CAPITAL MODELLING

FOR GENERAL INSURANCE ICAs

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A. INTRODUCTION.

A.1 OBJECTIVE OF THIS PAPER.

What does the paper do?
Under the ICAS (Individual Capital Adequacy Standards) regime in the UK, a firm is required by the regulator to undertake regular assessments of the amount and quality of capital which in its view is adequate for the size and nature of its business in order to meet the liabilities as they fall due.

Firms have to produce an internal capital model for their Individual Capital Assessment (ICA). This paper is intended to assist actuaries in this task, but also to help the reader understand the background to the issues involved. Thus it describes more than just capital modeling for ICAs: for example, the ICA requires the use of specified risk measures, but for other circumstances, a firm might wish to use different ones, as discussed in section B.2.

The paper is written as educational material. The style is sometimes a description, sometimes a checklist where this is helpful. Occasionally there is some repetition of material, when we found it useful to discuss the same topic under different major headings.

Who is the paper aimed at?
The paper is aimed at a senior actuary responsible for the overall output, and the users of his work, to see that it meets the necessary principles. We assume that the reader already has a reasonable knowledge of capital modeling, so that we do not give detailed "recipes" with which to build. There is much already published material, and we do not aim to repeat all that has already been well written elsewhere. Instead, we have at times provided a "signpost", which enables the practicing UK actuary, or users of actuarial advice, to find in one place the issues he/she needs to be aware of, and the materials that are available for him/her to draw on.

What does the paper not do?
Capital Modelling is a complex and fast moving subject, and the paper does not aim to cover the whole topic, which would be too big a task. It does not go into deep technical or mathematical details, instead it is a practitioner's guide, in other words, given that you have a model, what issues should you consider when using the model. There is a wide range of suitable approaches, depending on the particular circumstances and the scale of any firm or portfolio, and we believe that it is not possible to provide "one single best" set of approaches. Instead, the paper pulls together into one document what its authors believe to be the issues and questions that need to be addressed in most calculations of capital requirements, together with suggestions of the most likely approaches.

A.2 I.C.A. RESPONSIBILITIES: ROLE OF THE ACTUARY VERSUS THE BOARD.

Not all of the work in an ICA is done by the actuary. The ICA submission is the responsibility of the Board. The Board might contain a range of skills and experience, from inside and outside the insurance industry. It is the responsibility of the firm's senior management and Board to ensure that these people own and challenge:

- the input assumptions;
- the model itself;

- the outputs from the model.

The more detailed and robust (i.e. well understood and documented) the link between risk identification and capital setting, effectiveness of key controls, and assumptions/parameterisation and data evidence, then the greater the level of confidence in the output.

Generally the actuary will play a central role in building the capital model. He/she can particularly contribute by showing the need to obtain high quality data, and by helping the firm pay particular regard to sources of uncertainty when modelling the risks that it faces. He/she should also be aware of creating the links with other professionals, as expanded on in section A.3.

A.3 COMPETENCIES AND RELIANCE ON OTHER PROFESSIONALS.

A capital model necessarily embraces most if not all the areas of an insurance firm's activities. The responsibility of an individual actuary will vary from case to case. The data available for any task will vary between different firms, and between areas within firms. The actuary may be the Board member responsible for the whole project, or somebody asked to help in a limited and defined capacity. It is unlikely that an actuary can do this without relying on inputs from other people.

The actuary is advised to consider his/her own experience and skills and whether or not these are adequate for the completion of the ICA. The core actuarial skill is financial modelling and, although many actuaries also have general business skills or expertise in other more specialised fields, he/she should usually expect to call upon experts of other professions or disciplines in producing an ICA.

Specific examples of areas where the actuary might consider working together with other professionals include:

- In performing an assessment of the risks faced by the business the actuary may work alongside the business' risk management professionals;
- The ICA is intended to reflect the aggregate capital implications of a complex array of risks that interact with one another. The actuary may be well-placed to model the aggregation of these risks, but the understanding of the detailed risks and their interaction with one another may be the domain of a group of more specialist experts, whose advice might be sought. For example:
  - In cases where pricing and/or reserving are performed by other actuaries, co-operation with the pricing/reserving actuaries would lead to a better interpretation of the data available;
  - Risks associated with the capital markets could be discussed with the business' investment experts;
  - Liquidity management provisions may not be well known to the actuary, so discussion of liquidity risk and mitigating actions may be held with a treasury function;
- If aspects of the ICA are delegated to other colleagues (for example in a group with several business units who perform their own analysis), the actuary may work together with internal auditors to ensure that internal systems and controls have been applied;
- If the basis of valuation of assets and liabilities is different from reporting bases used for other purposes (for example because the ICA uses an 'economic' valuation, while

reporting bases follow a more statutory approach to valuation) the actuary is advised to work with the business' reporting team to ensure that the valuation bases can be reconciled;
- The potential for latent tax liabilities, the possible use of tax assets in stressed scenarios, and the tax implications of possible risk-mitigating action can be quite complex matters, and the advice of tax experts can be invaluable in assessing the tax aspects of the ICA;
- The ICA should take into account the impact of commitments made through an occupational pension scheme, the actuary may wish to seek the advice of the scheme actuary and other advisors, particularly when establishing the degree to which the survival of the scheme impacts on the ability to meet policyholder requirements, as well as assessing the financial risks presented by the scheme itself;

The business may have entered into risk transfer contracts or capital structuring arrangements (internally or externally) which may not be interpreted easily without specific expertise. In such cases the actuary would usually seek the advice of the experts who have effected these transactions.

A.4 NEED TO UPDATE TECHNICAL ADVICE.

The topic is fast moving, but there is a body of good practice emerging. The practices regarding risk governance, risk management, risk measurement and capital management vary widely within the market and will continue to evolve. As such, the discussions and practices referred to in this document will be updated periodically to reflect current 'good' practice and also feedback from firms and regulators.

We wish to make clear that the current advice is provisional, that the ICAS regime is going to develop over a number of years, and we anticipate an update to the profession's educational material whenever there are significant updates to the FSA's views or guidance. We recommend that a follow up working party takes forward the task of keeping this document up to date.

A.5 A FOOTNOTE ON TERMINOLOGY.

For the benefit of overseas readers, please note the following practices in the choice of terminology:
- In the UK, insurance risk means the risks associated with the policies sold to insureds, as opposed to the other risk categories such as market risk etc. It is split separately between underwriting risk, being the risks of unexpected frequency and severity from the current exposure period, and reserving risk, being the risk attached to run-off from prior periods;
- In the documents of the IAIS and IAA, insurance risk means the risks attached to the firm's total operations, including market risk etc. Underwriting risk refers to means the risks associated with the policies sold to insureds, and includes reserving risk as a sub-component.

The usage in the UK has developed consistently with the FSA's preferred risk categories.

B. METHODOLOGY.

B.1 PROPORTIONALITY.

B.1.1 The concept of proportionality is central to the FSA regulatory regime. Given the diverse circumstances of insurance entities, different approaches and levels of detail may be appropriate. Two approaches are commonly available to firms when calculating ICAs, namely: stress and scenario tests; and economic capital models (normally stochastic). For small firms, stochastic models may represent a significant complexity and overhead requirement. Stress test-only ICAs may be sufficient for such firms at present.

B.1.2 The degree of sophistication of the capital model should be commensurate with the materiality of the underlying risks. Relevant factors will include the scale of the business, the scale of the risks, the complexity of the liabilities, and the scale and nature of the capital base, and the context of the analysis.

B.1.3 Different approaches may be appropriate for different circumstances. Where appropriate, the firm should develop a model that is sufficiently sophisticated to be robust. It is also important that management understands / 'buys in' to such a model. Even where a stochastic model has been used, stress tests are needed to validate the model for reasonableness and to help with calibrating assumptions.

It may be appropriate to use a BLEND of approaches:

- stochastic models for some risk categories;
- stress and scenario tests for other risk categories;
- ad hoc methods for yet other categories.

One of the difficulties in adopting a solely stress and scenario testing approach is in the aggregation of risks to arrive at an overall capital figure, e.g. specification of a correlation matrix between each scenario; and the assessment of 'ripple effects', i.e. the knock-on consequences of the crystallization of a risk event.

B.1.4 Any material simplifications made should be noted and justified. Notwithstanding any reasonable simplifications being made, the firm should respect the following good practices:

- attempt to identify all of the significant risks facing their business;
- demonstrate the link between their risk framework and the ICA calculation;
- use risk categories that are commonly understood and aligned to their business;
- explain how the FSA's categories have been covered;
- document the way in which any risks have been incorporated in the modelled element of ICA calculations (e.g. by using particular assumptions or changing certain parameters);
- list significant risks where no capital has been included, and demonstrate the effectiveness of the controls that have been relied upon.

B.1.5 Level of granularity.
Models can be constructed with varying degrees of granularity. Issues to consider when deciding upon the granularity to include within any model or area of a model include materiality, hardware constraints, software constraints, data, other uses of the model output, and resources.

Working at too granular a level requires significantly more parameters to model the separate risks and also potential correlations between them. However, working with aggregate data may not be appropriate where the underlying mix is changing, or where the external factors that influence certain sub-risks are changing. Applying the analysis at a more granular level ensures that the results are easier to communicate to the relevant business units. A practical approach might be to work at a convenient level of granularity for individual risk modelling, and then aggregate some of the sub-classes to model the potential correlation assumptions.

B.2 RISK MEASURES AND RISK APPETITE / RISK TOLERANCE.

Risk Measures.

B.2.1 For the purposes of an ICA, the risk measure is set out in advance by the FSA, in the interests of maintaining consistency across the industry. It is calibrated at a level of 0.5% risk of insolvency over a one year time horizon. However, there is a whole range of other risk measures possible, and it is useful to consider and understand the different metrics which can be used to describe risk.

Where we have a distribution of financial outcomes or any other quantitative measure, there are three steps involved:

- build a capital model, and calculate the statistical distribution of the outcomes from the model;
- choose a risk measure, including a solvency measure (economic, statutory, or other);
- choose a tolerance level (risk appetite) for that risk measure.

No one approach can be definitively said to be the right one. Some typical approaches seen in practice are as follows:

FSA / ICA.	Lloyd's / RBC. (2)	Example multinational firm.
Distribution. Output from internal model. *Risk measure.* VaR of net asset value. *Risk tolerance/appetite.* 0.5% VaR for new business over one year time horizon, with reserve risk to ultimate. (1)	*Distribution.* Gamma distribution. *Risk measure.* Expected loss cost. *Risk tolerance/appetite.* 0.000332 per £1 of net premium/net reserves (2006 YOA RBC model). To ultimate.	*Distribution.* Output from internal model. *Risk measure.* TailVaR of net asset value on an economic basis. *Risk tolerance/appetite.* 1% TailVaR over one year time horizon, with reserve risk to ultimate.

Note (1): we appreciate that the FSA discuss different risk tolerances over a 3 or 5 year horizon. The tolerance shown above is illustrative.
Note (2): we appreciate that Lloyd's are moving towards a more ICA based approach. The above illustrates the current RBC position, and also that different measures are possible and used in practice.
The FSA model seeks to equalise probability of default, while the Lloyds RBC seeks to equalise monetary calls on the Central Fund.

B.2.2 For normal day to day management, e.g. profit forecasting, dividend planning, allocating ROE targets, the firm may be more concerned about deviations around the mean, and so a measure such as standard deviation may be a useful risk measure. Standard Deviation (or a multiple) is useful if comparing against the expected result, but does not reflect the skewness

of the fat-tailed distributions often found in these risks.

B.2.3 When considering capital adequacy and solvency assessment, it may be more useful to look at measures such as VaR and TailVaR. VaR is useful if considering the risk of adverse deviation expressed as a risk of ruin, but does not capture the quantum of losses beyond the quantile level. It can also result in a capital requirement that clearly meets an objective, and is useful if the purpose is counting number of defaults. Drawbacks include a focus on one side of the distribution (compared with standard deviation) and ignoring the magnitude of the most extreme losses – important if the objective is to achieve some expected overall payout ratio.

TailVaR is useful if considering the risk of adverse deviation and concerned about losses beyond the quantile level, and measures the average loss once beyond that point. This type of measure is also useful when you wish to guarantee certain desirable mathematical properties when combining different risks (for example coherence).

A regulator might be interested in the "number of headline failures", which is what VaR will measure. A multinational Group might want to keep most of its capital in its head office territory, and then recapitalize a subsidiary after an adverse scenario, in order to take advantage of "payback" conditions after a major loss. It would then be interested not only in the frequency of insolvency but also the magnitude of any losses, which is what TailVaR will measure.

Risk Appetite.

B.2.4 Once a measure has been defined, then the firm can express an appetite in terms of that measure. For example, for normal day to day management, the appetite may be expressed in the following ways:-

- want the ROE to be x% with a standard deviation of y%;
- want the ROE to be greater than x% with a y% chance;
- no more than x% probability of falling below £Ym in capital;
- no more than x% probability of falling below a certain rating level (e.g. A-).

For solvency assessment purposes, it is more common to focus on rare outcomes in the tails of the distribution, such as the 0.5% VaR or 1% TailVaR. Although not necessarily the FSA's intention, it is considered to be broadly similar to a BBB rating. This is not to say that the FSA wants firms to be capitalized to a BBB standard. The ICA forms the basis of the ICG, which the FSA regards as the regulatory intervention point. Thus in practice, the ICA level is the absolute minimum or "floor" level at which a firm would want to operate, and most would want to operate at a higher level, partly to avoid minor shocks triggering regulatory action, and partly for sound marketing reasons. For more on this topic and choice of percentiles, see section G.4.

A 0.5% risk tolerance, reflecting an outcome only "once every 200 years", might seem remote, but the reader should note that this could arise from the combination of several events, each with a less rare probability. Note that, instead of thinking in terms of "return periods of 200 years", you actually need to think in terms of "one in 200 companies as risky as the company under consideration will fail next year".

For interest, we show in the table below the approximate risk tolerance for other rating levels (note that these are bond default probabilities, which may or may not be directly comparable to insurer strength ratings) :

Rating level.	Percentile.	Risk.	"Return period".
BBB	99.5%	0.5%	1 in 200
A	99.95%	0.1%	1 in 1,000
AAA	99.99%	0.01%	1 in 10,000

B.2.5 The reader should note that the choice of risk measure and choice of tolerance level are not separate items, they are both required to determine a capital level. As an example, given a lognormal distribution with mean 1,000 and standard deviation 1,000, the different VaR and TailVaR levels correspond to each other as follows:

Lognormal: mean 1,000, s.d. 1,000 (mu = 6.561, sigma = 0.833)				
VaR	TailVaR		TailVaR	VaR
95%	84.8%		95%	98.3%
99%	97.0%		99%	99.7%
99.5%	98.5%		99.5%	99.8%

B.2.6 There are many situations where the appetite is nil, for example, we will not write risks in a certain territory. In these instances the process is one of measuring and controlling and setting thresholds, rather than expressing an appetite (e.g. *risk acceptance policies, underwriting policies, reinsurance policies etc).*

B.2.7 Documenting thresholds is necessary for the monitoring of Key Risk Indicators.

Intrinsic versus Residual Risk.

B.2.8 Where relevant and useful to do so, a risk assessment might first identify the 'intrinsic' risk (i.e. exposure in the absence of controls or mitigation), and then consider the appropriate systems and controls to be put in place. These systems and controls may include closer monitoring, reduction of the intrinsic exposure, internal off-setting approaches, or laying off of risk, for example through financial transactions with third parties. For many firms, operational risk assessment considers the possibility and impact of failure in these controls. In some cases, even important ones, it is not possible to quantify the intrinsic risk with great accuracy, and a more qualitative approach may be appropriate. Where intrinsic risk has not been quantified it may be possible to quantify the marginal changes in risk arising from the addition or removal of specified controls. Such information is useful in assessing the value of such controls.

Is capital the answer?

B.2.9 The ICA may be based on risk assessed net of controls or mitigants - however, as part of operational risk there is still a need to assess the potential capital implication of failure of controls. Capital is only an answer where there are many risks across which you can diversify, so that the aggregate capital is available if one or some of the risks materialize. If this is not the case, and the amount of technical capital required is too large to make economic sense, then an alternative system of management activity is required.

B.3 START POINT FOR MODELLING.

Choice of bases: economic versus statutory bases; links to published numbers.

B.3.1 As part of the ICA or any other capital modelling process, there is a need not only to assess the capital requirements, but also to compare it to the capital actually available. The starting point for any modelling should be the insurer's business plan. Any departure from this business plan (including published reserves for reserving risk) would need to be fully documented and explained. It is common to use an "economic" basis for assets and liabilities. As the choice of basis has the ability to impact the results materially, this should be a decision taken by management, and its implications understood.

Economic versus statutory bases.

B.3.2 Economic valuation approach.
An economic basis does not yet have a standardised definition. One version is "the present value of future cash flows, valued in such a way as to be consistent with current market prices where these are available". This has the following implications:

- all assets should be valued at market value, where market prices are available;
- all liabilities that depend on market returns should be valued based on arbitrage-free principles;
- all fixed cash flows should be valued using the current term structure of interest rates;
- for risks which are hedgeable, no market value margin should be applied;
- for unhedgeable risks that cannot be fully diversified (such as certain large-loss insurance risks, or major parameter risks), a market value margin should be applied to best-estimate cash flows in order to ensure that their discounted value is consistent with the price at which the liabilities could be transferred to a willing, rational, diversified counterparty.

In particular, this means that items to consider might include, but are not limited to, discounting values to allow for time value of money, removal of known margins, allowance for expected tax on any such margins, valuation of insurance subsidiaries on an economic basis, treatment of goodwill, the inclusion of current year profits and planned profits on new business up to the time horizon.

