another that a producer of another entity presents to the policyholder. In contrast, other policyholders will continue to pay premiums whether or not they remain in need of the protection, in some cases as a result of having them automatically deducted from their checking account or from pure inertia.

In addition, because of fear of lack of current or future insurability or the focus on expected future contractual guarantees that might not currently be in-the-money, expected policyholder behavior, particularly on an individual basis, will be rarely lead to 100% termination. This behavior under a range of scenarios can be difficult to estimate.

The extent or quality of customer service level or perceived brand value, both entity-specific factors, can influence many policyholder behaviors.

E6.2 Discontinuance rates

E6.2.1 For most contracts, contract discontinuance assumptions are estimated, since the entity is exposed to risk from the potential use of the policyholder options to withdraw or persist, and if termination is decided upon to select the timing or the amount of such contract termination. Discontinuance can result from ceasing premium payments (this does not mean that the reporting entity's liability is necessarily eliminated at that time) or terminating

the contract. Discontinuance can give rise to such action as the payment of surrender or transfer values, the exchange for a paid-up policy, or to a lapse without value.

E6.2.2 For most one-year contracts, a more common issue is the possible renewal of the existing contract. In most financial reporting standards, these renewals are only recognized when the accounting measurement objective is fair values when current customer relations are considered. Even in this case, the primary attribute recognized would be non-level claim costs across renewal periods.

E6.2.3 The following are some considerations that can affect expected discontinuance assumptions. Most of these factors are portfolio-specific, although some are applicable on an entity-specific or type of product-specific basis, with many the result of contract features, policyholder characteristics, and overall conditions that affect the market or overall industry.

- Benefits and options provided through contract features;
- The way the contracts were sold and marketed (e.g., a universal life contract sold as low premium term insurance or primarily for investment purposes)
- Contract duration, attained age and gender;
- Premium frequency and payment method and mode;
- Premium paying status;
- Size of contract and current, expected future, and changes in the financial condition of the policy owner;
- Relative advantages of lapsation/withdrawal and persistency to the policyholder (e.g., due to insurability, current or anticipated tax and other benefit situation);
- Incentives, such as pattern of surrender charges (especially the end of a surrender charge or conversion period) and/or persistency bonuses;
- Sophistication and price-sensitivity of the policyholder and intermediary;
- Expected extent of competition for the product;
- Interest rate scenario and other economic factors (particularly for so-called “interest sensitive contracts”);
- Insurer behavior and decisions, e.g., timing and amount of bonus/dividend distribution compared to expectations and competition, service level provided, non-guaranteed elements credited or charged, interest rate credited compared to that available elsewhere;
- Distribution system, type of producer, and other marketing practices applied;
- Claim management practice, particularly for non-life coverages;

- Culture, such as the contrast between the very low annuitization rates in certain Western countries (e.g., the U.S.) and certain East Asian counties (e.g., Japan); and
- Expected changes in aggregations as a result of changes in the entity's portfolio mix.

E6.2.4 If not guaranteed, the measurement of the surrender value payable on contract discontinuance, the following will usually be taken into account:

~~2.~~• Market and non-market assumptions applied in the projection;
~~3.~~• Any guaranteed surrender or transfer value scale; and
~~4.~~• Constructive or discretionary obligations provided for within the contract.

E6.2.5 Discontinuance experience normally has a significant effect on overall profitability to the issuer of many insurance and investment contract types, particularly its effect on expected future margins that exist to recover initial acquisition expenses and to compensate for the risk and service provided. To the extent practical, relevant and reliable discontinuance experience is used. In the absence of reliable experience data for the class of risk under consideration (e.g., new products or later durations in the policy), other comparable sources would normally be considered. These assumptions usually have to be portfolio-specific, reflecting other factors, including product and risk characteristics such as age.

E6.3 Other optionalities

E6.3.1 The cash flows of a contract can be affected by the use of policyholder options.

E6.3.2 Future premiums. The most commonly offered policyholder option is payment of future premium payments or deposits.

E6.3.2.1 These premiums or deposits may be regularly scheduled or their amount and timing can be flexible, e.g., for many universal life contracts. These latter include dumps or irregular premium paying patterns and partial withdrawals, which are separately estimated if the accounting standard provides for the effect of the expected pattern of use of these policyholder options.

