LLOYD'S

SOLVENCY II
DETAILED GUIDANCE NOTES
MARCH 2010

SECTION 5 - CALIBRATION, VALIDATION AND PROFIT & LOSS ATTRIBUTION

SECTION 5: CALIBRATION, PROFIT & LOSS ATTRIBUTION AND VALIDATION

Overview

This section outlines the Solvency II requirements for calibration, profit & loss attribution and validation.

The calibration of the Solvency Capital Requirement (SCR) differs significantly from that currently required by Lloyd's for the calculation of syndicate ICAs. Agents should note in particular that the 12 month time horizon used for calculation of the SCR is not the same as the "to ultimate" basis of the current ICA calculation. In addition to providing a regulatory SCR number on this 12 month basis, Lloyd's expects to require agents to be able to produce a "to ultimate" number at the same 99.5% VaR confidence level. It is important that managing agents understand the differences from current modelling approaches.

The purpose of the profit & loss attribution test is to ensure that the internal model captures the main sources of profit and loss facing the firm. It will also be an important element in establishing use of the model. Managing agents will be required to reconcile actual profits/losses booked with the output of the internal model to the extent that the model should be able to categorise risk into the main drivers of the syndicate's profit and loss statement. This could be considered as a special form of back-testing of actual results against model risk categories in addition to demonstrating that the outcomes in respect of individual risks are within an expected range of outcomes.

Validation is considered to be a critical part of demonstrating that the internal model is suitable for setting capital for regulatory purposes. Managing agents will be required to develop a comprehensive validation process which is ultimately owned by the board and draws on relevant skills from the organisation. Managing agents will be required to have a written validation policy in place, setting out how the validation process is to operate.

Guidance

Managing agents should note that this guidance represents Lloyd's best view of current requirements but is subject to ongoing discussion and change as both CEIOPS proposals and FSA requirements become finalised and Lloyd's own development on Solvency II progresses. Lloyd's will continue to monitor and review progress in these areas and seek to update the guidance as appropriate.

The commentary on proposed level 2 measures attached highlights the relevant sections for the dry run and does not reproduce the full level 2 text. Any additional guidance provided in this document is intended to supplement the level 2 measures, not repeat them, and agents must therefore ensure that they are familiar with all of the requirements and do not rely solely on the additional guidance provided here.

Whilst this document refers to general Solvency II requirements, this guidance is specific to Lloyd's and managing agents in many areas. Due to the unique structure of Lloyd's and the application of the Solvency II directive at society level, some of this guidance will not be relevant to non Lloyd's firms.

Contents

This section includes the following

- Level 1 directive text and commentary on application of proposed level 2 requirements to Lloyd's managing agents

- Guidance on calibration

- Guidance on profit and loss attribution

- Guidance on validation

- Appendix 5a – Examples of validation tools

- Appendix 5b – Reverse stress testing

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LEVEL 1 AND LEVEL 2 MEASURES

The Level 2 measures set out here are based on CEIOPS paper Doc-48/09 (formerly CP 56), published October 2009. These measures may be subject to modification before they come into force.

Calibration

Directive Article 122

1) *Insurance and reinsurance undertakings may use a different time period or risk measure than that set out in Article 101(3) for internal modelling purposes as long as the outputs of the internal model can be used by those undertakings to calculate the Solvency Capital Requirement in a manner that provides policyholders and beneficiaries with a level of protection equivalent to that set out in Article 101.*

2) *Where practicable, insurance and reinsurance undertakings shall derive the Solvency Capital Requirement directly from the probability distribution forecast generated by the internal model of those undertakings using the Value-at-Risk measure set out in Article 101(3).*

3) *Where insurance and reinsurance undertakings cannot derive the Solvency Capital Requirement directly from the probability distribution forecast generated by the internal model, the supervisory authorities may allow approximations to be used in the process to calculate the Solvency Capital Requirement, as long as those undertakings can demonstrate to the supervisory authorities that policyholders are provided with a level of protection equivalent to that set out in Article 101.*

4) *Supervisory authorities may require insurance and reinsurance undertakings to run their internal model on relevant benchmark portfolios and using assumptions based on external rather than internal data in order to verify the calibration of the internal model and to check that its specification is in line with generally accepted market practice.*

Application of proposed level 2 requirements to Lloyd's managing agents

Article 122/CEIOPS Doc 48/09: 6.50-6.60

Different time period and risk measure

A managing agent may use different time periods than one year and different risk measures than 99.5% VaR over one year in their syndicate internal model as a whole, or for different risks or business units within the model.

The time period chosen must be appropriate and justified. The requirements set out in Articles 120 to 126 apply whatever time periods or risk measures are used.

If a different time period from one year is used, a managing agent must:

- demonstrate that the internal model appropriately reflects the impact risk quantification arising from using a different time period;

- demonstrate that all significant risks over a one-year-period are properly managed;

- ensure that the data used is still appropriate considered in the context of a 12 month time horizon; and

- justify the choice of time horizon in view of the average duration of the liabilities of the managing agent, of the business model and of the uncertainties associated with too far time horizons.

Equivalent protection of policyholders

Where practicable, a managing agent must derive the syndicate SCR directly from the probability distribution forecast generated by the internal model. If this is not practicable, then Article 122(3) applies.