The key advantage of an economic basis is that it assesses that the insurer has sufficient assets to meet liabilities as they fall due. When producing a valuation on an economic basis, it is good practice to provide a detailed reconciliation with the regulatory capital. In addition, it should be demonstrated that:

- margins are in line with the firm's documented description of how it accounts for assets and liabilities, including the methods and assumptions for valuation;
- there is objective evidence and a track record to support margins being maintained.

B.3.3 Economic valuation of assets.
The stated accounting value of an asset might not be its realizable value. In the ICA, assets should be valued based on what they would actually be realized for when they are required to be liquidated in the scenarios projected, taking account of their realistic value and the time at which they would fall due. A suitable starting point should be a market value. Other considerations might include, but not be limited to:

- can this asset be realised?
- can this asset be used to pay a claim?
- when do we expect to receive this asset / pay this claim?
- would the answers change in a stress scenario such as after a catastrophe?
- in the case of cashflows expected to occur over a particular short-term, e.g. within one year, do we wish to ignore time value issues?
- in the case of subsidiaries, consider whether it is likely that they are subject to the same stresses as the parent, leading to impairment in their value. the modeller should consider whether they have demonstrated that the value taken can actually be realised and passed up to the company (via dividends or sale) if necessary;
- are there comparable transactions that we can infer (market consistent) valuation bases from?
- management has to decide on the treatment of certain items as capital or as reserves. for example:
  - claims equalisation reserves.
  - the UPR could form an additional margin due to the time value involved. The appropriateness of incorporating this margin into the economic capital should be considered (while not forgetting the volatility of the UPR).

Links/reconciliation to published/audited accounts and business plans.

B.3.4 Use of data prepared on an audited basis reduces scope for manipulation of information to engineer a desired result. If data in the capital model does not link to an audited set of accounts then it is good practice to document and explain reasons for and the amounts of the differences.
Where the assumptions differ from business plans, consideration should be given to why this is the case. Issues that could be considered include but are not limited to: time horizons, best estimates, Group assumptions and the insurance cycle. It is possible that future new business plans contain a deliberate element of "stretch" for motivational reasons. It might be considered optimistic to take credit for this in capital planning.
Consider the accounting basis used in the published accounts; does this link to management accounts and / or business plans?
It may be helpful to show and explain differences between all bases that exist for the entity being considered.

B.3.5 Treatment of known margins in reserves.
Some firms might have reserves and business plans on a best estimates, whilst others might include different levels of additional margins. It is desirable that ICA assumptions can be linked explicitly to stated reserves and business plan figures. To the extent that these Ultimate Loss Ratios (ULRs) and reserves have been stated on a better than best estimate basis, the probabilities of losses will be reduced. If a firm is operated on a 'best estimate' reserving basis, the ICA is likely to be higher but potentially less volatile than for an otherwise identical firm with margins in its reserves or plans.
Removal of known margins should enable reserves to be closer to best estimates. If it is decided to allow for margins, this should be explained and quantified.

- there may be reports against which these adjustments can be reconciled or checked;
- the possible tax implications of releasing any such margins should be considered;
- if such margins are not removed then the implications on the resulting capital requirements ought to be considered. Any margins which affect expected volatility of reserves to ultimate - need to include in stressed analysis;

- The modeller will need to fully justify the extent of any reserve margins as it is a deviation from the published accounts.

B.3.6 Considerations in respect of reserve discounting are as follows:

- define and explain the treatment of which reserves have been included. E.g. Outstanding claims and IBNR reserves only, or UPR and AURR in addition;
- ensure that gross, reinsurance and any reinsurance bad debt provisions are treated consistently;
- consideration should be given to both the average time of payment and the discount rate to be used;
- you may wish to consider payment profiles / mean terms used in investment benchmarking and/or reserving work. However, investigate whether these contain known margins or bias and consider whether consistency is desirable;
- when selecting the actual discount rate to use, issues to consider include but are not limited to:
  - the term of the item(s) being discounted;
  - whether a single discount rate is desired for use in all discounting calculations;
  - the currency of the item(s) being discounted;
  - whether to use a risk free discount rate or not (e.g. if after hedging there is still residual systematic risk);
  - any desire for the discount rate to remain unchanged between valuations or to vary according to market conditions;
  - consistency with any discount rates used in pricing, planning, or economic models;
  - proper treatment of non-interest bearing assets (e.g. brokers balances);
  - whether you treat differently the returns earned on technical (matching) assets, versus those on surplus assets.

B.3.7 Deferred tax.

As with all inadmissibles, the firm should consider whether they have adequately demonstrated that these have genuine value, that whatever risk is the reason for them being regarded as inadmissible by the valuation rules is either mitigated in some way or covered by the capital charges.

In particular, the firm should carefully consider the treatment of tax in a stressed environment, and whether there would be permanent impairment of tax assets or material reductions from timing issues. Considering how tax issues at times of stress may impact other aspects of the realistic assets and liabilities is also desirable.

For example, consider a deferred tax asset that has been treated as inadmissible for statutory solvency purposes. On an economic basis, for a central estimate that is profitable, this has value for the firm. However, the model would have to ensure that this asset is still recoverable in a stress scenario. The situation is more complicated if the firm is part of a bigger tax group, e.g. contains a life insurance arm that is also carrying out ICA modelling.

B.4 TIME HORIZON AND RELATED ISSUES.

B.4.1 There are several aspects to the time horizon used for modelling:

- the overall projection period;
- the amount of new business/renewals allowed for in the capital assessment;

- assumptions about the circumstances in which the projected liabilities are run-off;
- time allowed for the business considered to run-off;
- the frequency with which the solvency test is applied over the projection period (where 'solvency' is defined as assets greater than or equal to policyholder liabilities, both measured on an economic, or 'market-consistent' basis).

B.4.2 The guiding principles to observe are as follows:

- allow for new underwriting over a suitable period, including the extent that new underwriting brings capital strain (even when diversified into the existing business) and/or there is no plan or will to raise/inject capital before the business is written;
- make recognition of the position in the underwriting cycle, including expected reductions in profitability as the market softens, given knowledge of the firm's own market position, and planned growth or reduction in market share. It may be appropriate to alter the capital requirement for a given volume of business as the cycle changes. This may require a full projection over the cycle or could be dealt with by capitalising expected profit strain;
- given the uncertainty in reserves and future claim costs, the projection period should be long enough to reflect the time taken for the reserves to run-off. Over time it is important to monitor:
  - the accuracy of the projections as information emerge, indicating a deterioration in experience or that pricing is inadequate;
  - if appropriate adjust the models to react to that information;
- whatever new underwriting is allowed for, consider all residual uncertainty once new premiums cease, and allow for full deterioration to ultimate, without the smoothing that is typically involved in estimating reserves and setting liability values for accounting purposes;
- in allowing for run-off, do not take undue credit for expense margins in premiums – allow for full run-off expenses and an appropriate contribution to overheads. It is normally appropriate to assume that the business will be a going concern when considering the run-off of liabilities. It would, however, be appropriate to make some check that the ICA capital set aside would cover the additional expenses associated with closure to new business;
- if there is an assumption of reduction in the portfolio after a loss, the firm should be able to demonstrate a track record of cycle management.

Overall projection period

B.4.3 The FSA has stated that a one-year projection period, for example, may not represent adequate analysis. The FSA expects at least consideration of longer horizons, although it accepts that a higher probability of impairment over a longer time-horizon would be acceptable, for consistency with the base assumption of 1:200 over one year: "*the ICA should be calibrated to the 99.5% confidence level over one year, or if appropriate to the firm's business, a lower confidence level over a longer time period … we believe that 98.5% over three years or 97.5% over five years are broadly equivalent for our purposes … if using a confidence level of 97.5% over five years, we interpret this to mean five years of new business … consider and allow for the ultimate claims development both from risks incepted during and before this period ... means that in this case the risk measure used is 97.5% throughout the projection period to ultimate".*

Even when using the longer period, the modeller should check the 99.5% level over one year:

- to confirm that undue credit is not being taken for profits from future new business written after the occurrence of an extreme adverse scenario;

- to cover the issue raised in section B.4.13.

B.4.4 When deciding on the projection period for the model, considerations to make allowance for are:

- the firm's plans for raising new capital and/or paying dividends, and the capital-sustainability of the business plan;
- the time it would take to react to adverse experience, for example by injecting capital, reducing new business volumes, re-pricing or re-underwriting;
- the speed with which accurate information becomes available to allow the detection of adverse experience;
- the possibility that the firm may continue to write business on unfavourable terms for a number of years before this becomes clear;
- any expected loss-making periods through the underwriting cycle, which may represent working capital strains, regardless of any uncertainty in claims experience;
- the impact on new business terms/rates immediately following a major loss event (note that it is not appropriate automatically to assume that the market will harden immediately after such an event).

New business and renewals.

B.4.5 Planning Period.
The allowance for new business and renewals is closely allied to the overall projection period. Typically businesses plan for the following three to five years, but re-plan at least annually. Depending on the means of capitalisation of the firm, it is usually undesirable to raise further capital, and businesses would plan to release capital in the form of a regular dividend stream. For this reason, regular re-appraisal of future capital requirements is a core part of business planning.

B.4.6 New Underwriting.
Unless the business is in run-off, capital requirements would usually consider the impact of new underwriting (be it renewal of existing business or totally new business):

- where new underwriting would typically represent a capital strain, as existing business runs off it should be expected to release capital under an ICA framework;
- in normal circumstances, business should be expected to generate profit, and it may be appropriate to allow for this when measuring the capital strain. The interaction between new underwriting and the capital release from existing business will of course be influenced by the underwriting cycle;
- therefore a firm should make allowance for new underwriting to the extent that this might impact on the firm's need to raise further capital in order to execute its business plan.

B.4.7 Future ICA requirements.
This requirement may influence the choice of projection period and allowance for new underwriting when assessing the time-zero ICA, but the choice should be made in the context of a projection of future ICA requirements. It may be more appropriate to use a short horizon for the ICA if this is accompanied by a projection of ICA requirements and realistic available capital over the business planning period.

B.4.8 Multi-year contracts.
For many non-life businesses, there is little distinction in capital terms between renewals and new business cases. However, if there is any contractual obligation on the firm to renew, the

liability and risk implications of the policyholder's option should be captured. Similarly, although most contracts extend for one year only, multi-year contracts should be allowed for in accordance with the liability they bring to the firm.

Going-concern and closure to new business.

B.4.9 Given that the ICA model allows for some years' new underwriting, and then projects the run-off of the residual liabilities, it is necessary to make some assumption about the circumstances in which the run-off takes place. It is normally appropriate to assume that the business will be a going concern when considering the run-off of liabilities. This means that the expenses allocated to the run-off business could be limited to those marginal expenses associated with the run-off, with perhaps some contribution to overheads.

B.4.10 Closure to new business.
It might, however, be appropriate to make some check that the ICA capital set aside would cover the additional expenses associated with closure to new business, in the stressed circumstances that the ICA is considering. When making this check, at least two alternative scenarios could be considered:

- the first follows the assumption that the firm continues to handle the run-off, with a combination of in-house and out-sourced capability (chosen to optimise the cost associated with meeting policyholder obligations). Consideration needs to be given to the on-going expenses, fixed and variable, as well as the more immediate shut-down costs such as redundancy payments;
- the second approach follows the assumption that the liabilities are bought out (through commutation or transfer to another insurer). In this case, costs might be more immediate and would include the market price for the transfer of risk. This market price would include the liability values at that point, the capital requirements associated with the uncertainty in those values, and any other pricing effects that might be associated with the extreme circumstances being considered. Bear in mind the possibility that the firm may not have a strong bargaining position and, depending on the external factors associated with the closure, the market capacity to take on the risk may be limited – with consequent increases in transfer prices.

Projection to ultimate run-off.

B.4.11 The minimum standard for the ICA is set with reference to the firm's ability to meet policyholder liabilities as and when they fall due. Therefore it is important that the measures of capital adequacy allow for the possibility that experience may deteriorate over the lifetime of the liabilities. For many firms, a full cashflow model of assets and liabilities for the duration of liabilities is not practicable, so it is important to ensure that the important aspects of risk are still allowed for. In other words, whatever time horizon is used, the business should be run-off to ultimate.

B.4.12 Many of the actuarial techniques used to assess reserve uncertainty naturally project the full uncertainty to run-off. Some firms, however, use an integrated DFA model for their ICA and project balance sheets over a selected period – often less than the run-off period for all liabilities considered. In these cases, the liability values used for projected balance sheets may not capture all of the potential for liabilities to deteriorate.

B.4.13 The modeller should consider the following. Suppose that the capital required for reserving risk for the run-off business is higher when projecting one year's worth of new business (i.e.

at the 99.5% level), than the capital required for reserving risk when projecting three years' worth of new business (i.e. at the 98.5% level). However, it could be that allowing for more new business will, in most cases, increase the capital required by more than the reduction in capital at the lower threshold. Consequently, the modeller should consider the impact of running the test at different time points, and whether he/she should take the highest level.

B.4.14 Market Price for Risk.
One approach to understanding both the liability valuation and capital aspects of the liability run-off is to consider market pricing of similar liabilities (see *closure to new business* above). It may be possible to use knowledge of current or recent transfers of similar business (especially at Lloyd's – although caution should be applied when using internal RITC values) to estimate a closed-form price for the residual run-off, without having to simulate the run-off fully. However, it is also possible that an actual market price may not be available, and the firm could consider "marking to model", which requires a model to replicate the likely level of market price for such a transaction.

B.4.15 As well as the liability risk over the run-off period, asset risk should be considered. In most circumstances the actual asset mix should be used to capture asset-liability risk fully.

B.4.16 Liquidity of new premiums.
While new underwriting continues, it is appropriate to allow for future premiums when considering liquidity risk. However, when projecting the run-off, this may no longer be appropriate – depending on the assumption about the going-concern nature of the run-off. The suitability of this liquidity assumption should be borne in mind when deciding whether a full cashflow projection is required for the run-off.

Frequency of solvency testing.
(For clarity's sake, in this section 'solvency' is defined as assets greater than or equal to policyholder liabilities, both measured on an economic, or 'market-consistent' basis.)

B.4.17 The fundamental requirement is for the liabilities to be met as they fall due. However, firms are also required to ensure that they have adequate financial resources at all times. It is possible to meet the first requirement while failing to meet the second at some point during the run-off of liabilities considered in the projection (based on knowledge available when balance sheets are struck).

B.4.18 Interim Solvency Testing.
Even if a full run-off model is being used, it would be appropriate to check interim solvency. The natural frequency for this is at each point when a balance sheet is projected. Typically this may only be annually, but this is possibly a constraint of modelling capability more than anything else.

The actuary may wish to consider additional work to understand the relative probabilities of ruin using different frequencies for the interim solvency tests, and then adjust the threshold for the 1:200 one-year model to approximate an equivalent continuous ruin probability.

B.5 OTHER MODELLING ISSUES.

B.5.1 Use of market data.
The use of own firm data to parameterise the model might not give sufficient statistical

credibility in terms of both size and relevance. The model might consider reference to market data, adjusted to reflect the firm's specific characteristics. If assessing volatilities (standard deviations) at a market level, adjustments should be made to reflect that the observed market volatility for a class of business, representing the pooled experience of many companies, will tend to be lower than the volatility of the single firm on a stand-alone basis. The documentation should give an explanation as to the relative balance between the firm's own data, market data and judgement.

B.5.2 Allowance for management and other actions.
A significant question is the extent to which a model should be "dynamic", i.e. where management decisions are built into the model and the path taken depends on the examination of certain model variables.

The rationale often used for building such relationships into a model is that management is not passive and would alter strategy in the light of new information. This issue is strongly related to the model time horizon. A long time horizon where there are no management interventions is likely to be very unrealistic reflection of the "real world". This modelled intervention should be backed up by suitable policies and statements of intent. If these actions rely on certain procedures or processes being in place then this needs to be documented. A consideration of the firm's historical performance in this area, its current control environment, and the possibility of an operational risk occurrence around these procedures/ processes, is required. For example, if assumed future loss ratios depend on closing unprofitable accounts and refusing to renew policies at unprofitable rates, the report should put forward evidence that the firm has actually done this during past downturns. The model needs to consider any possible time lag between the firm's management information systems picking up on the issues and the action taking effect.

Typically, when using stress and scenarios, the assumed management actions are easier to define and for their impact on the result to be observed. When using a stochastic model, the extent of management actions needs to be documented, and in cases where the impact is significant, an estimation of the benefit of the management actions assumed should be included.

B.5.3 There are other relationships that may be significant in stressed circumstances, such as the rating environment following a major catastrophe or changes in policyholder behavior. If these relationships are built into the model then results will reflect the implied relationships. Whenever relationships are built in, then the risk of this relationship not holding needs to be considered as an additional model risk.

B.5.4 Correlations, dependencies, tails.
Assumptions concerning correlation and dependencies are critical drivers of the ICA calculation, and need special justification. Relying solely on correlation 'drivers' (e.g. catastrophe models, inflation and the underwriting cycle) as the mechanism for associating losses, as opposed to an explicit dependency assumption across classes, might not be sufficient. The firm should pay specific attention to justifying the output of such models carefully with regard to the implied correlation, as the FSA have indicated that this is an area that they will examine closely within an ICA.

When considering tail risks, the correlation assumptions are very important, and to a large extent special justification will be needed to show whether the model has captured adequately the possibility that large risk events are more strongly related than more 'normal'

events. Relating the assumptions to implied relationships in the real world then forms the basis of selecting the correlation parameters. In particular, correlation coefficients appropriate for ordinary size losses might not be sufficient for the largest losses in the tail of the distribution.