E6.3.2.2 Other premium option features include automated premium increase acceptance where the policyholder has the right to not accept an automatic increase in an indexed policy or premium holidays in a pension contract.

E6.3.2.3 These are generally not under the control of the insurer, so may be considered by some financial reporting standards as intangible embedded assets. However, in most cases they are recognized in the measurement of

future cash flows anyway, as they may be considered an integral part of the insurance contract.

E6.3.3 Other. Other examples of policyholder options that may or more not have associated costs to an insurer include:

- annuitization (often of deferred annuities, but also possible as a form of settlement of a life insurance death or maturity benefit);
- conversion of a term insurance contract for a permanent life insurance contract,
- allocation of account values among alternative asset funds,
- exchanges of one life insurance contract for another of a different or similar type, without or without evidence of good health,

E6.3.6 In many cases, the effect of the use of these options is asymmetric in nature. Although closed form solutions or other bases for developing estimates may be developed or possible to be developed, a set of representative or stochastically generated scenarios may be just as or more appropriate to use in the calculations involved in some cases.

E6.3.7 Depending on cash flow expectations, the effect of this behavior can be restricted by the form of contract. For example, depending on the financial reporting rules, renewal of one-year contracts may not be recognized, although the probabilities may be the same as if the contract were written in a perpetual form (with or without conditions). A different treatment may apply depending on the ability of the insurer to change premiums or when future premiums are not specified in the contract.

E6.3.8 The expected behavioral affect on utilization and cost of any deductibles, coinsurance or experience rating arrangements on claim experience of health insurance and some property & casualty insurance contracts.

E6.3.9 Other policyholder options may or may not have costs associated with them. These can include:

- Use of policy loans, including the right to take out or change the amount of the loan and the right to specific conditions of a loan;
- Add a new family member to an existing contract, either at a guaranteed or current rate;
- Change or add insureds, insured properties, beneficiaries or owners;
- Change the form of contract or feature of a contract, e.g., from a with-profit to a not-for-profit contract;
- Choose or change coverages and amounts in a group plan by an employee or participant;
- Reset conditions or terms of guarantees, e.g., segregated fund resets;
- Choose or change the form of dividend payouts, e.g., cash, paid up additions, term insurance, and accumulations;

- Change the Bonus Anticipation Rate;
- Choose a lump sum payment or an annuity form at retirement or other annuitization date;
- Choose annuity payout forms other than single life (systematic withdrawal, joint and survivor, fixed period, etc.) at retirement or other annuitization date, where the benefit is a fixed percentage of the benefit for a single life;
- Choose the timing of retirement or other annuitization date;
- Accelerate benefit payments in the event of a dread disease; and
- Utilize a free-look provision, e.g., right of return of a policy in the thirty days after a sale, or otherwise rescind a contract.

E7 Other assumptions

E7.1 Insurer behavior

E7.1.1 Insurer behavior can affect the delivery of certain contractual elements for which discretionary action or the method of delivery is allowed or inherent in the product or service provided. These can include policyholder dividends/bonuses, charges, fees or interest credits. For some products, the interest crediting process (the interest rate guarantees or the amount credited in excess of the guarantees) can become complicated, e.g., a deferred annuity contract may be assigned 24 or more interest rate crediting buckets corresponding to when the corresponding premiums (or deposits) were received, all associated with a different interest rate. In this case, deriving reasonable behavior estimates under each practical scenario can be quite complex. In addition, insurer behavior can affect the expenses allocated to provide insurance risk services, such as the method of handling claims.

E7.1.2 If this behavior is restricted, for example by law, regulation, constructive obligations, or contract a single set of behavior is assumed to be consistent with the applicable restrictions, although it might vary by scenario. Alternative behavior may also be reflected if appropriate (on either a deterministic basis, or if asymmetric risks/costs are involved, using stochastic or representative sets of behavior consistent with economic and demographic characteristics).

E7.1.3 Contractual constraints on insurer behavior include a wide variety of guarantees embedded in an insurance contract. These vary significantly by type of insurance, contract and jurisdictions. They can include such guarantees as:

- Contract continuance and renewal, based on guaranteed or market rates;
- Premium, charge and fee guarantees or maximums;

- Cash, non-forfeiture, capital (principal), and maturity values, either in terms of absolute amount or a value based on current conditions;
- Minimum benefits or credited or committed credited investment earnings;
- Annuity benefits, e.g., conversion rates, annuitization assumptions (e.g., mortality table), and death, withdrawal, living or income benefits;
- Guaranteed future insurability benefits, in the form of ability to purchase additional insurance or maintain currently determined benefits; and
- Immediate coverage after application signature.