Where the SCR is not derived directly from the internal model, it must be reconciled to the internal model and shown to be consistent with it.

In such circumstances, equivalence must be demonstrated at least annually, but also following any significant changes to the syndicate's risk profile.

Reconciliations and demonstration of consistency need to do the following:

- Explain how risks are rescaled to 99.5% VaR over one year and show that this process does not introduce any material bias.
- Explain the reconciliation between the outputs of its internal model and the distribution of Basic Own Funds, where the latter is not produced directly from the model.
- Where a longer time horizon than one year is used, demonstrate appropriate consideration of the solvency position at the one-year point.
- Where a different time horizon than one year is used, justify the assumptions made in respect of dependencies between consecutive time steps.

The Statistical Quality, Validation and Documentation Standards, and the measures in respect of external models and data, apply to any approximations used to calculate an SCR that is not derived directly from an internal model. Particular emphasis will be placed on validation of the assumptions underlying approximations used against alternative assumptions.

Lloyd's may require a managing agent to demonstrate appropriate calibration of their internal model through the use of benchmark portfolios or external assumptions.

If the use of benchmark portfolios or external assumptions raises material issues regarding model calibration, the model may be rejected or a managing agent may be required to produce and action a plan to deliver adequate calibration.

Profit and loss attribution

Directive Article 123 (extract)

Insurance and reinsurance undertakings shall review, at least annually, the causes and sources of profits and losses for each major business unit.

Application of proposed level 2 requirements to Lloyd's managing agents

Article 123/CEIOPS Doc 48/09: 7.19-7.21

The profit and loss attribution should be transparent and explain a large part of a managing agent's annual profit or loss. It shall be used in the validation process and for managing the business.

Risk categorisation should be based on the material risks quantified in the internal model, but also extend to non-material risks and non-quantifiable risks. Profits and losses should be attributed to risks categorised within the internal model and any residual profits and losses should be attributable to non-material risks or non-quantifiable risks.

Profit and loss attribution is an important element of satisfying the Use test. Accordingly, appropriate internal definitions for profits and losses should be used but these should be consistent with the variable underlying the probability distribution forecast. A managing agent must understand the reasons for any difference between their accounting profits and losses and those used in the profit and loss attribution.

Article 124/CEIOPS Doc 48/09: 8.174-8.175

Profit and loss attribution provides information as to whether the risks in the internal model are complete, and whether there are any material risks in the risk profile of a managing agent which are not represented in the internal model.

Any indication from the results of the profit and loss attribution which implies that the risk categorisation of the internal model does not reflect the risk profile of the syndicate shall be escalated to the board of the managing agent. If further qualitative and quantitative analyses of the results show that the model does not reflect the risk profile appropriately, then the model shall be improved.

Validation policy

Directive Article 124

Insurance and reinsurance undertakings shall have a regular cycle of model validation which includes monitoring the performance of the internal model, reviewing the ongoing appropriateness of its specification, and testing its results against experience.

The model validation process shall include an effective statistical process for validating the internal model which enables the insurance and reinsurance undertakings to demonstrate to their supervisory authorities that the resulting capital requirements are appropriate.

The statistical methods applied shall test the appropriateness of the probability distribution forecast compared not only to loss experience but also to all material new data and information relating thereto.

The model validation process shall include an analysis of the stability of the internal model and in particular the testing of the sensitivity of the results of the internal model to changes in key underlying assumptions. It shall also include an assessment of the accuracy, completeness and appropriateness of the data used by the internal model.

Application of proposed level 2 requirements to Lloyd's managing agents

Article 124/CEIOPS Doc 48/09: 8.127-8.149

Validation standards apply to the internal model in its entirety, but specifically covering each of the following, as a minimum:

- Data
- Methods
- Assumptions
- Expert judgment
- Documentation
- Systems/ IT
- Model governance
- Use test

The validation policy should also cover the process for its own periodic review.

A managing agent must analyse the outputs from running its validation tools. Such analysis must extend to a qualitative review of the quantitative results.

Results of the analysis should be escalated to the appropriate level of management. This information will be used in deciding whether any changes are needed to the internal model.

Every managing agent is responsible for the validation process, not Lloyd's.

External review and systems may contribute to the validation process, but the board of a managing agent has ultimate responsibility to approve this process, and that responsibility cannot be delegated to a third party.

A managing agent must have a validation policy, that sets out how they will validate their syndicate internal model(s) and why that approach is appropriate. It must cover the following, as a minimum:

Purpose and scope of validation

The purpose of the validation policy is to set out how a managing agent aims to ensure that the design and operation of the internal model is appropriate. The validation policy should set out its scope, covering all parts of the internal model (including those set out in Paragraph 8.127 above). Any parts of the internal model not covered should be explicitly identified, with reasons for their exclusion.

Further, a managing agent shall set out the extent to which they will aim to gain comfort that their internal model is appropriate, and also set out how they will achieve this level of comfort. When setting the scope of validation, a

managing agent should consider the materiality of the different internal model components. They should consider sensitivity testing when determining materiality for this purpose.

Where expert judgment is used, the validation policy shall explicitly consider the validation of expert judgment, as set out in the measures on statistical quality standards.