B.5.5 Sensitivity testing.
Even where a stochastic model has been used, stress tests are needed to validate the model for reasonableness and to help with calibrating assumptions.
Models for an insurance business can become complex as there are many drivers. Sensitivity tests on the model can demonstrate the key parameters that appear to be the key drivers of the outcomes. These need to be assessed by management and also against stress and scenario tests as in many cases it will not be possible to conduct sufficient sensitivity tests that impact the full distribution of outcomes.

B.5.6 The need to build in some relationships and the potentially complex inter-relationship between variables would lead to the use of simulation approaches in preference to direct analytical methods. Where simulation approaches are used the number of simulations should be such that there are sufficient observations at the percentile levels being examined. For complex models this may be assessed by rerunning the models for a selection of simulation counts and examining the sensitivity at various percentile points to the number of simulations.

Risk measures that provide a summary of the outcomes beyond a percentile point (such as TailVaR) will be impacted by the same considerations as above. In addition the behavior of the models in the tail beyond the percentile point under consideration will need to be examined for stability and sensitivity.

The output commentary needs to consider the following issues:

- demonstrate sufficient sensitivity tests of the model have been carried out and that these sensitivities are understood by the firm's management;
- the potential for parameterisation error and model error, stating what adjustments have been made to cover such errors;
- demonstrate that the management has reviewed the overall loss distribution of the model as part of its ICA assessment;
- all parameters clearly identified and justified.

B.5.7 Use of external models.
There may be detailed process models that are used as an input into the business model (such as natural catastrophe models). The same considerations need to be applied to these models as to any sub-model including applicability and the potential model error.
If the firm makes direct use of external catastrophe models, it should consider how to allow for the possibility of model error and for events not included within the catastrophe model library. The implied distribution should be consistent with the reinsurance purchasing plans and with ordinary business plans.

Where external models are used, the degree to which these models have been validated, tested or otherwise evaluated should be made clear. Where the models have been specifically tailored to the firm's requirements, this should also be made clear. Consideration should be given to any key assumptions or limitations within the model and how consistency between the external model and the rest of the model has been ensured.

B.5.8 Parameter uncertainty.

There are many potential sources of parameter uncertainty, but the most common is lack of credible relevant data on which to base the main assumptions, because the ICA is modelling rare events. One approach is to consider the number of years of available data, and the class of business being modelled, including a back-test of the key assumptions. This would enable a broad high-level reasonableness assessment of the parameters, and indicate potential areas of significant under/over estimation.

Parameter uncertainty can have a significant impact on the underlying ICA, and this needs to be adequately communicated to senior management, including the provision of sensitivity tests surrounding the key parameters. Where relevant, the firm should also regularly review the key parameters to ensure their continued applicability.

C. RISK CATEGORIES.

C.1 INSURANCE RISK.

Split of Insurance Risk into separate modelling categories.

C.1.1 It is not unusual for firms to consider insurance risk in terms of the separate categories of underwriting risk, reserving and reinsurance risk. However, these elements are not unconnected, and interdependencies should be allowed for. For example, if Courts start awarding more generously this can affect the losses on both new business and reserves.
A firm that underestimates the reserves needed is more likely to underprice new business if it makes similar, erroneous assumptions in both exercises. This association needs to be recognised in models by allowing for an appropriate link between underwriting and reserving risk

C.1.2 Underwriting risk.
This is defined as the risk arising from new business written over the agreed time horizon. Underwriting risk may also be broken down further into the following categories:

- claims risk, which represents the underlying volatility of claims per unit exposure;
- pricing risk, which relates to market competition and other pressures on the level of price per unit exposure.

Claims risk should ideally be split into variability of frequency and severity versus economic factors, such as inflation. An understanding of the underwriting cycle and the firm's ability to withstand cyclical pressure is key to separately identifying the pricing risk from the claims risk component. The risk attached to unearned exposures should be considered also, but may be treated either as reserving or underwriting risk.

Claims frequency and severity risk

C.1.3 Claims risk may also be split into regular attritional losses versus large losses – both individual large losses and large catastrophe losses. For some risks it may be appropriate to model an aggregate loss distribution but for larger, less frequent losses it may only be possible to model the true volatility and the impact of reinsurance properly with individual loss models. Historical data studies and business plan forecasts may also be shown separately by these splits.

When using statistical distributions to model future claims variability, it is likely that skewed distributions, such as the 'Log Normal' distribution will be more suitable than 'Normal' distributions.

C.1.4 Regular losses.
'Regular loss' is here used to mean non catastrophe or non-large losses. The definition of what is a catastrophe or large loss is not precise and different firms use different approaches. Some practitioners separate out major market losses only and others separate out all losses over the firm's excess of loss retention. It is common practice to base this definition on the attachment points of the excess of loss programme, which helps to demonstrate the embedding of the ICA process in the firm's business.

The modeller should examine actual historical experience, but should also consider

potential current exposures and the likely impact of material changes in the business mix or in the risk profile of the business written, e.g. new, retired or rapidly growing classes, changes to policy deductibles / programme attachment levels, policy count retention ratios, perils covered. The modeller should also consider the extent to which inflation, rate changes, definition of large claims and other external factors can impact the historic development data, and whether the volatility of future inflation will be in-line with that in the historic data.

The impact of exposures written under long term, non-cancellable policies, should be considered. In such cases the modeller should review the risk associated with the resulting lack of underwriting flexibility, e.g. pricing or coverage changes in response to unexpected claims frequency. It will be important to treat such policies consistently with annually-renewable business to ensure that the results can be combined, as well as to consider correlations between changes in experience in future periods.

C.1.5 Individual large losses.

Some firms attempt to build a probabilistic analysis of prospective claims frequency and loss size distributions and will start with actual historical experience, but the return period of these losses is likely to be long in comparison with the period of data available, so some extrapolation is required, which is always cause for extra care.

If building a frequency/severity model, consider setting parameters for the model using historical experience adjusted where relevant, with allowance for changes in terms and conditions as well as inflation. There is a need to supplement this with work studies based on: changes in exposures, changes in sums insured, policy limits, linesizes, risk profiles of policy counts and premium by size bands, curve fitting of actual experience from lower levels, market studies.

This can be further supplemented with interviews of underwriting personnel on wider sets of exposures, or potential rare exposures, although this is more subjective.

It is good practice for these analyses to be consistent with similar analyses for reinsurance planning and purchasing decisions.

C.1.6 Large catastrophe losses.

Analyse the potential for Catastrophic losses - count and size compared with cover available, including the cost of reinstatement premiums and any possible reinsurance exhaustion. A probabilistic analysis of prospective claims frequency and severity might include the output from recognised catastrophe models, e.g. exceedence probability curves, with an explanation of the data and assumptions used in the analysis.

Consider any material changes proposed for the prospective underwriting year compared to the previous years.

Consider the risks associated with reliance on reinsurance described in section C.1.25-C.1.27. Consider the phase in the cycle of natural fluctuations in sea surface temperatures (for example) and the implications this has on severity and frequency of catastrophe events. The actuary should also consider the impact of any longer term trends (climate change for example) on the past data, and whether it remains a good guide to the future, see section F1.12 for more details.

C.1.7 There are a number of external models which have gained market acceptance and are widely used. Any model is dependent on its parameters. If the firm uses a broker to provide quotes for their reinsurance programme, they may observe a range of values, and it is helpful to comment on the differences. Sensitivity testing to determine which are the key drivers followed by consideration of how well founded the knowledge of those parameters can be illuminating. Comparison of results from different models may assist in understanding underlying modelling uncertainties, especially bearing in mind the lack of historical data at percentiles as extreme as 99.5%.

It is important to bear in mind that an externally-provided model does not mean a "correct" model. The firm should take responsibility for the assumptions, distributions, parameters and scenarios used within the model, and therefore credibility of the model output, and also comment on perils and exposures that are not covered by the standard models.

C.1.8 Cat modelling error.
There is a need to consider the risks associated with the modelling and other assumptions made when evaluating levels of exposure. Sensitivity-testing to determine which are the key drivers should help to understand model error and parameter error, as should an analysis of historical performance of models and the implications for potential impact of erroneous assumptions.

It may be appropriate to compare the selected model with deterministic stress tests (e.g. by applying current exposures to several well known historical events), and certainly characteristics of typical losses driving the important percentiles should be well-understood.

External and economic claims risks.

C.1.9 Where relevant the modeller should consider systemic risk (e.g. effects of an economic downturn) and/or the potential impact of changes to regulation or legislation (e.g. retroactive legislation creating new heads of liability, increasing the level of awards). In some cases these considerations may become an explicit part of the model – for example recessionary effects on creditor business – and in other cases they will implicitly inform judgemental selections.

C.1.10 Economic inflation.
This is a key driver of correlation between market and insurance risk. In insurance risk inflation affects future premium forecasts, and links to claims development (sometime super imposed), both for future business and existing reserves. Inflation is therefore a driver of underwriting and reserving risk and of the correlations between them.

The appropriate type of economic inflation to consider will vary by line of business, with some lines requiring consideration of price inflation and others consideration of wage inflation. Depending on the importance of these assumptions sensitivity testing may be appropriate. For longer-tail lines the value for which claims will be settled is difficult to estimate, so there is a need to sensitivity test or stress test the assumptions applied to the eventual nominal values of these settlements. The model should consider whether volatility of future inflation will be in line with that in the historical data.

C.1.11 Superimposed inflation, including inflationary shocks, e.g. legislation.
Claims are typically developed by applying claims inflation either separately forecasted or superimposed on top of the real cashflows and economic inflation.

One-off, retroactive, legislative changes can be modelled in various ways:

- they come in discrete jumps – imposition of Ogden, Courts Act, for example, might be modelled as individual spikes on top of "normal" claims inflation;
- effects might be included as part of overall average claims inflation, with a broader range of variability;
- there could be a one-off uplift on reserves across all years.

Superimposed inflation is not just judicial. Claims that depend highly on labour costs, such as motor repair, may have inflation element more closely linked to wages than consumer prices – but this type of inflation lends itself better to simple statistical distribution.

C.1.12 Economic drivers of claims experience.
Inflation has been discussed above. Other economic drivers of claims risk include the impact of interest rates on credit insurance and general economic conditions, for example on personal lines results, or the incidence of fire claims. A recession may be correlated with generally poor experience in a number of lines.

C.1.13 Allowing for emergence of latent claims (long-tail disease / latent claims reserve risk).
Latent claims may lend themselves better to scenario-testing than stochastic modelling but it may be appropriate to incorporate a latent claims element into a DFA model.

They can be split into two types: the likely extent and variability of ultimate costs from currently-identified latent causes, and the emergence of as-yet-unidentified latent causes. For some in the first type, e.g. UK asbestos, the model may be able to test variations of the key parameters around a central estimate. For the second type, one approach is to consider scenarios based on a particular event and projected exposure; another allows for latent claims related to the extent that they have been experienced in the past.

Pricing and premium risks

C.1.14 Premium volumes.
Premium volumes are linked with market conditions and likely management actions. Relevant considerations include business plans, corporate strategy, the position in the underwriting cycle, the risk that premium rates will be lower than anticipated in the business plan, actions likely to be taken in normal circumstances, and actions likely to be taken in stressed circumstances.

C.1.15 Risk of underestimation of rates.
Consider uncertainty in the adequacy of the firm's pricing. It is more transparent to have explicit assumptions concerning premium rates and the potential for premium rates to deviate from plan. Comparison of historical with assumed future loss ratios is a good test of the robustness of the assumptions about underwriting cycle effects. A review of projected ultimate loss on a best estimate basis may be produced as part of the reserving work and that, together with a detailed understanding of relevant recent changes, may suffice for modelling purposes.
Loss ratio assumptions and assumptions as to their variability are often critical drivers of capital requirements and it is important to ensure that they are soundly based, within the limitations of the available data. Equally the thinking around risk is assisted by identifying the key pricing parameters, what drives those parameters, what is known about those drivers and how stable those drivers are. The likely delay between emerging experience

and pricing reaction needs to be made clear.

C.1.16 Market pressures on rates/policy terms.
Management attitude when the market softens is important – it may be necessary to consider behaviour in previous cycles and evidence that such behaviour may or may not be repeated. If management actions are built into the model ensure that some reaction time is incorporated - what evidence has there been of reactions to market trends in the past? Market pressure might impact policy terms & conditions other than pricing, and this may emerge as adverse claims experience.

There may be additional risks attached to dependence on intermediaries for a disproportionate share of premium income. This may make the firm more exposed to market pressure on rates, terms and conditions, or even to mis-selling risk. However, this may be captured as operational, rather than insurance, risk.

C.1.17 New business lines with less available information.
New business lines can be especially risky because the information available to quantify expected costs and variability is usually more limited. Although rapid reaction to emerging experience will be important, in many cases market statistics can provide excellent guidance and particularly on some short tailed lines with good monitoring and reaction procedures the risk is much reduced.

C.1.18 Over-rapid growth; the relation between volume and quality.
The model needs to consider the risks of:

- the effects and pricing implications of rapid growth or decline in the volume of parts of the underwriting portfolio;
- the effects of rapid growth or decline in the volume and nature of new business written;
- the ability of firms to adjust premium rates or charges for some products and the speed with which the firm can build an accurate picture of and react to new information;
- mis-pricing (especially for new business).

Reserving

C.1.19 Reserve risk.
Reserving risk is the risk that the firm's estimate of its future liabilities in respect of business already accounted for proves to be inadequate and that it suffers financial loss as a result. This risk may arise because of limitations in the data on which the estimates are based, inappropriate judgements in reserve parameter or model selection, uncertainties related to the consequence of behaviours outside the firm's control, difficulties in quantifying the effects of known changes, changes in external conditions which introduce new claim causes and changes in the severity or frequency of known causes.
Current stochastic techniques capture part of the variability but should not be applied blindly. There is a strong need to understand the underlying processes and risk, and allow for the possibility of structural change.

C.1.20 Basis for the technical provisions.
The reserves used as the basis for risk-assessment may well not represent a best-estimate in themselves. Some understanding of historical reserve development will be helpful in deciding the extent of any margins or deficits in the starting reserves. It may be appropriate to adjust the reserves before making the risk-assessment, especially if the capital

requirements are to be compared to available capital calculated on an economic basis.

C.1.21 Where relevant, consider the range of possible outcomes relating to any disputed claims, particularly where the outcome is subject to legal proceedings.

Bear in mind social changes including an increase in the propensity to claim and to sue.

C.1.22 Typical statistical approaches to reserving uncertainty include:

- 'bootstrapping';
- aggregate reserve variability, often based on the 'Mack' method;
- other methods involving the stochastic modelling of link ratios.

It is good practice to compare the results of more than one method. The documentation needs to demonstrate whether the methods adequately reflect the risk of lengthening development patterns, and how they have captured future claims inflation (e.g. have they just used the implied inflation in the historical data without adjustment, is future inflation consistent with the inflation assumptions implied by the economic scenario generator for market risk).

Consider carefully the diversification credit arising across accident years, lines of business, or between reserving risk and underwriting risk, and whether these credits truly exist.
In using these methods it is worth bearing in mind that the uncertainty associated with estimating the variance of the distribution is usually greater than the uncertainty associated with estimating the mean of the distribution.
Consideration of implied coefficients of variations by different classes of business may help. There are a priori expectations of relativities which can be incorporated e.g. smaller classes probably have higher coefficient of variation than larger classes and some long tailed classes probably have higher coefficient of variation than some short tailed classes.

Whichever statistical method(s) you use, it is important to be confident that they reflect the underlying processes and the risks and uncertainties arising from them. No statistical model is sufficient if applied blindly.

C.1.23 The output of the reserve modelling calculations can be supplemented by some or all of the following:

- review of the firm's historical track record of gross and net reserving (overall, by class of business, gross and net);
- explanations when an unexpected deterioration in the ultimate loss position has occurred;
- consideration of the range around best estimate reserves;
- rationale for any material difference between the best estimate and booked reserves (e.g. intended confidence level);
- stress testing of major reserving assumptions, e.g. claims inflation, relevance of past trends, claims frequencies;
- commentary on known reserving issues, (e.g. Courts Act, US APH, UK asbestos) in particular, the sensitivity of reserves to the assumptions made, and any scenarios already developed;
- commentary regarding the impact on reserving of material changes in business mix;
- any impact on business planning assumptions (e.g. ULRs) as a result of unexpected reserve deterioration on prior years;
- back-testing of historical under/over-reserving given new information.

C.1.24 Where discounting reserves: cashflow pattern uncertainty.
Uncertainty as to the timing of reserve and new claim cashflows can add to the uncertainty as to the nominal and present value of those cashflows. It is therefore important to model cashflow timing uncertainty as well as the underlying values of the cashflows.

Modelling of the discounting of reserves is considered further in section B.3.

Reinsurance

C.1.25 Reinsurance risk
The credit risk associated with the reinsurance risk component is considered in section C.3. Consideration of the risks associated with reliance on reinsurance might include:

- lack of matching reinsurance (coverage, period of cover etc.);
- potential for exhaustion of cover – horizontal and vertical;
- over-concentration with individual reinsurers, exacerbating credit risk;
- post loss impact (availability and/or price of future reinsurance, and market cycle);
- reinsurance capacity constraints;
- allowance for future reinsurance costs or gaps in cover – in particular, allowing for the run-off of unearned exposure when inwards business is on a risks attaching basis and reinsurance losses occurring;
- the reinsurance asset representing recoveries on claims already incurred.

When using statistical modelling, gross losses can be simulated and mapped through the relevant reinsurance programmes, identified explicitly. Consider exhaustion (vertical & horizontal) and reinstatement costs. Where reinsurance programmes are complex, this calculation will be difficult to perform explicitly and approximations may be appropriate In such cases allowance may be made for the operational risk inherent in the complexity of the programme.