E7.1.4 Changes in corporate strategies, whether in response to changes in conditions or management, should be reflected as they emerge or in certain cases as they are implemented successfully.

E7.1.5 Constraints to the recognition of the effect of this behavior is common, possibly as a result of contract features, legal requirements, or constructive obligations. Insurer behavior can also be prescribed based on its board resolutions or company policy.

E7.1.6 Insurer behavior can affect future insurer expenses, in terms of efficiency and effectiveness of operations of almost all of its functions, including those related to claim administration.

E7.1.7 Applicable financial reporting standards may require certain assumptions regarding expected behavior.

E7.1.8 Expected consequential policyholder behavior should be consistent with assumed insurer behavior. In addition, assumed insurer behavior should be consistent with the other assumptions selected.

E7.2 Reinsurance considerations

E7.2.1 In general, the counter-party to a reinsurance treaty is assumed to be knowledgeable about the contingencies involved. For example, it is usually assumed that the counter-party will exercise the terms of the agreement to its financial advantage, e.g., its ability to exercise contractual changes, usual and customary practices within the industry, and past practices of the parties involved. This can include recapture or commutation of a treaty, payment of a reinstatement premium to restore reinsurance protection, rating trigger of an action if a reinsurer's rating decreases to a certain level, change to the current scale of reinsurance premiums or expense allowances that may be dependent on the scenario of cash flows, and recapture options.

E7.2.2 Counter-party credit (non-performance) risk. The payment history, credit rating, risk-based capital ratios or other available relevant information about

a reinsurer are taken into account in determining the probabilities of expected reinsurance recoveries that affect the measurement of the reinsurance asset. The extent that these factors are considered in the insurance liability or reinsurance asset will depend on the accounting standard for reflecting this risk.

E7.3 Other assumptions

Other assumption not described in this paper include morbidity and recovery rates for contracts involving health insurance, rates and amounts of salvage and subrogation, longevity rates for pure endowments, annuitization and conversion rates.

TABLES AND CHARTS

GLOSSARY

- **Assumption**. An input parameter used in an estimation model to measure actuarial items, such as liabilities for insurance contracts or economic capital for an insurer.

- **Asymmetry**. The extent to which a probability distribution deviates from a symmetric form (with equally weighted sides around the mean.

- **Best estimate** (also see *current estimate*). Usually refers to as a best available estimate of an expected or mean value (i.e., probability-weighted average of all possible outcomes), which is the interpretation taken in this paper. In some circumstances can refer to the most likely outcome or include a risk margin as in IAS 37.

- **Blue Book** (see *A Global Framework for Insurer Solvency Assessment)*

- **Capital**. The amount of resources available in excess of the entity's liabilities, sometimes referred to as the net assets of the entity. *Economic capital* is the amount of capital required to maintain a viable entity. *Regulatory required capital* is the minimum amount of capital an insurance entity needs in order to remain in business without a regulator requiring an adverse action, such as taking control of the entity.

- **Conditional tail expectation** (also referred to as *Tail Value at Risk* (*TailVaR*)). The conditional expected value of that part of a probability distribution that lies above a given quantile.

- **Cost of capital**. The opportunity cost associated with a given amount of capital.

- **Cost of capital method**. An approach used to estimate risk margins that is determined based on the cost of holding the capital needed to perform the obligation.

- **Credibility**. In actuarial literature, it is the extent that a given set of information can be used or relied upon for the purpose of estimation. In its application, information from a first source of information is given a certain weight, while external or other information is given its complementary weight (one minus the first weight).

- **Current entry value**. The amount a policyholder would have to pay to an insurer at a point in time if the policyholder would acquire a new contract of a

similar nature for its remaining lifetime at that point in time. It is a result of the application of a customer consideration model.

- **Current estimate**. The unbiased estimate of future cash flows, considering all currently available information, that reflects the time value of money.

- **Discontinuance rate** (also referred to as *surrender rate*, *lapse rate*, or *policy termination rate*). The probability of a policyholder terminating a contract, usually on a voluntary basis. The conversion of the contract through a non-forfeiture option is usually included in this probability.