Validation tools used

Validation tools used in the validation process must be set out in the validation policy. A validation tool is any approach used to show that the internal model is appropriate and reliable. It may be a mathematically well defined test, a qualitative judgment or any other process with such an aim.

Frequency of validation process

The validation policy shall state the frequency of validation for each component of the model. The proportionality principle shall apply.

Further ad hoc checks on the validity of an internal model may be required in response to significant changes in the external environment. The validation policy shall identify materiality thresholds that trigger such checks when breached.

Different validation tools may be run with different frequencies.

Governance of validation results

The validation policy shall set out clear responsibilities for all the validation tasks required in the validation process.

The validation policy shall set out how the results of the different validation tools are reported and how the results will be used if the tests show that the internal model did not meet its objectives.

Pre-set criteria must be defined which will determine whether results need to be escalated and whom they must be escalated to.

The role of senior management in the validation process must be specified within the validation policy.

Validation must take place at managing agent or syndicate level, as appropriate, even if the Lloyd's business forms part of a wider group.

Limitations and future developments

Known limitations of the validation policy must be specified, with specific reference to any elements of the internal model not covered by the policy.

Planned developments in the validation policy shall be identified.

Documentation of the validation policy

The validation policy shall be documented, clearly setting out what is involved in each part of the validation process and who is responsible for ensuring it is done. The policy must be geared to the organisation of the managing agent and its syndicates.

Independent review

The validation policy shall set out how the independent review, whether internal or external, is used in the validation process, why that review is deemed independent, and how independence is maintained over time.

Explanation of why the review is deemed to be independent should take into account at least:

- the responsibilities and reporting structures for internal review; and
- the remuneration structures for external review

The requirement for independent review is subject to the principle of proportionality.

Backtesting

A managing agent needs to document and implement backtesting processes and establish a governance framework around them. The backtesting process requires a set of trigger events to be defined, e.g. the realisation of a loss that exceeds a predetermined limit. Trigger events chosen by a managing agent should be specific and appropriate to the syndicate risk profile. Trigger events should cover individual risk categories, e.g. investment or underwriting events, in addition to a total portfolio profit & loss view. The occurrence of a trigger event then leads to an investigation which typically covers the following topics:

- Identification of the portfolio where the event was triggered.

- Analysis of the root causes that led to this event.

- Examination of how the root causes are reflected in the internal model with the aim of identifying potential model weaknesses.

- Comparison to the existing internal model stress tests and assessment of the continued validity of the stress test assumptions.

In addition, a managing agent shall also, on a regular basis, analyse the results of backtesting events that are not above the trigger threshold.

Note, however, that the lack of trigger events may just as well indicate issues with the model as does their occurrence.

The backtesting results shall form the basis of an analysis which identifies the reason for divergences between modelled results and reality. A managing agent shall use other validation techniques and qualitative analysis to decide whether the deviation is random, the result of a permanent change, or a model assumption error or parameter estimation error.

There shall be discussion, at the appropriate level of management, as to whether deviations require a change in the model, and whether any such change will be to the model structure or only to some of the parameter values. The precise escalation path and management decision taking process in response to significant deviations shall be the part of the validation policy. The policy shall contain the goals and measures of the backtesting process.

Backtesting shall be applied at various levels of the business activity (e.g. to individual parameters and to portfolio results). As more relevant data (internal or external) becomes available, more detailed backtesting can be done and more comfort can be drawn from the process.

Expert judgment is subject to backtesting. Where expert judgment was used in modelling, backtesting shall include a comparison between prediction and realisation. Backtesting should be carried out at least annually and ideally more often, if practical.

Where actual data is not available model predictions shall be compared to data which is as "real" or "market-based" as is practically possible. Where model predictions are compared to estimates of the actual data based on models, there may be an increased danger of overlooking model weakness.

Where actual realisations may not be directly available, the model forecasts may be compared to realisations made on the base of a comparable data set. Where a comparable data set is used, there is a danger of subjectivity in its choice and a managing agent shall justify why the particular comparable data set chosen is appropriate.

Model robustness

A managing agent shall perform an analysis of the robustness of their internal model. This shall include, as a minimum, sensitivity testing and further tests on the stability of the model.

Management need to understand and be comfortable with the sensitivities of the model. This analysis may be performed by introducing small changes to assumptions and may be complemented by a qualitative review of the model results derived from changes to:

the model architecture, structure, formulaic definition and/or numerical procedures; and/or

the parameters used by the model.

A managing agent shall perform a critical analysis of the results from the sensitivity and stability analysis to determine whether changes are required to the model. Governance processes shall be in place to ensure that results are escalated to senior management in an appropriate way.

A managing agent shall identify and document the most significant assumptions and demonstrate the effect on the results to changes in the assumptions.

The results from sensitivity testing shall be reviewed at least annually and shall be considered when establishing policies and limits.

Sensitivity testing is especially important in validating parts of the internal model which place particular reliance on expert judgment, or where the expert judgment has a material impact on the results. This is due to the level of uncertainty that may be associated with the expert judgment.

In some cases a small difference in the input may justifiably result in a large difference in the output. In these cases, a managing agent must be able to explain the underlying reasons for the sensitivities and the sensitivity testing shall illustrate how the cause-effect-relation is modelled adequately.