There are risks associated with inadequate wording or failure to complete all documentation before occurrence of reinsured events. Some of these risks may be best covered under operational risk but in either case it would be worthwhile assessing suitable scenarios.

C.1.26 Insurance Risk: Stress and Scenario tests.
Even where a stochastic model has been used, stress tests are needed to validate the model for reasonableness and to help with calibrating assumptions. A standard set of factors to consider for stress and scenario tests are set out in PRU 2.3.33-2.3.34.

Operational Risk attaching to Insurance Risk.

C.1.27 There is operational risk attached to insurance risk. It is important to state clearly whether this is included under insurance risk capital, or handled separately under operational risk.

C.2 MARKET RISK (INCLUDING FOREIGN EXCHANGE).

C.2.1 Market risk refers to the risk that arises from fluctuations in values of, or income from assets, in interest rates or in exchange rates. Factors to consider when modelling market risk are as follows:

- changed market values of investments;
- variation in interest rates and the effect on the market value of investments;
- a lower level of investment income than planned;
- the possibility of counterparty/ issuer defaults, unless captured under credit risk;
- the possibility of a severe economic or market downturn or upturn leading to adverse interest rate movements and/ or equity market falls affecting the firm's investment position;
- price shifts in asset classes, and their impact on the entire portfolio;
- inadequate valuation of assets, if not captured under operational risk;
- the direct impact on the portfolio of currency devaluation, as well as the effect on related markets and currencies;
- extent of any mismatch of assets and liabilities, including reinvestment risk;
- the extent to which market moves could have non-linear effects on values, such as derivatives.

If the approach to market risk modelling that the firm uses for its ICA model is similar to that used for other purposes, e.g. asset allocation, this will assist in demonstrating embedding of the ICA process in the business.

C.2.2 Market risk modelling considerations – overview.

- the various asset classes tend to be linked to each other– consider what correlation assumptions are appropriate;
- asset classes may also be believed to be correlated over time, for example a fall in equity values in the previous year may be corrected in the next year;
- the actuary must determine whether he/she has the required skills and economic knowledge to conduct the market risk investigation;
- consider using the analysis conducted by third parties such as investment managers/ department;
- the actuary needs to decide on the way each asset class is modelled, the risks the insurer faces for each of these classes, and devise appropriate validation scenarios. it is important to maintain the consistency between the assumptions in the assets and liabilities sides of the model;
- the firm's senior management must buy-in to and be comfortable with the chosen modelling approach.

C.2.3 Correlation between market risk and insurance risk. A consideration is the potential impact of the following:

- inflationary link to claims, (claims costs and timing), as well as links to bond and equity returns;
- an economic downturn may generate:
  - a fall in equity prices;
  - a change in policyholder attitude e.g. a surge of arson claims;
  - larger losses to classes related to the economic cycle, such as creditor and MIG (mortgage indemnity);
- the effect that a particular insurance disaster will have on investment portfolio returns if it has a detrimental effect on the financial markets.

C.2.4 There is a choice between modelling a notional asset portfolio versus modelling the actual assets:

- modelling individual assets is very time consuming, it is often simpler to use classes/ term/ currency split (also use credit rating where applicable);
- widely spread assets or an investment policy that relies on standard assets may be reasonably replicated by a notional portfolio. But where say concentration in individual sectors/stocks/durations differs substantially from the index, this should be allowed for;
- consider the difference between the actual portfolio and the potential "limit" portfolio. This applies in the case where the asset managers have the freedom to move away from a (matched or strategic) benchmark, for tactical trading reasons. The way to model this extra risk will depend on the controls over what permissions the asset managers must obtain in advance, and how long they are allowed to run unmatched positions.

C.2.5 Rebalancing of the portfolio should be modelled where it is required by the investment policy rules, e.g. to achieve pre-set asset portfolio mix, or to achieve a constant duration:

- the reinvestment rate at each future point in time and for each asset class should be consistent with the scenario that has led to the projected rebalancing;
- the choice of decision rules should be consistent with what is done in practice and be in line with the instructions to the investment department;
- allow for trading cost if there is a frequent and proactive investment strategy;
- if the modelled portfolio goes into run-off in an extreme scenario, it may be necessary to consider changes in the duration of the underlying assets.

C.2.6 Matching of assets to the liability profile: the relationship between investment matching & market risk:

- the closer the returns on the assets of the insurer follow the liability in terms of timing, nature and currency, the smaller is the mis-matching risk;
- the model needs to make clear mismatch possibilities within investment policy. The extent of likely movements can be modelled from past market movements relative to the movements in the liabilities;
- any significant mismatching will emerge from the model as an increased capital requirement, and this amount should be identified and sense checked.

C.2.7 Exchange rates:

- if firm considers its assets and liabilities to be approximately matched by currency i.e. the assets mature in the same currency as the liabilities emerge, there is no need for large currency capital charges;
- large unhedged currency exposures would require modelling various currencies separately;
- it is common for firms in general insurance to match the currencies of assets and technical liabilities relatively closely. However, a firm that writes a substantial volume of business in a currency that is not reflected in the currency mix of its capital needs to model the FX mismatch risk. This can also arise in a Group, if there is excess capital held in one currency in one part of a group that is effectively supporting risks in another currency taken elsewhere within the same Group;
- for each currency, the same considerations as mentioned above in C.2.4 to C.2.6 are applicable.

C.2.8 Inflation - areas to consider:

- where appropriate, claims inflation is modelled separately from price inflation. This may include superimposing a higher level over and above the price inflation.

- more details are discussed in section C.1.

C.2.9 Use of Economic Scenario Generators (ESG).

Often, the market risk model will include an ESG, either internal to the firm or provided by an external supplier. Such models can be very complex. It is not necessary to understand all of the technical details, but it is good practice for the actuary to understand the following features regarding the underlying mechanics, assumptions and calibration of the ESG:

- what in broad terms are the relationships between the key variables, such as the level and shape of the yield curve, returns on stocks and cash, price and wage inflation. For example, does one variable drive some of the others, are some variables linked by a formula in their values;
- how do the initial values in the model compare with market values at the equivalent balance sheet date;
- how do the values progress with time: e.g. do some or all of the means or the relationships between them revert to some "long term" values; e.g. how is the variability about the mean modelled, and does it vary with time; e.g. if the ESG models several currencies, how does it manage the relationships between the same economic variable across the different currencies;
- how does the ESG's calibration reflect the balance between recent historical periods and perceived future changes. For example, if the central bank has recently decided to adopt a monetary policy targeted on a specific level of inflation, then maybe the relationships between economic variables derived before this change could be expected to differ in the future;
- how well does the calibration account for tail dependencies, i.e. in stressed conditions.

It is also important that the senior managers and Board responsible for signing off the ICA gain some insight into the workings of the ESG. A good practice would be to list values of the key economic variables from the ESG across a period of years before and after the start date for the modelling, and to have explained the key trends and movements.

C.2.10 Specific Asset Considerations:

- Changes in shape and level of yield curve: the ESG should generate variations in both the level and the shape of the yield curve. This is particularly important if discounting is done using the yield curve.
- Equity Returns: Both the variations in equity prices as well as dividend returns need to be considered i.e. not just total return. Allow for the correlation between changes in yield curve, economic conditions and equity returns.
- Exchange rates - exposure/reporting currency: Matching by currency should reduce market risk, but the effect on bottom line of conversion of profit/loss in foreign currency is still a source of risk.
- Catastrophe losses may generate currency risk particularly where there is a period between payment of claim and recovery from reinsurers.
- Valuation of non-traded assets: properties. Property valuation is not an exact process. Valuers' estimates may lag the market slightly, which may have unfavourable consequences if the market falls suddenly. Properties are also an illiquid asset, with implications for liquidity risk. This should be considered as part of the parameterisation process. It may affect the realisation values.
- Subsidiaries are also an illiquid asset, with implications for liquidity risk. This should be considered as part of the parameterisation process. Consider the potential link between any insurance event and the realisation values of the subsidiaries.

- Consider what value might be realized from subsidiaries in stressed circumstances, how quickly this value could be realized and at what cost (transaction costs, leakage in value or restrictions in the amount of value that can be liquidated quickly enough). It is important to understand the mechanisms that could be used for realizing the value of subsidiaries and scenario-test actual events that would give rise to a need to do this.
- Unusual asset classes e.g. derivatives: Need to ensure the model is consistent with underlying securities.

C.2.12 Stress and Scenario Tests for Market Risk.
Even where a stochastic model has been used, stress tests are needed to validate the model for reasonableness and to help with calibrating assumptions. A standard set of factors to consider for stress and scenario tests is set out in PRU 2.3.22-2.3.24.
Examples of stress tests to arrive at a capital allowance for market risk include:

- a rise in interest rates of X% leading to reduced asset values;
- a change in the spread of corporate bonds/ yields;
- a Y% fall in equity prices;
- currencies depreciate against sterling by Z%;
- movements in property values.

When detailing the magnitude of the stress test used, it is good practice to explain why the level of stress was chosen. In practice for simple asset holdings a stress test is often sufficiently accurate to calculate a capital requirement.

C.2.13 Operational risk attached to market risk.
Emphasise whether operational risks such as failure of investment managers is included under market risk capital, or handled separately under operational risk.

C.2.14 Liquidity considerations are dealt with in section C.4.2.

C.2.15 Pension scheme risk: treatment of Defined Benefit (DB) Pension Fund.
The model may need to consider the strategy for managing any relevant DB scheme and the likely effect of particular economic outcomes on the scheme. Consult the pension scheme actuary if applicable, who may have already prepared DFA analyses for the scheme. Ensure that the treatment is consistent with the rest of the business, especially any correlations with the firm's own market risks. The ICA is concerned with the firm's own policyholders, not with the pension scheme itself. It is the insurer's contractual or constructive liabilities towards the pension scheme which are within the ICAS regime. Further details are discussed in the FSA's Insurance Sector Briefing of November 2005, in paragraph 4.34.

C.3 CREDIT RISK.

C.3.1 Credit risk refers to the risk of loss if another party fails to meets its financial obligations, or fails to perform them in a timely fashion. Credit risk modelling can be split by the categories:

- investment credit risk, e.g. from holdings of non-government bonds;
- counterparty credit risk, namely reinsurance recoverables, and where material, premium debtors, including pipeline premiums, and other balances with intermediaries and banks;

The risk of whether the reinsurance programme is suitable for the firm's gross liabilities is

covered in section C.1 on insurance risk.

C.3.2 Investment Credit Risk: Modelling Approach.

A modelling approach will consider the probabilities of default of each counterparty, and the degree of default, i.e. partial or total. A normal starting point is the ratings available from external rating agencies, and it is possible that the ESG used for market risk may be used to provide some of the necessary modelling and parameters. Where this risk is substantial, the firm might consider modelling of migration risk and spread risk.

The model should allow for dependencies between the counterparties, and should also consider the issues of:

- correlations between the assets held;
- the likelihood of systemic financial risk;
- potential correlation with the financial and economic modelling factors used in the assessment of market risk;
- the possibility of varying levels of loss given default for different category of asset, e.g. ledger debt, reinsurance outstandings, reinsurance IBNR, and reinsurance UPR.

Ideally the model should allow for likely future volatility of credit rating, but this can be included in current estimates/ parameter selection.

C.3.3 Counterparty Credit Risk: Reinsurance Recoverables.

Credit risk for reinsurance default is the potential loss to a firm arising from either the default of a firm's reinsurer or non-payment (due to a dispute) above the reinsurance bad debt provisions held. In determining the capital requirement for reinsurance credit and dispute risk, the ICA should reflect the concentration and financial strength of the underlying reinsurer. The ICA should also take into consideration the increased risk of reinsurance failure in extreme loss scenarios – published ratings sometimes reflect average default rates, rather than the likelihood of reinsurance default at the more extreme tails. In modelling terms, this would involve correlating reinsurance failure rates with large loss scenarios. The model should consider the expected timing as well as the amount of recoveries. Intra-group reinsurance should be treated consistently with external reinsurance – if the firm believes that greater knowledge of another Group firm improves the recovery position, this needs careful documentation. The model also needs to consider any possible correlation between the different reinsurers.

For future reinsurance default rates, external rating agency views are available. The amount of recoverable at risk should allow fully for IBNR claims. It may not be sufficient to use current levels or reinsurance recoverable in the firm's balance sheet. The modelling should consider not only the performance of the existing reinsurance asset but also the performance of future potential recoveries. For example, when modelling rare natural catastrophe events of large magnitude, it is necessary to apply default rates to the large amounts of recoverable that they will concentrate, i.e. this part of credit risk modelling will have to be linked to insurance risk.

External rating agency default rates reflect the likelihood of failing to pay all claims in full, so when using these probabilities, the model may be able to assume a partial recovery, rather than assuming nil.

The model should consider whether it is necessary to consider the extent to which, under

extreme circumstances, the probability of an insurance or a market loss is correlated with reinsurer default rates:

- if the reinsurer is located in the same territory as the event, there is likely to be a high degree of correlation;
- if the reinsurer is located in a different territory and has a wide spread of other risks, a lower degree of correlation may be appropriate;
- the degree of correlation may depend on classes of business written, and may be linked to the risk appetite under consideration. E.g. for a very large catastrophe and associated reinsurance default the return period may exceed 1/200.

If the firm has substantial reinsurance recoverables to model, the reader should consider the issues raised in paragraphs 6.71 to 6.74 of the FSA's Insurance Sector Briefing of November 2005.

C.3.4 Credit Risk: Stress and Scenario tests.

Even where a stochastic model has been used, stress tests are needed to validate the model for reasonableness and to help with calibrating assumptions. A standard set of factors to consider for stress and scenario tests are set out in PRU 2.4.13 to 2.4.15.

Important points to note are:

- potential "ripple" effects, for example overlaps between adverse economic or insurance scenarios and the behavior of counter-parties;
- hidden costs of adverse credit scenarios, e.g. extra costs of collection, delays reducing the present value of recoveries.

Scenarios to consider might include:

- the degree of credit concentration, e.g. the failure of one or two of the firm's largest debtors or intermediaries;
- a deterioration in the creditworthiness of the firm's reinsurers, intermediaries or other counterparties; e.g. hypothecate that every holding or debtor goes down one notch in rating category;
- credit spreads widening, e.g. take your current holdings, keep the ratings unchanged, and hypothecate that the spread over government bonds widens by a certain amount;
- the effect of the collapse of one or two of the firm's largest reinsurers on the firm's reinsurance programme and the subsequent impact this may have on the firm's outstanding reinsurance recoveries and IBNR recoveries;
- the prospect of reinsurance rates increasing substantially or reinsurance being unavailable;
- any existing or possible future disputes relating to reinsurance contracts on a pessimistic basis and the extent that they are not already reflected in the value attributed to the reinsurances.

C.4 OTHER RISK CATEGORIES (OPERATIONAL, LIQUIDITY, GROUP, EXPENSES).

C.4.1 OPERATIONAL RISK CONSIDERATIONS.

Operational risk is defined as the risk of loss resulting from inadequate or failed internal processes, people and systems or from external events. It may be less suitable for stochastic modelling, and may require more ad hoc treatment. A standard set of factors to

consider for stress and scenario tests are set out in PRU 2.3.29-32.

There is often little data available to firms and there are limitations for firms seeking to apply any market-wide benchmarks. So there is therefore greater need for management judgement in this area, and the firm has to explain these judgements. The firm has to demonstrate a credible approach, i.e. it has used an appropriate approach to calculations, and involved the people in the business in the best position to apply judgements. As far as possible, the firm should identify all the material operational risk scenarios specific to its own business, and use as little as possible 'rules of thumb', such as a percentage loading on other ICA components, or 'market average' loadings. It is preferable to use outcomes linked to the generated scenarios. Material scenarios might number between 20 and 50, depending on the size of the company. The hardest judgement is often whether operational loss scenarios are inside or outside of the confidence level being used by the firm for its ICA, and the model needs to explain how such judgements have been made.

If using a quantitative approach, the general methodology might be as follows:

- use either external or internal operational event databases to calibrate quantitative loss distributions for different risk categories;
- use scenario analysis discussions with business unit management, and simple scorecards / templates to subjectively assess and rank operational risks and controls, and to adjust the outputs of quantitative approaches.

Whatever the approach, it is good practice to consider and report upon the following issues:

- is operational risk considered in its entirety, as a completely distinct risk category that includes all operational failures that can cause losses, including those resulting in a loss previously recognised as insurance, credit etc.
- is operational risk included as an element of each risk category, with the remaining operational risk category consisting of the balance of operational risks not dealt with elsewhere (e.g. business continuity plans, loss of staff etc).
- how do you avoid missing or double counting risks.
- consider whether holding capital is the appropriate response to certain operational risks.
- make use of appropriate sources of opinions on risks that the entity is exposed to.
- ensure that where risk profiles / risk registers exist that these have been reviewed and each event considered.
- investigate any available appropriate market or competitor benchmarking information.
- consider looking into external loss databases, partly to search for examples of loss events that may have happened to other firms, and also those which are too remote to exist in the firm's own risk database, being derived from day-to day risk management activities.
- if the firm has outsourced operations, look through to the underlying service provider. Consider knock-on impacts of any service failure, even if the Serve Level Agreement has financial penalties.

C.4.2 LIQUIDITY RISK CONSIDERATIONS.

Liquidity risk is defined as the risk that sufficient financial resources are not maintained to meet liabilities as they fall due, or are only realized at substantially less than the market value. It may be less suitable for stochastic modelling, and may require more ad hoc treatment. A standard set of factors to consider for stress and scenario tests are set out in PRU 2.3.25-28.