- **Exit value**. The amount an insurer would expect to pay or receive at the current date if it transferred its outstanding rights and obligations under a contract to another entity.

- **Explicit assumption method**. An approach used to estimate risk margins included in the measurement of a liability in which margins are estimated for each major assumption under risk explicitly.

- **Extreme event risk** (also referred to as *catastrophe risk*). The risk of occurrence of outcomes with unusually high severity, usually with a very low probability of occurring.

- **Fair value**. The amount for which an asset could be exchanged or a liability settled, between knowledgeable, willing parties in an arm's length transaction. [IAS 32.11]

- **Financial risk**. The risk that the market assessment of the value (its price, including applicable time value of money) of an item changes, without reflecting a change in the item itself: "The risk of a possible future change in one or more of a specified interest rate, financial instrument price, commodity price, foreign exchange rate, index of prices or rates, credit rating or credit index or other variable, provided in the case of a non-financial variable that the variable is not specific to the party to the contract." [IFRS 4, Appendix A]

- **General insurance** (also referred to as *property & casualty insurance* or *non-life insurance*). Insurance covering property and liability risks. Sometimes includes health insurance risks.

- ***A Global Framework for Insurer Solvency Assessment*** (also referred to as the *Blue Book*). Written in 2004 by the Insurer Solvency Assessment Working Group of the IAA.

- **Guarantee**. An obligation that is not subject to an option of the obliged and does not specifically depend on the performance of the obliged.

- **IFRS 4**. International Financial Reporting Standard Number 4, "Insurance Contracts".

- **Insurance**. Accounting: A contract feature under which one party (the insurer) accepts significant risk from another party (the policyholder) by agreeing to compensate the policyholder if a specified uncertain future event (the insured event) adversely affects the policyholder. [IFRS 4, Appendix A]. The legal definition of insurance is subject to local law and regulation, but in all cases relates to the provision of insurance coverage.

- **IAA**. International Actuarial Association.

- **IASB**. International Accounting Standards Board.

- **IAIS**. International Association of Insurance Supervisors.

- **Liability** (the liability for an obligation for an insurance contract in some regulatory contexts is referred as a *technical provision* or *actuarial reserve)*. The amount recognized in the balance sheet of an entity that represents the net effect of the net obligations under an insurance contract. Accounting: "A present obligation of the enterprise arising from past events, the settlement of which is expected to result in an outflow from the enterprise of resources embodying economic benefits." [IAS 37, Definitions]

- **Life insurance**. Insurance risk associated with the death or survival of an insured. It often is used to include annuities, and in some contexts also includes some forms of health insurance.

- **Loss adjustment expense** (for life and health insurance sometimes referred to as *claim settlement expense*). Expense of an insurer associated with the management or defense of its obligation with regard to claims made under an insurance contract.

- **Margin over current estimate** (*MOCE*, see *risk margin*). The risk margin that reflects the level of risk and uncertainty in the determination of the current estimate.

- **Market factor**. A specified interest rate, financial instrument price, commodity price, foreign exchange rate, index of prices or rates, credit rating, credit index or other variable, provided that in the case of a non-financial variable the variable is not specific to a party to the contract. [taken from, but not defined in IFRS 4, Appendix A, in the definition of *financial risk*]

- **Measurement input** (also referred to as *assumption*).

- **Non-market assumption**. An assumption that refers to items other than price available from a market, such as mortality rates in the case of life insurance contracts.

- **Normal distribution**. A probability distribution which is symmetric around its mean whose density takes the form of a bell-shaped curve with a single peak.

- **Obligation**. The duty associated with a contractual promise or arising from regulatory requirements. Accounting: "A duty or responsibility to act or perform in a certain way. Obligations may be legally enforceable as a consequence of a binding contract or statutory requirement. Obligations also arise, however, from normal business practice, custom and a desire to maintain good business relations or act in an equitable manner." [IASB Framework, 60]

- **Offsetting risks.** A risk mitigation technique that uses the negative correlation of the uncertainty associated with a second set of obligations or rights to reduce the risk for a first set of obligations or rights.

- **Operational risk**. A risk of loss resulting from inadequate or failed internal processes, people or systems, or from external events affecting the operations of the entity directly, rather than directly related to contractual related risks.