Apart from sensitivity testing, further tests may be required to assess whether or not the results produced by the internal model are stable and robust. Further runs of the model using alternative seed values shall be able to produce results that are not significantly different if there have been no changes to the input parameters. Any changes in model output in these circumstances shall be reasonable, explicable and comprehensible.

Stress and scenario testing

Article 124/CEIOPS Doc 48/09: 8.166-8.173

As a validation tool, stress and scenario testing shall permit a degree of confidence by providing more information about what results look like under various conditions. It may also identify limitations of the model, thereby increasing the confidence of users in the outputs of the model. The stress and scenario testing and the resulting effects shall be monitored, assessed and updated on an ongoing basis.

A managing agent shall ensure that its stress and scenario testing methodologies are consistently and comprehensively applied throughout its operations, across significant risk categories.

An internal model shall embody assumptions about relationships between variables and about their behaviour under periods of stress.

A managing agent shall analyse the results, review the interaction of risks and mitigating actions, make recommendations and revise scenarios and calibrations in the light of the results. For agents that are part of an insurance group, the results shall be reviewed both at local as well as at group level. The results shall be compared to risk tolerances or other limits defined by the managing agent. Senior management shall be involved in overseeing a comprehensive coordinated stress and scenario testing programme.

A managing agent shall develop stress and scenario tests which they identify as most appropriate, given the characteristics of their own portfolios. They shall provide their board with a description of the methodologies used both to select stress and scenario tests and to carry out those tests in the model and the risk management system. They shall also explain why they believe that the stress and scenario tests are adequate for their risk profile.

A managing agent shall also conduct reverse stress tests to understand what stresses would seriously threaten their viability. This reverse stress testing must be documented and signed off by its board.

The implementation of the stress and scenario testing requirement shall be proportionate to the nature, scale and complexity of a managing agent's business.

CALIBRATION

The calibration of the Solvency Capital Requirement (SCR) differs significantly from that currently required by Lloyd's for the calculation of syndicate ICAs.

Article 101(3) states that the SCR should be calibrated so that it corresponds to the value-at-risk of the basic own funds of an (re-)insurance undertaking subject to a confidence level of 99.5% over a one-year period (covering existing business, as well as the new business expected to be written over the next twelve months). *Note the definition of premium provision may mean that this should include business the syndicate has committed to underwrite over this 12 month period.*

Agents should note however that in addition to providing a regulatory SCR number on this 12 month basis, Lloyd's expects to require agents to be able to produce a one year to ultimate number at the same 99.5% VaR confidence level. This will be required for LIM calibration purposes and also in determining member level capital as set out below.

Lloyd's may also require agents to run their models based on benchmark portfolios or external assumptions and this may be asked of an individual agent or the market as a whole. Lloyd's would expect to consider this issue further as part of the quantitative dry run process in 2011.

Managing agents should ensure that they fully understand the concept of basic own funds, claims provisions and premium provisions under Solvency II when reviewing and amending their existing ICA models for the purposes of calculating the SCR (refer to CEIOPS-DOC-33/09 - formerly known as CP39 - and also the separate Lloyd's guidance on Technical Provisions under Solvency II. The SCR represents the 1 in 200 year Solvency II balance sheet position in exactly 1 year's time. This can be expressed as the losses the syndicate would 'recognise' or book after 12 months. This is not the same as the 'ultimate' loss position currently required by the syndicate ICA calculation, as the volatility of risks beyond the 12 month balance sheet date are ignored and are included instead in the risk margin calculation – e.g. catastrophe events occurring after the 12 month balance sheet date on premium then in force. The solvency position booked at 12 months could in principle be greater than the ultimate position, although a commonly held view is that it would typically be lower.

The risk definition has similarities to modelling the UK GAAP balance sheet in a year's time, but it is not the same.

For example:

- Solvency II basis reflects loss volatility over 12 months *plus* a transfer value to a third party insurer.

- the Solvency II balance sheet does not have the concept of an unearned premium reserve. Thus, whilst a projected GAAP balance sheet would contain a UPR (corresponding to a 100% ULR or greater on unexpired business), this would not be present in the projected Solvency II balance sheet. For example, the projected Solvency II premium provision must be calculated on best estimate loss ratio assumptions.

- the Solvency II balance sheet contains an allowance for unincepted business where a legal obligation exists.

The projected premium provision should in principle incorporate any changes in expectations of the profitability of the business over the 12 month recognition period. For example, if future inflationary expectations have changed, or expectations over future claim frequency have changed then this should be incorporated into the projected premium provision.

Many syndicate ICA models currently simulate losses on a 'straight to ultimate' basis rather than a 12 month loss recognition basis. Managing agents will need to consider how their existing models require modification.

Future profits and wind up

Agents should also note the relationship between technical provisions and the SCR calculation. In particular, through calculation of a best estimate premium provision (rather than the current unearned premium reserve approach), expected future profits on existing business will be recognised as part of the technical provision calculation. This is a change from the current ICAS regime, where these expected future profits may have been treated as an offset within capital requirements.

Current advice over the classification and eligibility of basic own funds (CEIOP-DOC-39/09) proposes that Own Funds should be re-calculated based on wind-up assumptions with the corresponding 'winding up' gap classified as Tier 3 capital rather than Tier 1. These proposals also state that expected future profits recognised within technical provisions should be excluded from Tier 1 capital and should instead be classified as Tier 3.