It may be the case that, given the nature and the liquidity of the assets the firm holds, the nature of the insurance contracts written (i.e. positive cashflow of premiums before claims) and the associated asset-liability matching, the firm can demonstrate that it is possible to arrange for sufficient liquidity to be available, even in a time of stress. In this case, the need for liquidity risk capital in the ICA will be low. In evaluating exposure to liquidity risk, consideration could be given to:

- key aspects of the day-to-day treasury management processes;
- the impact of and ability to fund catastrophe events, i.e. an understanding of the key cashflows under a stressed scenario;
- any mismatching between expected asset and liability cashflows;
- the inability to sell assets quickly;
- the extent of any pledges on assets;
- cashflow positions generally and the ability to withstand sharp, unexpected outflows of funds via claims of a drop in the inflow of premiums;
- the possible need to reduce large asset positions at different levels of market liquidity, and the related potential costs and timing constraints;
- any other identified triggers of a possible liquidity risk event;
- investment guidelines and how these impact exposure to liquidity risk;
- the existence of contingent funding arrangements;
- the risk that reinsurance recoveries may not be received at the same time as the gross claim is paid out, as well as any regulatory requirements such as US Trust Fund issues.

C.4.3 GROUP RISK CONSIDERATIONS.

Group risk is defined as the potential impact of risks arising out of:

- a firm's membership of a Group;
- its relationship with other Group members;
- the activities of other members of the Group.

Potential areas of major and identifiable Group risk manifestation include:

- intra-group loans, letters of credit etc.;
- inadvertent stacking of reinsurance through different Group legal entities;
- inadvertent stacking of investments through different legal entities;
- shared services and outsourcing;
- intra-group guarantees;
- internal contagion;
- impact of a credit rating downgrade of the parent.

If modelling the Group itself, consider the difference between those risks that cancel upon consolidation and those that do not.

Some areas of Group risk may be considered within other risk categories, e.g. exposure to reinsurance credit risk with a Group entity. Where this is the case it is appropriate to recognise this within the Group risk area.

Further discussion is contained in section E.2.

C.4.4 EXPENSE RISK.

Expense risk is defined as the risk of financial loss from higher than expected costs and expenses. It can be considered either including or excluding expenses directly related to claims:

- expense risk could be treated either explicitly or implicitly.
- explicit treatment would need to include specific consideration of expense risk drivers and how these might be linked to other risk drivers, e.g. a link between insurance risk and expense risk.
- implicit treatment could simplify consideration of these links. If taking this approach it may be necessary to use a higher correlation assumption between, for example, insurance risks and expense risks.
- it could be appropriate to consider the materiality of expense risk for the entity in question.

Consideration could be given to the following features:

- split between fixed and variable expenses;
- timescale over which fixed / variable definition applies;
- items with a proportional or inverse proportional relationship with expenses;
- inflation risk;
- run-off expenses versus ongoing expenses;
- outsourcing possibilities, costs and risks;
- diseconomies of scale;
- any over-reliance on individual sources of business (e.g. insured / reinsured, broker, coverholder) and the potential impact on costs and expenses from loss of that business;
- where there is a risk of individual lines of business, or the firm as a whole, going into run-off then any additional costs associated with such a run-off situation should be evaluated.

D. STRESS & SCENARIO TESTING.

D.1 REQUIREMENT FOR STRESS & SCENARIO TESTING.

D.1.1 PRU 1.2.35R requires firms to carry out stress testing and scenario analysis appropriate to the nature of each major source of risk identified. Their purpose is, according to PRU 1.2.40G, to enable a firm to better understand its risk exposure in extreme events or circumstances (although per PRU 1.2.45G not in those circumstances that are too remote a possibility and only after taking into account the relative costs and benefits of doing so).

The use of stress and scenario testing is not isolated to the production of ICAs. Instead firms are expected already to be preparing stress and scenario tests as a matter of course as part of an integrated risk management framework, for deriving strategies for reducing risk exposures and developing appropriate risk controls.

Whilst it is not mandatory for stress and scenario tests to form the basis of an ICA report, they can be powerful tools in the production of an ICA. Typically, stress and scenario tests can be used for a variety of purposes including:

- As an explicit input into the ICA calculation.

The ICA can be wholly or partly based on stress and scenario tests, although for more complex businesses there is a strong expectation that some form of stochastic modelling will be applied. Stress and scenario tests are commonly used for those risks that cannot be easily modelled quantitatively and where more subjective judgement is required. Indeed, it is not uncommon for ICA reports to include some element of stress and scenario tests towards the ICA value.

- To calibrate and validate a stochastic model.

Where sophisticated models are being developed to estimate extreme losses, stress tests should be considered as an independent check of model output. This can be carried out at a granular level (e.g. are the simulated extreme losses for a specific class of business reasonable?) or at the overall model level (i.e. the aggregation of all modelled risks). In turn individual model parameters can be flexed to test the sensitivity of key assumptions.

- To assist management in understanding of a model and the risks facing the business.

The ICA is ultimately the responsibility of the Board and as such the actuary will need to engage with and seek the views of senior management. Stress and scenario tests are a useful mechanism for entering into a dialogue with senior management, and to give them comfort as to the reasonableness of the overall ICA value.

- To determine ‘risk appetite’ for the firm.

As part of its overall risk management process a firm should form a view as to its appetite for various risks and the maximum exposures on risks it is prepared to accept. Again, stress and scenario tests will often form a platform for deriving and articulating the firm’s risk appetite.

D.2 SELECTION OF STRESS TESTS AND SCENARIO ANALYSIS.

D.2.1 A firm's risk register will be one of the initial building blocks of an ICA and then the selection of stress and scenario tests should be made with reference to the risk register. The number of identified risks in the risk register will be commensurate with the complexity of the business but it is expected to include risks under each of the six broad FSA risk categories. The FSA will ask:

- to see an extract of the risk register highlighting the main risks;
- how often the risk register is reviewed;
- how risks have been graded in a consistent manner (both likelihood and size of loss event);
- how the risks are aggregated for the purposes of developing sensible scenarios;
- to see established owners for each of the risks in the register.

As a minimum, stress and scenario tests should be prepared for all major risks in the register which are not explicitly modelled stochastically, although best practice would normally include stress and scenario tests for all risks. The risk register should be used to provide a clear audit trail to demonstrate that capital has been allocated to all material risks identified by the firm. No material source of risk should be omitted without justification, and it is generally helpful to document risks initially classified as 'possibly material' and then reclassified as 'immaterial'.

In order to select an appropriate collection of stress tests it is first necessary to identify the role and purpose of each stress test. In selecting stress and scenario tests, risks should be prioritised according to:

- the events which are likely to have the greatest financial impact;
- the events which are highly correlated to other risks (and hence should be considered in conjunction with others to form complete scenarios).

It is important to note that stress testing is not just an actuarial exercise: the views of underwriters, claims managers and other risk managers should be sought. In particular the views of senior management in identification and quantification of stress tests are central to the underlying ICAS principles. A wide range of potential scenarios should be considered; for example small scenarios, which on their own can only have a modest impact, can be substantial when aggregated.

Ultimately the final selection of stress tests will be the responsibility of the Board, but the final selection would normally be expected to include the following broad categories of scenarios:

- changes to the firm's business plan or wider business strategy;
- scenarios which reflect changing market conditions such as the premium rating cycle or asset values;
- scenarios relating to extreme loss events, or a combination of smaller loss events;
- a combination of any of the above.

By definition a stress test is only a point estimate of an extreme loss event. In order to give greater insight into the nature of a risk the range of potential values around the chosen stress test and its likelihood could also be considered and communicated.

A common misconception is that stress tests are merely hypothetical scenarios based on the expert views of key risk owners. In practice stress tests themselves can, and in certain cases should, be based on a robust statistical analysis.

For the interested reader, we refer them to a report to the Canadian Office of the Superintendent of Financial Institutions (OSFI), which gives a detailed description of one approach to stress testing (link given in section H).

D.3 AGGREGATION OF STRESS TESTS.

D.3.1 Section E contains a more complete discussion regarding aggregation of modelling results.

There is no generally accepted method for the aggregation of stress and scenario tests. Nonetheless it is important that the aggregation stage is performed within a clear methodological framework: assumptions can then be flexed within the framework in a reasonably consistent fashion. The limitations and underlying assumptions of the framework itself should also be documented and understood by those responsible for production of the ICA. This is no different to the development of a stochastic model, which is merely a collection of assumptions within a more complex statistical framework.

Two broad approaches in the aggregation of stress tests seem to be emerging in the production of ICAs:

- a 'cause and effect' (or 'ripple effect') approach;
- aggregation via an explicitly defined correlation matrix.

Under the 'cause and effect' approach, each major risk category is considered separately as an extreme loss event, and then losses on other risk categories are estimated given that extreme loss event. The extreme loss under consideration could be at the 99.5% level for that risk group, or be at a lower confidence level. In some cases there will be "ripple effects" between risks, i.e. an extreme loss in one risk group triggers a loss in another. Similarly between other risks there will be no ripple effects, but 'random noise' means that modest losses may be experienced in other risk groups at the same time. Each of these combinations of stress tests represents a separate scenario and forms the basis of the aggregated capital requirement.

Alternatively, stress tests can be aggregated to an overall ICA by means of a correlation matrix plus some plausible assumptions on the relationship between the capital requirements and the standard deviation. The correlation matrix, which defines the dependency between each stress test, is often subjectively chosen. Under this method, all stress tests for each individual risk must be determined at the same confidence level (e.g. 99.5%); there are approximate methods to convert capital requirements at one quantile level to another to achieve this. The most basic form of this approach is known as a 'root sum of squares' method where the assumed correlations act as weights in the aggregation of the stress tests. When choosing the correlation parameters, aggregation to individual counterparties and risks within a group should be considered. More complex theoretical methods can be constructed; however given the typical lack of data on the dependency structure at extreme values it is arguable that such additional accuracy is spurious. It is also important to consider the impact of scenarios on other companies in the market and the impact this will have on the firm.

Whatever approach is adopted it is likely that the approach has a number of assumptions

which are based on subjective views and it is important to engage senior management in this; it is therefore critical that the process is well documented including reasons for the parameters eventually chosen. Scenario modelling, particularly where scenarios incorporate a number of different PSB risks (Insurance, Credit, Market, Liquidity, Group and Operational) and are aimed at being representative of the overall ICA amount i.e. holistic scenarios, can be very useful in validating correlation parameters in a more pragmatic way. One major advantage of this approach is that senior management can readily understand it.

Equally, working out whether a scenario is calibrated to a 99.5% rather than 95% or 99.9% is judgemental. In this context, it is good practice to compare the selected scenarios to historic events to help assess the overall reasonableness of the selected scenario.

D.4 USE OF REALISTIC ADVERSE SCENARIOS.

D.4.1 The use of realistic adverse scenarios has naturally tended to focus on the insurance and credit risks as these risks will typically be the source of the largest single risk exposures. For such risks, stress and scenario tests should normally be available as a natural by-product of running the business. However, it is important to encourage those involved to consider events that are rare but plausible; such events may not have been experienced in the past. There may be resistance to such scenarios and it is often useful to refer to the experience of other firms (where publicly available). Different firms will employ different methods to generate such disaster scenarios; however it is often useful to split the process into two stages: first defining the total (worst case) exposure to an event and second the realistic probable loss. In order to underpin the stress test a detailed knowledge of the underlying risk exposures will be required, whether it be the geographical spread of policies or the allocation of potential reinsurance recoverables by reinsurer. Where detailed knowledge of underlying exposures is insufficient, this in itself is a risk facing the business for which capital will be required.

It is normally appropriate to produce at least one stress test per FSA risk group for all major exposures. For operational risk it is usually appropriate to produce several scenarios covering different aspects of risk such as: damage to physical assets, rogue employee or failure of outsourcing. Credit for existing controls may be taken as mitigation but the impact of one or more controls failing should also be illustrated. Actuaries working within the capital process are encouraged to raise and promote these issues even if they are not involved in the calculation of a particular component.

It may be appropriate to use an extreme simulation from a stochastic model to define a scenario. This way one can be more certain that the scenario has the desired probability level and conversely the output from the stochastic model is tested for reasonableness as an attempt is made to fill in the details.

D.5 VALIDITY CHECKS.

D.5.1 Unlike a reserving exercise, it is difficult to ascertain whether capital calculations performed today are correct at a later date: if an event is witnessed that requires the use of capital, one cannot say what probability level the event related to; the feedback loop is slower for when trying to measure events with a 0.5% probability. Hence, whilst theoretically the “right” answer may exist; in practice it does not. This is true for both capital calculations based on

stress tests or on more complex economic capital models.

Nonetheless, actuaries are well placed to validate stress and scenario tests and to challenge or support the views of internal experts. It is appropriate to look at the past history of relevant events in the insurer's own data and published industry data to check that the capital set aside is comparable to this. For example, the modeller could use historic events based on the current exposure to assess the reasonableness of their catastrophe models. Where capital is lower than implied by historical losses, clear reasons should be identified and endorsed by management. In order to validate stress tests with a degree of confidence, knowledge of the business plans and actual and projected exposures is required. As a result significant information management systems may be necessary to provide the data to generate an accurate stress test.

It is sensible also to look at published industry benchmarks to test the split of capital between risk groups is not out of line, or if it is, seek to understand the reasons for the difference. The output from stress tests can also be used broadly to validate and calibrate stochastic models; however because the probability level of the stress test cannot be known with certainty this exercise will include an element of subjectivity.

Where stress tests are highly reliant on expert judgement rather than statistical analysis, there is a particular difficulty in ensuring that the stress test has been determined at the required confidence level (although this may apply also to economic capital models). Many risk owners (underwriters, claims managers and also actuaries) are more accustomed to considering values around the mean rather than at extreme percentile points. In this context the actuary has a role to play in translating the views of internal experts to appropriate stress tested values, and attempting to ensure a degree of consistency between those inputting into the process. Whilst there will always be uncertainty as to whether a stress test has been determined at the precise tolerance level, by drawing on data relating to historical events and the application of statistical principles, a consistent methodological framework can be developed in many cases.

E. INTEGRATING THE RESULTS INTO A TOTAL.

E.1 COMBINING RESULTS OF DIFFERENT STRANDS.

E.1.1 It is likely that more than one approach, model or stress test will have been used in considering all risks that the entity faces. The results of these different elements need to be brought together and a single result generated; one that can be compared both to available capital and other metrics.

In carrying out this aggregation, consideration must be given to both the method used to combine elemental results and the level of correlations that might exist between these elements.

E.1.2 Correlations and aggregation.
In any capital model, a key assumption is the method of aggregating the results of the effects of different risks for which the capital should provide. It is not necessary to provide capital sufficient to cater for all reasonably foreseeable worst outcomes occurring together. Correlations, positive or negative, or dynamic deterministic relationships should be allowed for between variables (in either case of a magnitude justified by historical observation; in accordance with any underlying economic model or by expert input).

Careful justification should be given to the appropriate correlations to assume between variables in the more extreme stresses relevant to ICAs. In some cases, it may be appropriate to assume a higher correlation than that historically observed to reflect relationships which only come into play in more extreme stresses.

E.1.3 Aggregation approaches.
When aggregating results without determining a joint distribution, the methods used should ensure that adequate weight is given to the capital requirement calculated for each of the individual risks. The methods should be appropriate and not inappropriately dilute or average out the capital requirements resulting from high impact risks. It is good practice to give a commentary on the selection of the parameters in any selected correlation matrix. Where statistical distributions are fitted to different risks, forming the joint distribution either in closed form or by Monte Carlo simulation is an appropriate method of aggregation using appropriate correlation matrix.

If statistical distributions are not fitted, or if the determination of a joint distribution is not possible, then more approximate methods of combination will need to be used. Particularly across different risks, it may be suitable to use a Var/Covar approach to aggregate the standalone risk measures, supplemented with tail scenarios.

E.1.4 Correlations within and between classes of business.
There are a number of key correlations which impact within and between risk classes including inflation, catastrophes, changes in the Court decisions, legal and regulatory changes. Within risk classes correlations exist: between lines of business; catastrophes affecting more than one line of business; between asset classes; between accident / underwriting years; and across development years.

E.1.5 Correlations between risk categories.
Areas to consider include correlation between insurance (a catastrophe) and credit risk

(reinsurance recoverables); the link between reserving risk and underwriting risk (either arising from changes in development patterns, changes in Court awards, or from underlying inflation); and asset liability matching and associated risks.

Especially important are the links/correlations between market and other risks:

- inflation is a key common driver between market and insurance risk, i.e. the model should reflect the link between inflation and investment returns, as well as the link between inflation and claim costs;
- the impact of economic downturn should be considered as this may impact the propensity to claim as well as more frequent fraudulent claims. Lines of business that can be impacted include mortgage indemnity, medical & health insurance (household, motor).

E.1.6 Diversification benefit across legal entities, territories and Groups.
Companies that are part of a Group might have an additional level of diversification between the different companies within the Group (and potentially across to different financial services sectors). It should be considered whether such diversification benefits exist, and what evidence of such diversification is available in the form of either historical experience or market information. This topic is discussed further in section E.2.

E.1.7 Correlations/dependencies – tail dependencies and stressed circumstances.
In some cases, it may be appropriate to assume a higher correlation than that historically observed to reflect relationships which only come into play in more extreme stresses. In particular, correlation coefficients appropriate for ordinary size losses might not be sufficient for the largest losses in the tail of the distribution. A recent example is the World Trade Centre event in the US, where property, liability, marine, aviation and PA policies all responded to one event.

The use of copulas is one theoretical way to model tail dependencies. An alternative approach is stressed correlation matrices that set out the implied correlations between the selected parameters, both under normal conditions and at the extremes. There are many different copulas, which can give different answers, and there is often not much data to parameterize them.