- **Option**. A right under a contract to unilaterally select one of a defined set of rights or obligations subsequently available under the contract.

- **Parameter risk**. The risk of an estimation error in an underlying parameter in the measurement of a financial item.

- **Percentile method** (see *quantile method*)

- **Policyholder behavior**. Selection by a policyholder of an available option within a contract.

- **Policyholder bonus** (also referred to as *bonus* or *policyholder dividend*). The amount paid to a policyholder by an insurer relating to a participating (insurance or investment) contract in excess of what is contractually guaranteed.

- **Pooling**. A risk mitigation technique involving the grouping of insurance contracts with similar insurance risk exposures.

- **Portfolio**. A group of similar items managed in combination.

- **Probability density function** (*PDF*). The shape of the probability curve of a mathematical function of a continuous random variable. It is the first derivative

of the *probability distribution function* (sometimes referred to as the *cumulative distribution function*] is the probability that a value is greater than a certain number.

- **Process risk** (also referred to as *deviation risk*). The risk of statistical fluctuation of an uncertain value due to a lack of size of what is being measured. It can be measured before or after risk mitigation techniques are applied.

- **Quantile method** (also referred to as the *Percentile method*). An approach used to estimate risk margins that expresses uncertainty in terms of the excess of a percentile (quantile) for a given confidence level above the expected value for a given period, such as the lifetime of the coverage.

- **Reference entity**. A large, well diversified and financially secure entity that is used to identify a hypothetical entity to determine certain assumptions in a measurement approach. In certain applications, the entity is assumed to be fully diversified.

- **Reinsurance**. An insurance contract issued by one insurer (the reinsurer) to compensate another insurer if an insured event occurs. [IFRS 4, Appendix A]

- **Replication**. A method by which reliable prices can be assigned through equivalent means, such as through observation of market prices for one or more transactions that are equivalent to the value desired.

- **Risk**. The variability in outcomes in a process that is fully understood, e.g., the result of rolling a pair of fair dice. [IAA Blue Book]

- **Risk concentration**. The extent to which an entity is overly exposed to a particular risk or type of risk.

- **Risk diversification**. A risk mitigation technique involving diversifying the portfolio. A risk is diversifiable if it is of sufficient size and type for which there are sufficient uncorrelated but dissimilar risks available to reduce the fluctuations caused by the risk or type of risk in a diversified portfolio.

- **Risk margin**. The amount of a measurement of a liability associated with the risk and uncertainty associated with insurance risk. An amount or *margin* reflecting an assessment of the uncertainty inherent in an insurance risk with certain attributes based on a specific measurement approach.

- **Risk Margin Working Group** (*RMWG*). The Task Force of the IAA, initiated in 2005, to respond to a request of the IAIS.

- **Risk mitigation technique**. A management approach that reduces a risk born by the entity.

- **Service margin**. A margin included in the measurement of a liability for services not involving insurance risk, if market participants would be expected to require such a price for accepting the risks associated with providing the service.

- **Skewness**. The extent to which a probability distribution deviates from that of a distribution which is symmetric in nature.

- **Stand ready obligation** (also referred to as an *unexpired risk liability*). The obligation to be prepared to deliver resources, e.g., a product or service in response to an event outside the control of the obliged.

- **Swiss Solvency Test** (*SST*). Statutory test of the adequacy of the capital held by a Swiss insurer.

- **Tail of the liability**. The portion of the probability density function of the expected cost of the remaining contract risk exposure in excess of a specified high confidence level.

- **TailVar** (see *Conditional tail expectation*)

- **Technical provision** (see *liability*). An amount set aside on the balance sheet to meet liabilities arising out of insurance contracts, including claims provision (whether reported or not), provision for unearned premiums, provision for unexpired risks, life assurance provision and other liabilities related to life insurance contracts (e.g. premium deposits, savings accumulated over the term of with-profit policies). [IAIS, Glossary]

- **Total balance sheet** (also referred to as *total financial resource requirements*). The sum of the technical provisions and required capital of an entity resulting from a specified regulatory measurement approach.

- **Uncertainty**. The additional variability in outcomes that occurs because the process is not fully understand, the model used might be incorrect to some degree and/or the actual model parameters will vary from the estimated parameters. [IAA Blue Book]

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