The calculation of the SCR (equal to basic own funds at the 99.5^{th} percentile) should in principle allow for this classification of basic own funds. Managing agents should note the issue and consider the potential impact of the proposals on the syndicate SCR calculation.

Member level capital setting

Following the introduction of the ICAS regime, Lloyd's has placed syndicate ICAs at the heart of member level capital setting. Member level capital has been set based on syndicate ICAs uplifted by a flat rate, which has been 35% to date. The use of the regulatory capital minimum and the simplicity of a flat rate uplift has been welcomed by the market and Lloyd's is developing its plans for capital setting under Solvency II with the objective of maintaining this approach.

There are, however, some key differences between an ICA and the SCR and managing agents should plan their model development with the expectation that Lloyd's will require a one year model number to ultimate, as well as the 12 month "balance sheet to balance sheet" regulatory SCR. We consider that in any event agents would be required to assess this within their ORSA, irrespective of our final data requirements for capital setting. We are mindful of the additional areas which will be covered within the ORSA (group risk and liquidity risk for example) and agents should plan for a requirement to submit a one year model to ultimate assessment, which includes all risks.

However, please note that Lloyd's is neither able to confirm the basis for member capital setting at present nor exclude the possibility of requiring additional information to the above. Notwithstanding that and while we cannot be definitive, we are asking agents to plan for submission requirements using the 99.5% VaR methodology on a one year time horizon, to ultimate, and not to a different calibration (e.g. TVaR, different confidence level or a three year time horizon) although there may be additional bases run as part of the ORSA.

PROFIT & LOSS ATTRIBUTION

The purpose of the profit & loss attribution test is to ensure that the internal model captures the main sources of profit and loss facing the firm. It will also be an important element in establishing use of the model. Managing agents will be required to reconcile actual profits/losses booked with the output of the internal model to the extent that the model should be able to categorise risk into the main drivers of the syndicate's profit and loss statement. This could be considered as a special form of back-testing of actual results against model risk categories in addition to demonstrating that the outcomes in respect of individual risks are within an expected range of outcomes.

If there is a source of profit / loss which is not captured by the model then this suggests a model deficiency and requires investigation and possible model revision. Profit & loss attribution is therefore also a specific validation test of the internal model. Accordingly, managing agents must evidence a clear process for board escalation where profit and loss attribution is not effective, along with the next steps required to resolve any model shortcomings.

The level 2 text does not set out which definition of profit and loss should be used (e.g. the reported GAAP accounts or an internal measure of economic profit/loss), however managing agents may find it helpful initially to reconcile back to the declared GAAP earnings statement, adjusted for discounting and profits on unearned premiums where appropriate. CEIOPS' advice is to use internal definitions for profits and losses which should be consistent with the variable underlying the probability distribution forecast. This would suggest measurement against a measurement of 'economic' profit rather than the current GAAP reporting basis. This may pose difficulties for firms which currently do not measure themselves internally on an economic or similar basis. Whatever the basis chosen, the profit & loss attribution test by its nature requires close liaison between the finance and actuarial teams and reconciliation between accounting systems and actuarial models. Indeed, CEIOPS' advice states that the causes of the differences between profits and losses in the attribution and those in accounting systems must be understood.

Profit and loss attribution must be carried out at 'Major Business Unit' level and the model's categorisation of risks must be sufficient to explain the main causes and sources of profit and losses. It is up to individual agents to determine the level most appropriate for each syndicate, but typically profit and loss attribution would normally be expected to be carried out for each major class of business, gross and net. Agents should also consider other sources of profit and loss – e.g. investments. Frequency of the profit & loss attribution test should be at least annual.

Managing agents should note that the guidance given here is in respect of the test for internal model approval only, and is not intended for external communication such as the Report to Supervisors / Solvency Financial Condition Report which may have additional reporting requirements for profit & loss attribution.

VALIDATION

Validation is considered to be a critical part of demonstrating that the internal model is suitable for setting capital for regulatory purposes. Managing agents will be required to develop a comprehensive validation process which is ultimately owned by the board and draws on relevant skills from the organisation. The validation process is expected to contain both qualitative and quantitative elements.

Scope

The scope of validation is wide, and it is not isolated to the calculation kernel. The scope of the validation will depend on the scope of the internal model itself. For example any IT systems defined as being included within the internal model should by default be considered for inclusion within the scope of the validation. Managing agents will need to consider carefully where to draw the line between validation policies within the scope of the internal model and policies on processes that are linked to the internal model but outside the scope of the approval process.