Scenario testing of extreme events is another way to gain understanding of the impact of large events including ripple effects. In all cases data is rare, and results would be very sensitive to assumptions made. Sensitivity testing is recommended.

E.1.8 Subjective approach in absence of data.
In many cases it may be necessary to assess whether there is full correlation, high, medium, low or no correlation in a subjective manner. If the correlation matrix chosen is based on expert opinions, the reasoning behind the choices needs to be documented. It is important to consider how this view gets updated for subsequent analyses.

E.1.9 Splitting out the ICA into PSB risk categories.
A number of methods are available. If capital has been assessed on a risk by risk basis it makes it easy to allocate to the PSB risk categories. Where diversification benefits exist consideration should be given as to how to / whether to allocate these back to risk category. Typically this can be done on either a proportional or a marginal basis, although the additional uncertainty from allocating capital to the separate constituents should be made clear within the ICA.

To carry out a marginal capital allocation for each and every subdivision may be very onerous. It may be possible to simplify by using the marginal approach only for the dominant peak risks ("top 10"), and an average rate for all the others. If a medium size risk has negative correlation with other elements, it needs to be treated on a marginal basis. If one or more elements seem to have very low marginal rate, consider if this is permanent or if it is only temporary, e.g. during payback conditions following a recent large loss.

E.1.10 Validation of overall level of diversification benefit.

There is no single way of defining the overall diversification benefit in the ICA. Although the 'fully' diversified ICA is the final result, the 'undiversified' result can be defined at many levels. However, it is natural to look for some assurance as to the reasonableness of the diversification benefit in the ICA.

Three approaches are suggested below, and it is probably appropriate to use a combination of the three.

i) There are some combination steps that are quite discrete and can be regarded as bringing their own diversification benefit. For example, key steps in the ICA construction might be:

- combine individual classes of business to establish overall insurance risk;
- combine the insurance risks with market, credit, operational, &c. risks;
- combine different business units - for example across geographical territories.

For each of these steps, the individual diversification benefit can be calculated and compared with the benefit assuming, for example, zero correlation. By seeing where the actual result lies on a range of 0 to 100% correlation, a judgement can be made as to the reasonableness of the diversification benefit.

ii) Within each step, explicit correlation assumptions can be identified and their effect on the diversification benefit estimated. By ranking the correlation assumptions according to their contribution to diversification benefit, the actuary can identify the key sensitivities and focus on those most important assumptions. Sensitivity-testing can be performed in the context of the first approach above - perturbing each key assumption and seeing how the ICA moves on the 0-100% correlation line.

It is important to bear in mind that diversification benefits do not build up in a linear fashion, and the outcome of these analyses may be influenced by the order in which the steps are considered.

iii) Scenario development is also a key aspect of reasonableness testing. Given the assessment of the ICA loss, scenarios can be constructed that have the right magnitude overall, but result from different causes or combinations of causes. Many scenarios that justify a diversification credit will involve a combination of gains and losses in different risk areas or parts of the business. The feasibility of these scenarios should be considered in the light of known or assumed relationships between different components.

E.2 GROUP AND CROSS-SECTORAL CONSIDERATIONS.

E.2.1 Diversification across a Group.

Any allowance for Group wide diversification should be made explicit. These assumptions

are often part of the rationale or business model of a large Group. The FSA will set high documentation standards for this issue:

- evidence will need to be shown that the variability of financial results in various Group companies are not fully correlated. It seems natural that auto claims in the US are independent from fire claims in France and liability claims in Australia. But the Group needs to consider whether or not premium cycles in one territory are linked with those in other territories, and the same question arises for inflation rates and investment returns around the world;
- diversification across the Group assumes that capital can be rapidly transferred to where it is needed in an extreme scenario. This will require demonstration of the mechanisms for making capital available to move, constraints that may limit this, associated costs and evidence that these could/would be invoked in times of distress.

If the Group takes credit for diversification, it must show that it has in like manner allowed consistently for the contagion risks between Group companies. Even if a Group is granted diversification credit in the parent by a regulator, there is some debate whether they would be allowed to allocate this part back down to the solo company assessments.

This topic is being debated as part of the Solvency II developments, and the FSA would prefer not to take a definitive position in the UK until the outcome is known at the European level. The CRO Forum has written a position paper on the subject, and for those firms for which cross-group diversification is an important issue, we refer the reader to that document, available at the link shown in section H.

E.2.2 Subsidiaries.

If the UK regulated entities have subsidiaries and/ or branches that may potentially require capital injections or if there is a reputation risk these need to be considered as part of the ICA assessment:

- look at the capital that the subsidiary needs to support its own business;
- look at the transferability of capital under adverse constraints, i.e. potential for constraints on the movement of capital between legal entities in distressed circumstances;
- the structure may also impact the assets that are calculated to compare to the ICA figures. The most sensible approach may be a consolidated/look-through basis;
- it is useful to show separate ICAs for each of the UK entities to get a comparable basis for the ECR.

E.2.3 Internal reinsurance / parental guarantees.

Firms should consider Group risk where the firm is part of a Group. If credit is taken for a parental guarantee within the ICA, firms should state this clearly within the ICA report:

- firms should consider the likelihood and financial consequences of both insolvency and credit downgrade of its parent, and how this risk is dealt with;
- ICA documentation needs to set out the reliance on parental guarantees – and the ICA if any for the parent needs to allow for such guarantees.

E.2.4 Treatment of assets / exposures to Group companies:

Consider the risk of capital support from parent:

- firms should consider the likelihood and financial consequences of both insolvency and credit downgrade of Group companies – particularly those to which the firm has direct exposure (e.g. through credit or reinsurance assets);
- default risk should be considered as if the counterparty were external, although some exposures may cancel on consolidation.

E.2.5 Treatment of liabilities to Group companies.
Care is required over the treatment of credit and other liabilities – especially to other Group companies, where legally the liabilities may be subsidiary to the firm's own policyholders:

- it may not be appropriate to assume that a subsidiary can have zero value at worst;
- any intra-group guarantees or other arrangements for which one party takes credit should be recognized appropriately by the counter-party.

E.2.6 Other areas firms might consider as part of the Group risk considerations:

- run-off costs if firm ceases as a result of the withdrawal of Group support;
- reputational impact – consider if and how this would impact on policyholders' interests and whether or not capital is the most suitable response to the risk;
- a change in Group strategy;
- drop in support as a result of increased funding requirements;
- breakdown in relationship with shareholders;
- regulatory action against another Group member;
- related party transactions;
- financial pressure upon syndicate or firm from elsewhere in the Group, which adversely impacts the syndicate or firm;
- support services provided by the Group company may become unavailable (e.g. Investment management, IT, actuarial etc.).

E.2.7 When aggregating simulated results across a Group, it is important to use a consistent set of simulations and allow for correlations. Two approaches can be adopted:

- either, each Group company provides the output results of its own simulations to the corporate centre in a standard style, and the centre has to combine these results, including the level of correlation and diversification benefit;
- or, each Group company provides input files of exposures and accompanying frequency and severity parameters, and the centre carries out the overall simulations.

E.3 OUTPUT OF RESULTS: COMPARISON WITH ACTUAL CAPITAL.

E.3.1 Comparison with capital base / available capital.
It is good practice to compare the results of the following calculations:
(i) the required capital arising from the ECR calculation;
(ii) the required capital arising from the ICA calculation;
(iii) the available capital on a statutory basis;
(iv) the available capital on an economic basis.
A tabular format similar to the following may help:

	Statutory	Economic	ICA/ECR %
Required capital	(i) = £Xm	(ii) = £Ym	£Ym/£Xm %
Available capital	(iii) = £Am	(iv) = £Bm	
Ratio of available to reqd.	£Am/£Xm %	£Bm/£Ym %	
Excess available over reqd.	£(A-X)m	£(B-Y)m	

E.3.2 The report should normally explain the key reasons for any substantial differences between (i) and (ii) and between (iii) and (iv). Good practice would be a tabular report of each item:

- for the required capital: showing the split of statutory and economic capital by major risk categories. For the economic capital extra items might arise, e.g. relating to operational risk, diversification credit;
- for the available capital: showing the split of statutory and economic capital by major items from both sides of the balance sheet. For the economic capital extra items might arise, e.g. relating to discounting of reserves, deferred tax assets.

The report should also comment on the relative sizes of (iv) compared to (i) and (ii). For example, it is possible for the ICA requirement to exceed the ECR, but for the firm to be able to demonstrate that it has more than sufficient capital on the economic basis.

E.3.3 Comparison to ECR.
Requests to compare the ICA to the ECR are to be expected. Depending upon the basis and methods used for the ICA calculations such a comparison, if made without appropriate commentary, could be misleading. For each of the ICA and ECR, considerations might include differences and similarities in:

- accounting basis;
- risks allowed for;
- aggregation of different risk types;
- treatment of any diversification benefits;
- risk appetite;
- time-horizon;
- calculation dates and data.

The document "F.S.A Calibration of the general insurance risk based capital model" may be of use in carrying out any comparison of ICA and ECR. A link is given in section H.

E.3.4 Expressing the ICA as a proportion of ECR.
The ECR is a retrospective calculation. The data and basis used to calculate an ICA is not prescribed. The as at dates used in any comparison would ideally be the same; this may not be possible. The method and timeframe used to produce the ICA may dictate which ECR to compare to. Nevertheless, even a broad brush comparison with ECR can be useful. Major percentage differences can prompt further investigation and/or explanations.

E.3.5 When is capital not appropriate.
There may be risks considered within the ICA framework against which it is decided not to hold capital. For such risks the reason for not holding capital should be clearly stated, together with the control framework in place.

E.3.6 Comparison to other benchmarks.
Benchmarking the ICA against other information might be useful. Many factors will affect the comparability of the ICA to the benchmark. It may be appropriate to consider, analyse and communicate these factors along with the actual numerical comparison. If the ICA model has the flexibility, it may be worth considering output at different security levels; this could then be compared to rating agency views. In the Lloyds environment comparison with RBC is often helpful.

E.3.7 Other reporting issues such as post ICA event issues, changes in methods/assumptions since previous report, analysis of change in capital requirements since previous report, and analysis of change in capital base since previous report are considered in section G.1.

F. VALIDATING THE RESULTS.

F.1 CHOICE OF PARAMETERS.

F.1.1 It is important that an ICA report contains sufficient details to allow the reader to understand the derivation of the parameters underlying the model distributions and the logic as to how these distributions aggregate in estimating the overall capital required. Because of the dynamic and interdependencies within models, it is important to consider the model as a whole as well as individual component parts. In other words do the overall results sense check, does the model behave as expected and if not can we explain why?

F.1.2 The choice of parameters as well as the distributions will depend on the structure of the model, the methodology and the availability of internal and external information. It is good practice to discuss the quality, quantity and relevance of the internal and external information available for the purposes of parameterisation.

F.1.3 To obtain "real world" outcomes, it is generally appropriate to calibrate models with reference to actual historical data / events. Calibration for extreme losses to historical data is very difficult. The report should discuss the considerable uncertainty surrounding the 99.5% loss in any model.

F.1.4 It is important that any adjustments in the parameterisation process (such as removal of outliers from historical data and allowance for future management actions) are fully documented and justified. This is not intended to undermine actuarial judgement; merely to ensure that these decisions are adequately documented and explained.

F.1.5 Proportionality.
The actuary should consider the materiality of the underlying risk considered in the context of the overall ICA. The considerations as discussed below are good practice for the most material risks. The extent to which the other risks are considered/ documented will be at the discretion of the actuary. However, in all cases the actuary should state in broad terms the methodology applied to the smaller categories of risk.

F.1.6 Considerations in respect of data validation include the following:

- data must be checked for completeness and accuracy. Grouped data used in the model should be checked back to source data for consistency;
- the data used in the model should span a suitable time period depending on its availability/relevance e.g. trends in the past may make the data unsuitable for use in the model;
- a sufficient level of data should be used to base the model on in order to produce a credible outcome;
- where possible and necessary, the historical data should be compared to market level and/or peer data.;
- models should ensure that data for inter-related elements show consistency between each element e.g. models which simultaneously allow equity, fixed interest and property returns to vary stochastically must have appropriate assumptions about the covariances between them;
- data validation might be better carried out by people external to those carrying out the manipulation.

F.1.7 Use of Market Data.
The quality and quantity of the firm's own data and extent to which it can be relied upon must be considered. In using a firm's own data, "survivorship bias" should be considered, that is by virtue of not going insolvent in the past the observed experience of the firm may be better than the market average. Market data is appropriate for assisting in the selection of parameters, particularly where limited historical information is available. However, where firms use market-wide information, careful consideration should be given as to the relevance of the information, and the appropriateness of the volatility. In general, a smaller portfolio will have a larger standard deviation as a percentage than a larger portfolio. As a result, the standard deviation (SD) of a small firm should likely be set higher than the observed SD of the whole market.

Selection of Parameters and Distributions.

F.1.8 When selecting the appropriate distributions and parameters the actuary should ensure that they adequately reflect the complete distribution of events, including the more extreme low probability and high severity events.

F.1.9 In circumstances where no appropriate single distribution can be found, the actuary should consider whether it is beneficial to segment the distribution to reflect the extreme events separately. Inevitably this will result in a trade-off between over-parameterisation and greater accuracy of modelling.

F.1.10 The choice of distribution will depend on the model structure, the characteristics of the data and the nature of the underlying risks. In all cases it should reflect the expectation of the firm (taking into account detailed knowledge of the risks) as well as historical evidence to date.
The choice of model or distribution may be due to theoretical reasons or be common market practice; ideally, several models should be considered and investigated before a final choice is made.
Tests exist to determine the appropriateness of parameters, often they can be best determined by viewing data graphically.
Care should be taken over removing so-called 'outlier' observations from historical data on the basis that they distort historical results. Where observations are removed, some additional loading is normally appropriate to avoid understating the experience. Similarly, truncating the tails of distributions may not always be appropriate and should be justified.

Parameter Uncertainty.

F.1.11 The length (or volume) of historical data may be limited by availability and relevance. The firm should consider the extent to which the model adequately reflects these uncertainties. Often there is insufficient data to be totally confident of the parameters or model, and some degree of parameter or model uncertainty is likely.
Where there is a lack of data, a more subjective approach to validation may have to be taken, for example, involving underwriters, reinsurance managers and other experts in assessing whether the selected model is reasonable and the bounds for sensitivity testing.
The effect of mis-estimation of the parameter values can be investigated through sensitivity analysis. This involves assessing the effect on the output of the model of varying each of the parameter values. It is important that the results of such a sensitivity analysis are communicated to senior management, and that firms review regularly the key parameters to ensure their continued applicability.

F.1.12 Models are based on past experience, and for some business it is likely that over time this experience will become out of date due to all manner of trends. When such trends start to emerge, the actuary should consider their impact on the results, even when the outcome is not certain. Best efforts should be made to start a debate and approximately quantify possible impacts; this will illustrate the parameter risk that models face. GN 50 is clear that care is required when giving advice based on underlying data that is not up to date.

Current examples of this are:

- climate change - it is essential that this issue is considered at present;
- Atlantic Multidecadal Oscillation (AMO);
- bird flu.

For example for climate change/ and/or AMO, whether the actuary is using an internal or an external model, he/she could ask questions of the model such as the following:

- if the model takes loss distributions: how have these been updated for US property risks to take into account the current "hot" phase of the AMO cycle; has the data relating to the previous hot phase of the cycle been adjusted to allow for a climate change trend? If not; why not? How have distributions been updated for subsidence risk (potential changes in the probability of more hot summers like 2003); how have distributions been updated to allow for increased flood risk in the winter?
- if the model takes catastrophe model output: does the catastrophe model allow for AMO/climate change? Is a set of stochastic simulations available that does this? Was this used, if not why not. How have storm surge factors been adjusted to allow for the increase in average sea surface levels?

Correlation Matrices

F.1.13 Consider the choice of parameters for correlation matrices – careful justification should be given to the correlations assumed between the more extreme stresses relevant to ICAs. In some cases, it may be appropriate to assume a higher correlation than that historically observed to reflect relationships which only come into play in more extreme stresses.
The choice of correlation coefficients will depend on the extent to which 'correlation drivers' have been used. Some models can sustain a relatively modest explicit correlation because the models have instead used a combination of external catastrophe model outputs, simulated underwriting cycles and claims inflation to drive correlation rather than imposing it explicitly.

Fitting distributions and determining parameters.

F.1.14 The method used to select and fit statistical distributions should be explained – such as goodness-of-fit, maximum likelihood estimators.

Documentation of the parameterisation process

F.1.15 The FSA recommends that an ICA report should include a complete audit trail of the parameterisation process for at least one “significant” class. This should include a summary of the raw data/benchmarks used and the adjustments (with rationale) in deriving the distribution and the parameters, as well as the logic as to how these distributions flow into the overall capital model. In addition, the full working papers or computer files should contain this

information on all classes modelled.

F.1.16 In principle, any model that projects a range of possible future outcomes can be back-tested. For ICA models, some degree of back-testing may be appropriate, either at the overall model level or within individual components. ICA models, by their nature, project a range of possible outcomes. Actual events show a single outcome that may or may not be consistent with an a priori assumption for the range of possible outcomes. This makes back-testing more difficult than for a model that merely seeks to predict the expected outcome.

Notwithstanding the data used to set parameters for the model, one form of back-testing is to roll the model back and check the consistency of more recent experience with the projections taken from the rolled-back model. Actual events are unlikely to match the expectation from the model's projections, but they can be used to check that the range of projections is consistent with experience that has been observed. It can be useful to plot historic outcome, with adjustments for exposure and other changes, against assumed distributions.