The level 2 advice requires the validation process to at least cover the following areas (alongside each, examples of what validation might look like are given):

Area of Validation	Example
Data	Accuracy and completeness checks, data reconciliations
Methods	Selected statistical distributions are supported by the data (or at least are not contradicted by past history)
Assumptions	Validated against actual experience or market data
Expert Judgement	Actuarial judgement is challenged by underwriters' views and vice versa
Documentation	Evidence that it has been read and signed off by relevant staff
Systems/IT	Appropriate systems controls, file back-ups and security in place
Governance	Evidence that validation output is reviewed by appropriate committees
Use	Show that the model is genuinely used and appropriate for the use. Show minutes, supporting analysis and any workflow history. Show how use influences model design and subsequent changes

Validation Policy

Each managing agent must have in place a written validation policy and any agent without a policy will not meet internal model requirements. The level 2 text explains in some detail the minimum requirements of such a policy and the suggested content of a validation policy is given below

Example Validation Policy Format

Proposed section header	Example fields
Title page	With Managing Agent / Syndicate name
Document control	Document owner, author, date, version number Person(s) approving the policy, date, version history, changes made
Table of contents	Summary of all headings and sub headings with applicable page number
Executive summary	Background (explain the need for the policy i.e. Solvency II)

	Business objectives for the policy
	Policy ownership
	Key stakeholders, signatories and period for policy review
	Communicating key uncertainty
Terminology	Glossary of terms
	Interpretation of the following terms to managing agent:
	o Syndicate specific requirements
	o Materiality
	o Proportionality
Validation Policy details - subsections	
Purpose and scope of validation	Outline purpose of the validation policy
	Clarify the scope of the policy, any areas excluded with reasons why
	Validation standards apply to each of the following:
	o Data
	o Method
	o Assumptions
	o Expert Judgement
	o Documentation
	o Systems/IT
	o Model Governance
	o Use Test
	Include the following:
	o Role of the Managing Agency board
	o Discussion on the level of comfort required by the board and how this is to be achieved
	o The application of the policy to individual model components
	o Consider the materiality of each component in the overall validation
Validation tools used	The following tools are to be used in the validation process:
	o Stress and scenario test
	o Reverse stress test
	o Back test
	o Sensitivity test (including correlation / dependencies)
	o Simulation / convergence test
	o Profit & Loss attribution
	o Standard SCR formula comparison
	o 'As-if' losses
	A description of each of these tools is set out in **Appendix 5a.** Each tool will be used to validate different parts of the internal model, as appropriate.

Frequency of validation process	Specify the minimum frequency of exercising the validation process for each material component of the model, e.g. Operational risk – quarterly
	Outline changes in the external environment upon which management would require further ad hoc validation checks
	Specify the changes in the external environment that could trigger these further checks, and the materiality thresholds that apply
Governance of validation results	Outline the governance process around the validation process.
	o what management body is responsible for all the day to day validation tasks for each module in the validation process
	o skill set / competencies required by the validation team
	o frequency and timeliness of reporting to management
	o how the results of the different validation tools are to be reported (both for regular validation checks and ad hoc checks)
	o how the results will be used if the tests show that the internal model did not meet its objectives
	o tolerance levels around validation results
	o when does management require further action
	o any further escalation procedures from management to the board
	o in relation to breaches of validation policy
	o in relation to results outside tolerance levels (refer Chapter 7)
Limitations and future developments	Outline the areas not covered by this validation policy and where the policy will be developed in future
Documentation of validation policy	Outline how documentation is monitored and amended
Independent review	List each independent reviewer (whether internal or external) and how and where they have been involved in supporting the review of validation policy
	Why the review is deemed independent and how independence is maintained over time
	Responsibilities and reporting structures for internal review
	Remuneration structures for external review
	Relationship with internal audit
	Which board committee is charged with initiating the review and appointing / removing the reviewers
	Process for handling differences of opinion between the dependent review and the independent review
Use of expert judgement	Outline the validation of expert judgement (where used)
Testing results against experience	Backtesting process
	Backtesting consists of the following steps:
	o Defining one or more trigger events
	o Monitoring to see if the trigger event has occurred

	o Identify the portfolio where the trigger event occurred
	o Analyse the root causes that led to this event
	o Examine how the root causes are reflected in the internal model with the aim of identifying potential model weaknesses
	o Comparison to the existing internal model stress tests and assessment of the continued validity of the stress test assumption.
	Define specific trigger events which lead to further investigation
	The extent of backtesting and which parts of the model it is to be applied to
	Outline how this is to be monitored, who by and the frequency with which it will be monitored
	Frequency of analysis of the results of backtesting events which are not above the trigger threshold
	How the results of backtesting explain divergences between modelled results and reality
	The use of comparable data sets where actual data is not available to compare to the model
Testing robustness of internal model	Outline how the robustness of the internal model is to be tested, including reliance on sensitivity testing, etc.
	Specify who is to perform a critical analysis of the results from the sensitivity and stability analysis to determine whether changes are required to the model
	Specify when results are to be escalated and to whom
	Set out the most significant assumptions and demonstrate the effect on the results to changes in the assumptions
	Frequency of sensitivity testing review
	Demonstrate where a small difference in the input may result in a large difference in the output
Stress & scenario testing	Outline how the stress and scenario testing and their results are to be monitored, assessed and updated
	Specify that the methodologies are to be consistent and comprehensively applied throughout the operations
	How senior management will oversee the testing programme
	Descriptions of the methodologies used to select the stress and scenario tests and to carry out those tests. Reasons why the tests are adequate for the risk profile
	Application of reverse stress tests
	Level of documentation required for reverse stress tests and when to be signed off by the board
Profit & loss attribution	Outline how the profit & loss attribution analysis is to be monitored and measured against
	Set out who is responsible for monitoring the profit & loss attribution and the frequency of review
Next steps/escalation	Next steps and escalation process (internal and external) following receipt of validation report:
	Process for deciding whether changes should be made to capital requirements

	Process for deciding whether the specific validation results should flow into model changes and associated timescales (refer to model change process)
	Process for deciding whether Lloyd's need to be informed immediately of the validation results
Appendices	Appendix 1 - Scope of the internal model
	Appendix 2 – Syndicate specific data requirements
	Appendix 3 – Validation Standards
	Appendix 4 – Description of Validation Tools

Importantly the validation policy must set out the validation tools that are used. The advice does not explain precisely what a 'validation tool' is, although it does give the very broad description that a tool is "any approach designed to gain comfort that the internal model is appropriate and reliable". This is up to each firm to define. Appendix 5a gives examples of various validation processes and tools that a firm may choose to employ. Many of the validation processes described in the appendix are mandatory under the level 2 guidance such as stress and scenario testing, sensitivity testing, and back testing. It is strongly recommended that these tests should be applied to every major risk module of the standard SCR formula in order to validate the model against the standard SCR calculation. The use of the model for 'risk ranking' should also inform agents as to which risk areas should be tested as a priority.

The validation policy must demonstrate how it achieves an independent review and must explain how the review process is independent. Lloyd's expects an independent validation report to be produced and be submitted to the board. The agent's definition of "independence" should be detailed and explained. One possible interpretation is that it is reviewed by individuals who were not involved in the model's design, development or parameterisation. This could include external and/or internal staff. The independent review will require various skills and expertise and agents must be able to demonstrate that the process involves sufficient skills in order for all areas of the model to be validated. Managing agents may choose to nominate various members of staff (e.g. from finance, underwriting, actuarial) to validate an element of the internal model. The managing agent should also explain the role of the internal audit function in the validation of the model, as well as any third party reviewers.

Lloyd's benchmark

Lloyd's will use and continue to develop its own syndicate model against which syndicate calculations will be compared. This will provide managing agents with an opportunity to validate their model against an independent benchmark but it will not on its own be sufficient to satisfy the validation requirements.

Back testing

The back testing process must specify defined trigger events so that investigations are undertaken when a loss exceeds a pre-determined limit - for example, if the loss breaches the 1 in 25 year loss level predicted by the model. These trigger events should be specified at both portfolio and individual risk level.

Stress and scenario testing

In recent months the FSA has placed considerable emphasis on the use of stress and scenario testing to validate the model. Managing agents should refer to FSA papers PS09/20 and CP08/24 for further detail, with annexe 3 of PS09/20 setting out the FSA's views on good practice in stress testing. It is clear that stress testing should not be considered as an inferior or secondary exercise to stochastic modelling and should be seen as a core part of the risk management system. In particular stress and scenario testing is an important mechanism through which senior management can engage with and challenge the output of the internal model (thereby contributing to demonstrating that the 'use' test is being met).

In addition to managing agents developing their own suite of stress tests, Lloyd's will specify a number of market-wide stress tests which will include the existing Realistic Disaster Scenarios.

Managing agents must also develop an approach for 'reverse stress testing'. This is a relatively recent addition to the validation toolkit. Further explanation of reverse stress testing is given in appendix 5c. For all stress &

scenario tests and reverse stress tests, managing agents must explain the rationale for each and why they are considered appropriate.

Agents should note that appendices 5a – 5c are intended as illustrative examples and guidance only and they should not be construed as minimum Lloyd's standards.

EXAMPLES OF VALIDATION TOOLS

1. Validation Processes

	Validation Process	Description
1	**Stress and scenario test**	Construct hypothetical extreme scenario (or combination of scenarios) and assess the loss (earnings) impact
2	**Reverse stress test**	Determine the level of loss which would lead to insolvency (or failure to deliver the plan) and work backwards to determine the scenario(s) which might lead to that level of loss
3	**Back test**	Compare actual results with modelled distribution – do they fall within the range expected by the model?
4	**Sensitivity test**	Vary individual model parameters to assess the impact on capital
5	**Simulation/convergence test**	Test to see how stable the modelled capital figure is to varying the seed or increasing the number of simulations
6	**Profit & Loss attribution**	Check to ensure actual profits/losses booked can be explained by risks being modelled. Are all sources of profit/loss captured by the model?
7	**Standard SCR formula comparison**	Compare and reconcile results of each main standard formula risk module with the corresponding internal model output. If material, agents may also consider reconciliation with sub-modules.
8	**'As-if' losses**	For catastrophe losses in particular: replicate the footprint of actual previous catastrophe events and determine as if losses from existing exposures. Does the catastrophe model generate the anticipated level of loss? Compare to actual experience and reconcile differences for change in risk profile, reinsurance arrangements etc Does the model generate similar aggregation of actual losses e.g. World Trade Centre losses across various classes?

2. Specific Validation Checks

- For each class of business or risk category, display the modelled output:

    o   is the marginal loss distribution reasonable and consistent with parameters?

    o   is the 99.5 percentile appropriate and sufficiently extreme?

    o   are lower/less extreme percentiles reasonable, especially given historic experience?

    o   is it consistent with pricing assumptions?

- Check against an independent validation model or alternative methodology: e.g.

    o   how does bootstrapping compare with other reserve risk methods?

- - how does one proprietary cat model compare with another?

  - how does market risk model compare with alternative economic scenario generator?