As the model is updated for future periods, new experience emerges. This new experience can be compared with the model's earlier predictions to check the need to revise either the model structure or the assumptions used.

F.2 VALIDATION OF MODEL.

F.2.1 Sampling error for stochastic modelling.

Sampling errors involved in Monte Carlo simulation can be estimated, either by using analytical formulas for standard errors, or by using increasing numbers of simulations until a number can be identified beyond which additional simulations add little additional accuracy.

To the extent practicable, a sufficient number of simulations should be used in the valuation so that the confidence interval is within acceptable levels of materiality. If a random number generator is being used, ensure it produces numbers which display sufficient randomness.

F.2.2 Model error.

The ICA report should demonstrate that sufficient sensitivity tests of the model have been carried out, and that these sensitivities are understood by the management. The ICA report should identify which of the parameters are the most critical to the ICA value, and give indicative movements in the ICA value for the most sensitive parameters.

The report might also give commentary on the potential parameterisation error and model error, stating what adjustments have been made to cover such errors.

F.2.3 Model validation.

The model itself will need to be tested with a full log of all the testing carried out. An internal audit of the testing and validation process may provide a useful independent check. Model validation could initially be carried out by someone within the actuarial team. Tests should be carried out to ensure that the output is consistent with the business plans.

Stress tests are needed to validate the model for reasonableness and to help with calibrating assumptions. The model should then be validated using sense checks and process review – ideally by individuals external to the actuarial team e.g. internal audit, finance team, third party, who should be suitably qualified to do the work.

F.2.4 Stress, scenario and other types of tests.

Stress and scenario tests need to be carried out to determine the expected financial

consequences of adverse circumstances and events arising within the relevant time horizon. Stresses consider movements in individual risk drivers whereas scenarios consider combinations of stresses that could realistically happen together.
A comparison should be made of actual experience with model output of future time periods (from previous runs) in order to assess whether any changes to the model need to be made.
Standard tests and business-specific tests should be applied where appropriate e.g. RDS tests for Lloyds.

F.3 CONTROLS/PROCESSES AROUND MODELLING.

F.3.1 It is important to demonstrate that there are adequate controls in place in the calculation models and processes. This will include:

- detailed documentation of the model and calculation process;
- internal sign-off: a formalised sign-off process;
- potentially an independent review, by external third parties.

F.3.2 Senior management involvement.
A key element of the FSA regulatory regime is that senior management should be closely involved in the process of risk assessment and control, and that this should extend to the Individual Capital Assessment. It is essential to be able to demonstrate that senior management have bought into the ICA process, understood the key issues and assumptions, been involved in the key decisions and accepted ownership of the final ICA itself. The ICA figure itself should be signed-off by the Board.

It is generally not good practice for one actuary, or a team only of actuaries, to complete an ICA in isolation, even if they are themselves a member of the senior management team. Communication within the organisation is of key importance, thus actuaries should usually consider education as an important element of the task. This will usually include both education of others in technical actuarial aspects and education by others in areas, as required.

F.3.3 Use of Consultants.
The senior management's involvement is equally important when the actuary is a consultant to the insurer in question, rather than an employee. Consultants specialising in risk management and capital modelling techniques may make a significant contribution, but they should always seek to ensure that their work is adequately understood and challenged, where appropriate, by the staff and management of the insurer. Conversely, internal actuaries may be in a position to assist management in their understanding of and support of or challenge to the work of their consultants.

F.3.4 Third party input.
In practice there may be areas under consideration where it is reasonable, or even best practice, to use software or ideas from a third party, such as a specialist provider of economic scenario generators or catastrophe models. However, it is important in these cases to ensure that the detail of the approach is adequately understood and its appropriateness confirmed by the insurer for the particular case in question. It would also be considered best practice that the ICA process and figure is peer reviewed by an independent (either internal or external) party.

F.3.5 Controls.

In all but the simplest cases it is desirable, before finalising an ICA, to demonstrate that certain controls have been enforced. These would normally include, but not be limited to, the following:

- checking the audit trail for certain items, possibly on a sampling basis but considering particularly the items of the greatest importance;
- reconcile the projections against business plans;
- sensitivity testing of the parameters that are key to the answer;
- sensitivity testing of the modelling structures employed that are key to the answer, which may often include dependency structures;
- considering the appropriateness of outputs from different views and at different levels of detail;
- considering the impact of substituting market data, where appropriate and available, in place of internal firm data;
- benchmarking elements of the inputs and/or results against those arising elsewhere, to the extent that these are or become available;
- independent review of the results, e.g. by comparing with internal stress tests where relevant, and/or by commissioning an external specialist;
- sign-off of key parameters within the organisation to ensure consistency, e.g. gross/net profiles with reinsurance department/ underwriters, investment returns with investment managers, etc.

F.3.6 Big picture checks.

Because of the complex interdependencies within models it is important to check the model as a whole, as well as the individual component parts. This is particularly the case with complex economic models, but is also true of ICAs based on stress and scenario tests. Important issues will include:

- do the overall results pass the sense check?
- does the model behave as expected, and if not can we explain why?

F.3.7 Internal audit.

In practice, suitably experienced internal auditors may make a useful contribution to the checking the ICA process.

F.3.8 Dynamic theory and experience.

The development of the theory of ICA modelling and the build up of experience, allied with software and hardware improvements over time, is likely to be such that models should develop over time. It will be best practice to reconsider each year whether aspects of the approach that were appropriate in the past should now be improved, though a full documentation of all parts of this checking process would not normally be necessary.

F.3.9 Making changes.

When updating the model it would normally be best practice to consider the impact of the changes in isolation, to allow at least a broad understanding of the “before” and “after” of the individual alterations. Convoluting several changes at once, especially if re-parameterisation is undertaken simultaneously, would not generally allow sufficient comfort that the detailed changes were correctly made. It is not necessary or practical, however, to document fully all possible and actual changes considered. However it should be considered how best to construct a reasonable change-control process.

F.3.10 Comparison of results to those from other methods.

Comprehensive testing of a model could include understanding how the results would change if different methods, models, approaches etc. had been used. If such comparisons are made then consideration should be given to communicating the results of these comparisons. Care should be taken to ensure it is clear which of the methods tested, if any, has actually been used in the final results. If a result has been selected after consideration of results from multiple methods then this should be made clear.

Reasons behind and detailed understanding of the quantification of differences between methods could be particularly informative. However, there may be circumstances where such an analysis is not practical. For methods that do not facilitate such comparisons explaining why this is the case is also informative. Bear in mind that a 'method' may refer to a small component of the overall model: for example an approach to reserving risk within a full DFA model.

G. PRESENTING AND USING THE RESULTS.

G.1 THE FIRM'S I.C.A. SUBMISSION TO THE F.S.A.

G.1.1 It is the responsibility of a firm's Board or governing body to submit an ICA report to the FSA, not the responsibility of the actuary. It is likely that the actuary will be acting as part of a multi-disciplinary team, producing a report for submission to the Board, rather than directly to the FSA. As such, the actuary needs to be clear as to his/her role in the production of the ICA, with responsibilities for specific areas understood by all parties.

G.1.2 This section G.1 discussed issues in respect of the firm's submission, so that the actuary can understand the background. Section G.2 discusses issues in respect of the actuary reporting on his/her output from the capital modelling work.

G.1.3 In practice the full ICA documentation is likely to be the responsibility of a number of people, of which the actuary may be only one. It is not necessary to separately identify "ownership" of the different aspects. It is important, however, that the responsibility of senior management for the overall report is recognised.

G.1.4 Ideally the involved actuary should be familiar with the whole content of the report and feel able to accept an element of responsibility for the entirety. In practice, however, the actuary may have concerns on areas that they have not "owned", especially where the areas are outside of that actuary's skill-set. Those concerns should generally be aired in a suitable manner, such that senior management are made aware of them where relevant. As long as this process has been followed, the actuary should still be able to accept their part of the group responsibility for the report.

G.1.5 The FSA published an Insurance Sector Briefing in November 2005, which contains suggestions in respect of a suitable format for an ICA submission. In section 6.5, the FSA set out a list of issues that they have found helpful in their reviews, and we include it here in full:

- "those firms which we think have provided a good ICA submission have structured their report in a similar way to that of a financial condition report. They have clearly outlined and explained the financial condition of the firm going forward and the interlinkages between risk management and capital assessments;
- a clear audit trail between the risks identified, how the firm has calculated those risks and how these amounts are aggregated in deriving the overall ICA amount;
- a high-level overview of the entire ICAS process, setting out how the various components have been built up, aspects of the ICA that are outside the technical modelling framework and the overall aggregation process in determining the final ICA;
- details of the governance procedures and Board sign-off;
- sensitivity testing to changes in the underlying assumptions that have the most material impact on the ICA;
- comparison of results using different quantification techniques. We note that we have seen a wide variety of techniques applied, but we have rarely seen these compared with other common approaches;
- a commentary on the availability and underlying reasonableness of information available for estimating parameters and projecting possible scenarios;
- the use, appropriateness and source of any market statistics to help describe the parameterisation of the firm's ICA."

Appendix 2 of the same document contains an example of an ICA submission format. This format is not mandatory, but we recommend that the actuary considers the issues set out in that specimen format, where appropriate and proportionate to the circumstances of his firm. We do not repeat here the contents of that format, but refer readers to this document, at the link given in section H.

G.2 REPORTING ON THE OUTPUT FROM THE INTERNAL CAPITAL MODEL.

G.2.1 It is likely that various levels of reports or documentation will be produced to support an ICA calculation. They need to be designed to assist the firm's Board and senior management meet the requirements set out in section G.1. Each firm will be different in its approach, so the suggestions in this section can only be indicative.

A useful structure might be to produce separately:
(a) A high level summary;
(b) A fully detailed internal report, designed for an audience of senior management and the Board;
(c) The detailed technical calculations.

The level of documentation within these reports is likely to vary with both the target audience and the nature, size and capital position of the firm in question. The summary (a) might be relatively short in length, and is likely to concentrate on the implications of the calculations for running the business, and might contain recommendations for further actions or investigations. It might set out the following:

- a brief overview of the ICA methodology and key results;
- the main findings of the ICA analysis, including the outputs discussed in section E.3;
- a summary of the financial position of the business and the risks to which it is subject, including key performance indicators such as statutory solvency and other capital management measures;
- brief descriptions of the capital and dividend plan;
- a commentary on the most material risks, why the level of risk is acceptable or, if it is not, what mitigating actions are planned;
- a commentary on the sensitivity tests applied to the key assumptions;
- commentary on major issues where further analysis and decisions are required.

The report (b) will not contain all of the details of the calculations, but should contain sufficient explanation of methods, assumptions, parameterization and sensitivity tests for senior management and the Board to discharge their duty to the FSA, to demonstrate that they fully understand and own the results of the ICA calculations.

G.2.2 The actuary is likely to be a significant source of advice to the final outcome, particularly in the areas of modelling of insurance risk, market risk and credit risk, and in the aggregation of separate capital requirements to produce one single final outcome. If the actuary is requested to produce a formal report that is a significant and clearly identifiable piece of work by him/her in the context of the firm's ICA, then it is covered by the requirements of the Guidance Notes of the Institute, and the reader should refer to those documents. An update to GN12 will be appearing later this year. In the case where an actuary is an integrated part of a mixed team of professionals, then we understand that it is unlikely that his/her work

needs to be regarded as a formal report, except if, when viewed as a discrete assignment, the actuarial work would warrant a formal report. In this case, this Guidance Note applies only to the actuarial content of the overall work.

Other circumstances where a report or piece of work in support of an ICA does not need to be regarded as a formal report are if it is:
(i) minor in scope;
(ii) prepared by way of assistance to other expert members of the capital modelling team;
(iii) exploratory in nature, for example illustrating ways of modelling operational risk capital requirements in the face of sparse data.

Whether or not the actuary is producing a formal report under the terms of GN12, he/she should consider whether it is appropriate to report on the issues discussed in sections G.2.3 to G.2.13.

G.2.3 The report should consider addressing the issues arising out of comparisons of actual experience with that expected under the assumptions in the last similar report. For the purpose of an ICA report, where expected experience relates to rare events, it may for certain risks be more suitable to address the issues arising out of comparisons of the results obtained in the current report with those in the last similar report. For example, an analysis of change, as described further in sections G.2.8 and G.2.9 below, might satisfy this requirement.

G.2.4 The report should normally address the key assumptions. An assumption should be considered key if it has a material impact on the results of the calculations. Assumptions of particular importance in a capital model include the choice of distributions of random values, and the choice of correlation or dependency structures.

G.2.5 In the report, consider drawing attention to any material shortcomings in the available data. An ICA is concerned with extreme events, and as such there will rarely be sufficient historic data for an ICA calculation to be fully credible statistically. In an ICA report, the member may choose to distinguish between data that is sparse because rare events are being modelled, and data that has shortcomings for other reasons.

G.2.6 Consider commenting on new data that has emerged, for example, by reference to an analysis of expected versus actual outcomes. For the purpose of an ICA report, where expected experience relates to rare events, results may need careful interpretation and communication when smaller data sets are involved.

G.2.7 Significant changes in methods/assumptions since previous report.
Where these have occurred consideration should be given to communicating the changes made, the reasons for the changes, the impacts of the changes. It is good practice to consider the impact of each change in isolation but, where several changes to a model have been made, this may not be practicable. Where appropriate, an analysis of change could be performed, as discussed in sections G.2.8 and G.2.9.

G.2.8 Analysis of change in the capital requirements since the previous report:
Reasons for differences in results may be approximately analysed between various sources:
(i) changes in methodology and/or key assumptions;
(ii) changes in the volume of risk in the different risk categories;
(iii) changes in the “riskiness” or distribution of risk in the different categories;

(iv) changes in correlations and dependency structures;
(v) other factors, for example changes in risk policies.

Separate comparisons at each level of modelling, for example by risk category, in total prior to diversification and in total post diversification, would lead to the most complete understanding of any change in requirements. However, to do this in full for every source mentioned in (i) to (v) might be too cumbersome, and it may be more appropriate to analyse separately only the most significant contributions.

G.2.9 Analysis of change in the capital base since the previous report:
If required by the scope of the report to compare the required capital with the available capital at a total level, an analysis of change in the capital base would help significantly in communicating understanding of both the movements in the capital base and movements in the relative solvency position. Depending upon the basis used, the analysis may be similar to those performed already for performance reporting purposes.

G.2.10 The report should normally include a section providing a summary of methods used and explaining to which elements of the data a method has been applied, and also specify and discuss the key assumptions and judgements.

G.2.11 The report should normally contain detail sufficient for another suitably experienced member to form an opinion on the original member's key judgements and assess the reasonableness of the results. When judging the reasonableness of the results, the other member will bear in mind the comments of section G.2.13 below. Given this, the other member will be assessing whether, given the statements regarding the models used, the data used and the adjustments made to that data, the calculations have been performed reasonably accurately.

In the case of a report supporting capital modelling and ICA work, it would assist in meeting this requirement if the report includes a section with a structured approach to sensitivity testing. This would require each of the key assumptions or parameters to be flexed as appropriate, and for the impact to be shown in terms of the indicative movements in the ICA value. This also represents good practice in terms of allowing the Board and senior management to understand the key drivers on the result, as part of discharging their duty to understand and own the results of the ICA.

G.2.12 The report must provide clear interpretations of any point estimates shown. In the context of an ICA report, the quoted results are often the percentile from a distribution.

G.2.13 The report should normally indicate the degree and sources of uncertainty surrounding the results of the calculations that the member has made and sensitivities to key assumptions.

Both parameter error and model error will be inherent in an exercise involving the assessment of extreme loss events. Whilst the ICA may be considered reasonable and appropriate given the data and the methods employed, it will not be possible to state with certainty that the final ICA value is accurate in the context of a 99.5% confidence risk metric. It is important that the member adequately communicates this uncertainty to senior management. This is not to undermine the results of his/her work, it is so that senior management appreciate the reality that applying parameter uncertainty can have a significant impact on the amount of the underlying ICA.

Parameter uncertainty will arise because of the lack of credible relevant data on which to

base the main assumptions. This is clearly an area that by its very nature is difficult to quantify. The following approaches represent good practice:

- considering the uncertainty of each class separately and assessing the variability, considered the number of years of available data;
- sensitivity tests surrounding the key parameters, in a structured approach to as discussed in section G.2.11;
- back-testing the key assumptions for reasonableness against historical data, to obtain a broad high-level reasonableness assessment of the parameters;
- reviewing regularly the key parameters to ensure their continued applicability.

G.3 UPDATING OF I.C.A. RESULTS AT INTERIM PERIODS.

G.3.1 The ICA is constructed at a point in time, typically a year end. The firm needs to be able to monitor the impact of events at interim periods. The FSA requires the firm to maintain adequate financial resources at all times, and to make sure that the assessment of adequacy is reported to senior management as often as is necessary. In particular, the firm would be expected to reassess the adequacy if there should be a material change in circumstances, and this needs to be defined.

G.3.2 It may be that it is too onerous for the firm to re-run a full ICA exercise more than once a year. In that case, the firm could devise a system of:

- annually: the internal capital model is evaluated, re-parameterised, and refined;
- annually: a full review of all risk and capital calculations is performed (changes in results being reconciled from year to year by an analysis of change);
- quarterly: an update of risk and capital calculations is performed on an approximate basis, and for the most significant elements;
- supplemented by: trigger points on key variables, which would indicate the need for a full or partial re-appraisal.

These could be split into two categories:

- movements impacting on actual capital, e.g. actual experience in asset values, reported profits, cash flows;
- movements impacting on required capital, e.g. actual volumes of risk being written, trends in premium rates, a large strategic change, a significant change in reinsurance arrangements.