- Alternative risk measures: e.g. compare 99.0% TVaR risk measure with 99.5% VaR

- Market benchmarks for capital:

  - compare against standard formula SCR and MCR

  - compare against other regulatory capital requirement models

  - compare against rating agency models and charge factors

  - compare against Lloyd's benchmark capital model

- Develop 'common sense' checks and rules of thumb:

  - £xm reduction in mean profit => £ym reduction in capital

  - 10% increase in underwriting volumes => y% increase in underwriting risk

  - impact of no reinsurance

  - impact of no discounting

  - impact of withdrawal of a key class of business

  - impact of geographical diversification

- Breakdown of simulated output in the tail: what is driving the aggregate losses at different percentiles? Is this reasonable?

- Re-run previous year's model parameters and seed on current model

- Diversification and aggregation checks (note that limitations and failings should be considered and taken into account where relevant):

  - root sum of squares

  - check stand-alone capital for risk category < Aggregated risk capital

  - does the model generate simulations with aggregation across differing risk categories: e.g. underwriting, credit, liquidity and market risk?

  - comparison against historic analysis of correlation

  - scatter diagrams of model output e.g. class rank correlation

- Validation of use: interview business users on their level of understanding

- Peer review of results and parameters

- Reconciliation checks on data inputs:

  - a comparison with data used for the previous exercise;

  - a comparison with data used for the previous exercise;

  - checking that data values lie within reasonable (or defined) limits;

  - outlier analysis of data points

- Walk through of individual simulation: Examine an individual simulation and trace the path through the model
- Graphical examination of fitted loss distributions to actual historical losses; goodness of fit tests

REVERSE STRESS TESTING

The FSA is placing increasing emphasis on firms to introduce 'reverse stress tests'. Managing agents should note that significant detail is already given in FSA documents PS09/20 and CP08/24. The following summarises the rationale given behind reverse stress tests:

A reverse stress test begins from a defined balance sheet or loss outcome (for example, an illiquidity scenario or insolvency) and then asking what event or combination of events could lead to such an outcome. One of the objectives of performing such a stress test in reverse, is to try identify specific series of scenarios which together act to compromise the firm's ongoing viability. These could be triggered by market events which themselves lead to several mutually reinforcing pressures on a firm.

A variation of reverse stress testing is to take simulated tail output and to justify how it might actually happen in practice. For example, what specific events could drive a simulated £xm investment loss, combined with a £ym underwriting loss.

The FSA states that the purpose of the reverse stress test is to identify and consider scenarios that would lead to a firm's business model becoming unviable. It therefore goes beyond the assessment of solvency. A firm's business model is described as being unviable at the point 'when crystallising risks cause the market to lose confidence in the firm'. For example, when counterparties and other stakeholders would be unwilling to transact with or provide capital to the firm and, where relevant, existing counterparties may seek to terminate their contracts. Such a point could be reached well before a firm's regulatory capital is exhausted.

The primary use of reverse stress-testing is as a risk management tool to improve business planning and risk management rather than to inform decisions on appropriate levels of capital or liquidity specifically. However, with regard to model validation, the internal model should be able to generate outcomes which are independently conceived by the stress testing exercise. Failure of the internal model to produce simulated outcomes broadly consistent with the reverse stress test would suggest that the model is failing to fully reflect the risks facing the firm.

The FSA see an important benefit of reverse stress-testing as the thinking behind the scenarios. The reverse stress test is expected to encourage improved understanding of risks throughout an organisation, especially at senior levels. For the exercise to be relevant and meaningful, engagement with senior management is an important pre-requisite.

The principle of proportionately applies equally to the implementation of reverse stress tests. Smaller and less complex organisations would be expected to conduct less complicated reverse stress-testing, possibly more qualitative than quantitative. On the other hand, larger and more complex organisations will need to conduct more extensive stress testing, which will be both qualitative and quantitative in nature.

EXAMPLE SENSITIVITY TESTS

Underwriting Risk	• Increase planned ULRs by 10% absolute • Double large loss frequency • Increase catastrophe loss frequency • Change severity distributions for attritional and large losses • Increase standard deviation of attritional losses • Remove a specific reinsurance programme • Increase standard deviation of rating movement • Increase correlation across all classes • Remove all class correlations • Remove correlation between attritional/large/catastrophes • Expenses overrun by +20%
Reserve Risk	• Compare alternative reserve risk methods • Depending on the method, increase class reserve volatility • Increase mean inflation assumption • Higher, lower and zero discount rate
Credit Risk	• Increase reinsurance default probabilities • Downgrade all reinsurers by two notches • Reduce reinsurance recovery % • Combine all reinsurers below specified rating • Assume complete and total failure of largest reinsurer • Assume failure of largest broker
Market Risk	• Increase volatility of equity holdings • Increase volatility of bond holdings/interest rate risk • Increase currency volatility • Raise bond defaults • Increase correlation between asset types • Increase inflation • 'Turn-off' each of the above sources of market risk in isolation of the other sources • Acceleration of claims payments

Operational Risk	• Increase frequency of specific operational risk events
	• Increase loss from largest 10 operational risks by 20%
Aggregation and correlation	• Increase any correlation factors across all major risk modules
	• Increase correlations for specific pair-wise dependencies
	• 100% and zero correlations between risk codes
	• Zero correlation between risk components
	• Increase tail dependence/copula effect