The first category is similar to financial performance reporting under so-called KPI's. The second category could be produced as part of regular risk reporting under so-called KRI's.

G.3.3 When monitoring events which impact on required capital, an ideal scenario is to know for each major risk category and type the marginal capital requirement for small changes in that risk type. In practice, this is likely to be too ambitious and onerous, and the firm could consider a simpler approach, by constructing a list for each major risk type:

(A) a measure of other anticipated "volume" of the risk;

(B) a factor relating the volume of that risk to its stand-alone contribution to the total capital;

(C) a further factor which reflects the tendency of that risk to contribute to the overall diversification credit in the firm's total capital requirement.

The product of (A), (B) and (C) would be close to the net amount of capital attributed to each major risk type. Then, the firm could monitor changes throughout the year in the volume of risk (A), and assume that, to a first approximation, factors (B) and (C) stay unchanged for "small" changes in (A). It could then assess reasonably swiftly changes in its required capital at interim periods.

G.3.4 The factors (A), (B) and (C), and the trigger points for a fuller review, can be assessed during the full annual review. For example, for each risk type and assumption which has an impact on the capital requirement of more than say 5% of the total, the firm could on a trial and error basis, assess the impact of changes of say plus / minus 10% / 20% / 30%. Although unsophisticated, this approach can quickly highlight which are the risk factors most worthy of regular monitoring. Also, this work might be undertaken anyway, to help senior management validate their understanding of the ICA model and process. The choice of what level the triggers should be set at will likely be influenced by the impact of changes in a risk type on the gap between the ICA and the ECR / ICG, and the gap between required capital and actual capital.

G.4 EMBEDDING IN THE BUSINESS.

G.4.1 The FSA is clear in its intent that risk management and maintenance of adequate capital resources are clear and important functions in the management of insurance firms. There is a danger that the ICA *model* might become the focus of attention, to the detriment of:

- the risk assessment, controls and monitoring that form the foundation of capital adequacy standards;
- the valuable information and insights that can be gathered from the risk assessment and financial modelling.

The understanding of the risk (i.e. what actually pushed the firm into insolvency) is perhaps more important than the numbers produced from the calculations.

The output of the ICA should have the following objectives:

- it should be understood readily by insurance professionals;
- it should encourage good underwriting performance and risk management behaviour;
- it should assist in the performance management process, business plan review process and risk management framework.

G.4.2 Use Test.

Regardless of the quality of the ICA model, the FSA's ability to rely on internal models when considering Individual Capital Guidance depends fundamentally on evidence that the ICA process is embedded into the management of the business (the 'use' test), in ways described in the rest of this section. Embedding in the business requires that management understands and believes the ICA framework and results. Using the results and insights of the framework is a major part of embedding in the business.

For example, this needs demonstration that the firm:

- engages senior management and other technical expertise;
- makes use of appropriate data sources in deriving the ICA and other capital assessments;
- uses the ICA calculation principles and models for day to day management purposes;
- uses the results of the ICA calculation to influence risk management strategy and to

prioritise risk management activity.

Other areas of activity to demonstrate embedding include:

- capital management;
- capital allocation;
- asset-liability management: investment strategy and policy;
- risk steering / risk management;
- target setting;
- pricing;
- performance measurement;
- management compensation.

Inputs to the model – risk assessment.

G.4.3 The assumptions used in the capital model should be driven by risk analyses. Many businesses already have well-established systems and processes for identifying, registering, controlling and monitoring risks, issues and actual events. The risk register probably covers all risks to the business, not just risks that affect the ability to meet policyholder liabilities, or for which capital is an appropriate response. Firms need to be able to demonstrate that their risk assessment processes capture and quantify all their risks.

G.4.4 The risk assessment should be a regular process – updated also whenever material new information is available. Where relevant and useful to do so, a risk assessment might identify the 'intrinsic' risk (i.e. exposure in the absence of controls or mitigation), and then consider the appropriate systems and controls to be put in place. These systems and controls may include closer monitoring, reduction of the intrinsic exposure, internal off-setting approaches, or laying off of risk, for example through financial transactions with third parties. In some cases it is not sensible to identify the intrinsic risk but it is appropriate to identify these areas explicitly. The 'residual' risk after the application of controls can be separated into two categories, depending in whether or not capital is an appropriate response. For many firms, operational risk assessment considers the possibility and impact of failure in these controls.

G.4.5 Capital as a response to risk.
For risks that should impact on the firm's capital requirements, it is necessary to decide on the appropriate capital response. That is the role of the basic ICA model. Data from the risk assessment can be combined with experience statistics to influence the structure and parameters for the ICA model. It is crucial to capture all available risk information – including the judgement of business risk experts – and not rely exclusively on pure experience data.

G.4.6 Prospective information.
Many risks cover events that are yet to happen and therefore for which there are no experience data. Typically the better the existing risk assessment and control framework, the more prospective information will be available. This should reduce the extent to which the actuary has to rely on experience analysis to derive parameters for the ICA model.

Interaction with business plans.

G.4.7 The core of the ICA model is often the business plan, which should represent something close to the firm's expectation of its future progress.

G.4.8 Bias in business plans.
For the ICA to be valid and useful, it should be consistent with this expectation. However, it is important to consider the possibility of bias in the business plan. For example, many firms put 'stretch' targets into their business plan; these may over-estimate volumes and profitability levels for motivational reasons, and there is a risk that this leads to unreliably low estimates of the capital implications of the risks the firm actually takes. Other firms may publish plans that they generally expect to beat, possibly by a significant margin. In this case capital assessments may be unreasonably high, unless the bias is adjusted for.

G.4.9 Projection of ICA.
The business plan is an important feed into the ICA at any point in time, but it is also necessary to consider the future capital implications of the business projections. Projections of ICA will ideally be incorporated into the business planning process – including scenario testing, so that management are aware of possible requirements for capital injections, and can plan the business' dividend strategy based on capital requirements and projected emergence of surplus.

Output from the model – capital and returns.

G.4.10 Just as capital planning sits alongside business planning, the ICA model should inform the way that the business allocates capital to business units, business lines, distribution channels, etc. A firm would typically employ a return on capital approach to deciding appropriate uses of its capital. The ICA is one measure by which the firm can assess the capital implications of alternative business mixes and growth rates, and it allows risk adjustment of the capital requirements as well as potentially the return measures. If the firm has existing economic capital models, it may be that it uses a blend of different capital requirements, such as economic, regulatory and rating agency views. It is also good practice to use common methodologies, data and processes where possible between the models for assessing economic and regulatory capital.

G.4.11 Portfolio management.
Through this allocation mechanism, the business can make portfolio choices with the liabilities it takes on (the business it writes in the context of the liabilities it already has) and the assets it acquires. It can also make decisions about the total level of capital and the way that this is financed – and the ICA can be useful in the communication of this position to capital suppliers and their agents, who need this information to make their own portfolio choices.

G.4.12 Risk mitigation costs.
Finally, the ICA model can be used to understand the cost/benefit implications of possible risk controls, hedges, reinsurance decisions, etc. This information can be fed back into the risk assessment so that decisions can be taken about such controls, and the residual risk re-appraised and in turn fed back into the ICA model. It can also be used in the prioritisation of risk management activities.

Output from the model – monitoring performance.

G.4.13 As well as the basic ICA capital calculation, a model that passes the 'use' test should be capable of providing tools for monitoring the business. For example, by projecting capital requirements in line with the business plan, it should be possible to update the capital

requirements as experience emerges – even if that experience is not totally in line with the business plan.

G.4.14 Underlying drivers.
To achieve this, the ICA modelling process should consider the underlying drivers of capital requirements. With some acceptable approximation it should be possible to analyse the ICA into components that can be linked to the main items projected in the business plan, and reported in management information. The former is necessary for projecting future requirements, but the latter can be used to track solvency requirements more continually.

G.4.15 Sensitivity-testing.
Closely linked to this process is the testing of the sensitivity of the ICA to internal and external risk factors. Such sensitivity-testing is important to the firm's ability to respond to emerging experience. In particular, sensitivities to the main assumptions can be used to provide earlier warning of adverse experience, and help to define 'key risk indicators (KRI)'. This can improve the time management need to respond to such adverse developments and reduce their impact on profit – as well as ability to meet policyholder requirements. KRI information can be fed back into the risk assessment, thereby completing another control cycle built around the ICA.

Risk Appetite.

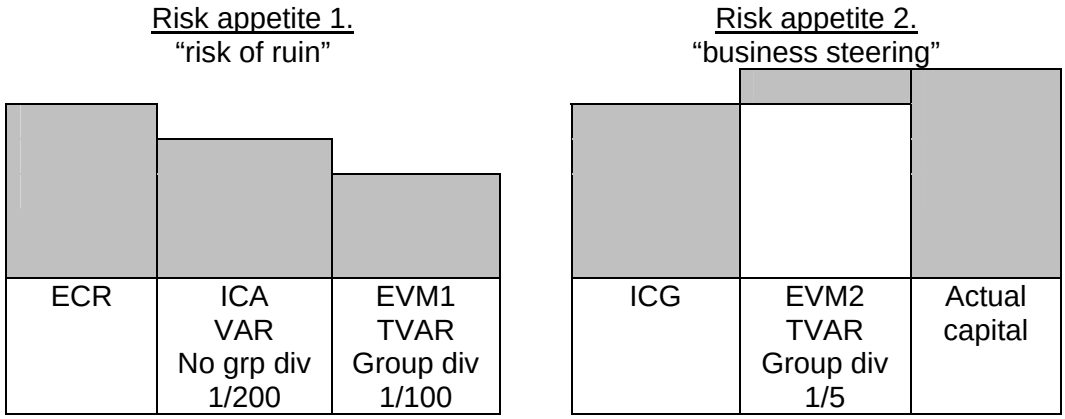
G.4.16 A suggested risk measure for production of an ICA is given by the FSA, but as the firm embeds capital modelling into the running of the business, it may want to choose different risk measures. For normal day to day management a firm may be more concerned about deviation from mean, and so a measure such as standard deviation is a useful risk measure.

G.4.17 VaR versus TailVaR: VAR: the FSA has suggested a VaR-type measure as suitable for the ICA. However, a firm might prefer TailVaR as a measure of the extent of loss, if the firm intends to recapitalise business units after a severe loss, either for reasons of payback, or because it wants to maintain certain market shares worldwide.

G.4.18 Whichever measure of risk the firm is using, modelling at different tolerance levels can be useful. For example:

- a 1:200 VaR measure over one year might be regarded as a minimum, equivalent to the regulatory standard to be used as a benchmark for regulatory intervention;
- a VaR measure calibrated to a lower probability of ruin, or the equivalent TailVaR measure, might be used as a management target capital level. This could be based on a target credit rating, or intended to achieve a given probability of capital falling to the regulatory intervention level;
- a standard deviation measure may be used to understand the potential for earnings to fall below a chosen level, to help management understand and plan for the impact of this on shareholders.

G.4.19 Whatever the output from its own solvency assessment based on its own economic model, the firm is subject to the constraint of the regulatory capital, which is given by its ICG. The ICG is regarded as a regulatory intervention point, and the firm will want to operate at a level above that point, where medium term shocks should not bring it down below the ICG.



- "risk appetite 1" is for solvency purposes: the firm assesses sufficient financial resources to meet its obligations (a) impact of changes in information over the next 12 months (b) on the cost of claims to ultimate, (c) calibrated for rare events;
- "risk appetite 2" is for purposes of dividend and capital planning: the firm wishes to stay in excess of its ICG over medium term periods;
- for modelling variability around the plan, the firm wants a capital model calibrated to more frequent events, say the 60th or the 75th percentiles, but the ICA model needs to be calibrated for rare events. It is important to ensure that these approaches are consistent.

Governance and quality control

G.4.20 Key information provided by the ICAS process should be used at Board level in the firm. The FSA will wish to see evidence of this, and the actuary should ensure that the appropriate information is made available to the Board, and the executive management on their behalf.

G.4.21 Policy owners and committees.
Any risk policy owners or committees should be aware of the ICA information that is relevant to them. For example, if the impact of credit risk on the ICA is clear, then this information in the context of the whole ICA should be part of the management information considered by the credit risk committee.

G.4.22 Modelling feedback.
As well as providing key risk and capital information to those responsible for decisions in respect of risks, by fitting the ICA work into the firm's governance structure, the actuary can optimise the quality of the modelling, using feedback to improve the focus, structure and parameters of the model.

G.4.23 Independent review.
Given the importance of decisions that could be taken on the strength of the ICAS process, it is likely that the takers of those decisions will expect a high degree of independent review – not just of the ICA model, but of the whole process that embeds ICAS into the management of the business. It is not for the Profession to advise on the appropriate degree of review, but any actuary involved in the production of an ICA should apply a degree of quality assurance to their own work, consistent with professional standards, and ensuring that the documentation of their work is of auditable quality.

G.5 ISSUES OF APPLICATION; BEYOND MODEL RESULTS.

G.5.1 Different bodies receiving an ICA might have different opinions, different requirements, different approaches, all of which may be valid.

- e.g. FSA ICA, internal economic models, Lloyd's RBC, Lloyd's proposed "economic capital applied by the centre";
- e.g. Some large groups take credit for worldwide diversification in their internal models, however the FSA is not in favour of this for the ICA;
- the actuary needs to be aware that different approaches might be used in different circumstances.

G.5.2 Impact of new regulations and new accounting standards.

The FSA will allow firms to use their published IFRS numbers as a starting point for ICA, except that:

- the firm should eliminate any unrealised gains or losses arising from the fair valuation of the firm's own credit risk;
- special treatment is required for accounting actuarial gains in respect of a defined benefits pension scheme.

Further explanation is available in PS 05/05.

H SIGNPOSTS TO OTHER PUBLISHED MATERIALS.

The links below are not necessarily a full and final list, they represent useful sources of information that the Working Party have come across in the course of their work.

General Insurance Newsletters on the FSA website.

F.S.A. Insurance Sector Briefing November 2005.
http://www.fsa.gov.uk/pubs/other/isb_icas.pdf.

CRO Forum papers.
Internal capital models:
http://www.ceiops.org/media/files/requestsforadvice/CROBenchmarkingPresentation%20200506 10.pdf.

Diversification and Group issues:
http://www.ceiops.org/media/files/requestsforadvice/DiversificationWhitePaper20050610.pdf.

Calibration of the ECR.
http://www.fsa.gov.uk/pubs/cp/190/ww_report.pdf.

Lloyd's 2007 ICA Guidance and Instructions.
This was published on 17 March 2006, and because of the timing, we have not been able to refer to the detailed text in this document, only the high level principles.
http://www.bulletins.lloydsoflondon.com/bulletins/mktcirc.nsf/mktBulletins/Y3770/$file/Y3770.pdf .

IAIS.
http://www.iaisweb.org/06trends.pdf.
http://www.iaisweb.org/185stresstesting03.pdf.

CAS.
There is a lot of information available on the CAS website regarding Dynamic Financial Analysis. The Dynamic Risk Modelling Committee (previously DFA Committee) is in the process of writing a Dynamic Risk Modelling Handbook and a paper on Executive Level Decision Making Using Dynamic Risk Modelling.

There are some papers and models on DFA which developed since 1997:
http://www.casact.org/members/CDRM/cdrm.cfm.

There many papers on DFA, Risk & Capital Management and Enterprise Risk Management at the following link:

http://www.casact.org/coneduc/houts.htm.

IAA.
IAA has a report: "A Global Framework for Insurer Solvency Assessment". In this report high level principles for capital models have been defined, and these have been endorsed by the IAIS.

No specific guidance is given, but there is some discussion regarding Standardized Solvency Assessment. Chapter 6 in particular outlines the key considerations to be considered. It describes two approaches toward a Standardized Factor-Based Approach.

The full report is available at
http://www.actuaries.org/LIBRARY/Papers/Global_Framework_Insurer_Solvency_Assessment-members.pdf.

Australia.
The Australian general insurance standards as at 9th March 2006 can be found on the Institute of Actuaries Australia website. The standards and guidance include:
Professional Standards:
PS300 - Actuarial Reports and Advice on General Insurance Technical Liabilities
PS305 - Financial Condition Reports for General Insurance
Guidance Notes:
GN351 - Premium Rate Certification for NSW Motor Accidents Scheme
GN353 - Evaluation of General Insurance Technical Liabilities
The overall framework appears to be similar in direction and look to those applying in the UK; 'Minimum Capital Requirements' (MCR) are calculated either by use of a 'Prescribed Method' (PM) or, if an insurer has permission from both APRA and the Treasurer, an in-house capital measurement model – an 'Internal Model Based (IMB) Method'.
http://www.actuaries.asn.au/

Canadian Solvency Regulations: Practical Implementation.
The Canadian solvency regulations for P&C insurers:
http://laws.justice.gc.ca/en/I-11.8/76802.html#rid-76898.
http://www.osfi-bsif.gc.ca/app/docrepository/1/eng/guidelines/capital/guidelines/mct_guideline_e.pdf.
http://www.osfi-bsif.gc.ca/app/DocRepository/1/eng/guidelines/capital/guidelines/MCT_ReportingPages_e.xls.
http://www.osfi-bsif.gc.ca/app/DocRepository/1/eng/guidelines/capital/advisories/Advisory_PC_Target_e.pdf.

Any professional guidance you receive to help with your preparations of local solvency returns?
http://www.actuaries.ca/publications/1999/9930e.pdf.
http://www.actuaries.ca/publications/2003/203060e.pdf.
http://www.actuaries.ca/publications/2002/202069e.doc.
http://www.actuaries.ca/publications/1999/9917e.pdf.