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# Lloyd's Minimum Standards

## MS13 – Modelling, Design and Implementation

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# MS13 – Modelling, Design and Implementation

## Minimum Standards and Requirements

These are statements of business conduct required by Lloyd's. The Minimum Standards are established under relevant Lloyd's Byelaws relating to business conduct. All managing agents are required to meet the Minimum Standards. The Requirements represent the minimum level of performance required of any organisation within the Lloyd's market to meet the Minimum Standards.

Within this document the standards and supporting requirements (the "must dos" to meet the standard) are set out in the blue box at the beginning of each section. The remainder of each section consists of guidance which explains the standards and requirements in more detail and gives examples of approaches that managing agents may adopt to meet them.

## Guidance

This guidance provides a more detailed explanation of the general level of performance expected. They are a starting point against which each managing agent can compare its current practices to assist in understanding relative levels of performance. This guidance is intended to provide reassurance to managing agents as to approaches which would certainly meet the Minimum Standards and comply with the Requirements. However, it is appreciated that there are other options which could deliver performance at or above the minimum level and it is fully acceptable for managing agents to adopt alternative procedures as long as they can demonstrate the Requirements to meet the Minimum Standards.

## Definitions

**EIOPA** - The European Insurance and Occupational Pensions Authority

**LCM** – Lloyd's Catastrophe Model

**LCR** - Solvency Capital Requirements

**LIM** - Lloyd's internal model

**MCR** - The Minimum Capital Requirement

**Risk Appetite** – Is the level of risk that an organisation is prepared to accept, before action is deemed necessary to reduce it.

**SAO** - Statement of Actuarial Opinion.

**SBF** - Syndicate Business Forecast.

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**SCR** – Solvency Capital Requirement

**The Board** - Where reference is made to the Board in the standards, managing agents should read this as Board or appropriately authorised committee. In line with this, each agent should consider the matters reserved for the Board

under the Governance Standard in order to evidence appropriate full Board discussion and challenge on the material items.

**VAR** - Value-at-Risk.

**YOA** – Year of Account.

## Section 1: Calibration

### MDI 1.1 Full internal model

Managing agents shall use a full internal model to calculate the SCR and SCR to ultimate.

Managing agents shall ensure that the SCR and SCR to ultimate are calculated using a full internal model and therefore will not use a partial internal model consisting of modules of the Standard Formula.

Lloyd's requires all syndicates to use a full internal model to calculate the SCR and ultimate SCR (see standard 1.3). A full internal model must quantify each element of risk individually, either stochastically or through stress and scenario tests.

A partial internal model which uses one or more modules of the Solvency II standard formula is not permitted.

### MDI 1.2 SCR calculation

Managing agents shall ensure that the SCR corresponds to the Value-at-Risk of the own funds<sup>1</sup> of a syndicate subject to a confidence level of 99.5% over a one-year period.

Managing agents shall calculate the SCR:

- on the presumption that the syndicate will pursue its business as a going concern;
- calibrated so as to ensure that all quantifiable risks to which a syndicate is exposed are taken into account;
- to include existing business, for an on-going syndicate, as well as the new business expected to be written over the following 12 months; and
- to exclude exposures relating to market risk arising on excess assets.

Managing agents should provide a regulatory SCR covering one year of new business measuring the risk over a twelve month time horizon at the 99.5% VaR confidence level. This covers existing business, as well as new business expected to be earned over the next twelve months. The one-year SCR is the difference between the current Solvency II balance sheet and what it would be in one year's time including claims paid during the year, given a 99.5th percentile adverse outcome. This can be expressed as the losses the syndicate would earn or book in 12 months' time. The SCRs should be prepared on a going concern basis.

The SCR is based on all quantifiable risks including the market risk arising from syndicate assets at t0, assuming a net nil balance sheet, plus premium income for the new year of account. Any assets in excess of this should be excluded.

Consequently, the closing premium provision at t1 should be based on projected emerged experience. In the model at t1, managing agents will have two pieces of information to estimate the closing premium provision:

1. Their initial estimate of the closing provision based on the SBF assumptions; and
2. The performance of the business over the twelve months from t0 to t1.

The closing premium provision in the model should reflect this information and be estimated accordingly.

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<sup>1</sup> Own Funds represent the assets in excess of those required to cover expected liabilities

## Consistency with TP calculations

Agents should also note the relationship between technical provisions and the SCR calculation. In particular, through calculation of a best estimate premium provision, expected future profits on existing business will be recognised as part of the technical provision calculation.

### MDI 1.3 SCR to ultimate calculation

Managing agents shall ensure that the SCR to ultimate corresponds to the Value-at-Risk of the own funds of a syndicate subject to a confidence level of 99.5 % of one year of new business with the risk measured to the ultimate run off of the business.

Managing agents shall calculate the ultimate SCR:

- on the presumption that the syndicate will pursue its business as a going concern;
- calibrated so as to ensure that all quantifiable risks to which a syndicate is exposed are taken into account;
- to include existing business, as well as new business attaching to the proposed year of account;
- to exclude exposures relating to underwriting years beyond the proposed YOA; and
- to exclude exposures relating to market risk arising on excess assets.

Managing agents are required to produce the SCR of one year of new business with the risk measured to the ultimate run off of the business. This to ultimate SCR should be provided in addition to the one-year SCR number.

The ultimate SCR takes account of one year of new business in full attaching to the next underwriting year and the risks over the lifetime of the liabilities (“to ultimate”). ‘Ultimate’ is defined as the final realised position – not the most prudent time step path to ultimate. The ultimate SCR considers all risks attaching to the proposed year of account and excludes exposures relating to underwriting years beyond the proposed YOA. This differs from the one-year SCR where un-accepted legal obligations on the t1 balance sheet will relate to underwriting years beyond the proposed YOA.

For the calculation of the ultimate SCR models are required to capture all risk types to ultimate with the exception of market risk, which may be modelled over a shorter time horizon (subject to a one year minimum). For the one-year SCR, the ultimate time horizon is permissible for credit risk and operational risk. The modelling time horizon should be clearly set out in the methodology document.

## Member level capital setting

Lloyd’s will require a one-year to ultimate, as well as the 12 month “balance sheet to balance sheet” one-year SCR. The “to ultimate” SCR will be used for setting member level capital requirements.

### MDI 1.4 Solvency reporting

Managing agents shall submit their LCR forms and SCR reports at least annually.

Managing agents shall submit their LCR forms and SCR reports:

- in accordance with the Lloyd's timetable; and
- where there is a material change in the syndicate risk profile.

Syndicates are required to remain adequately capitalised on a continuous basis. All managing agents are required to consider the impact of emerging information on the syndicate capital requirement and notify Lloyd’s if this causes a capital movement of greater than 10% (measured before impact of risk margin, foreign exchange and Reinsurance

Contract Boundary). Agents are also responsible for advising Lloyd's where syndicate loss experience may reasonably be expected to have eroded member capital, i.e. where syndicate loss experience is expected to exceed 15% of the capital associated with any year of account. The consideration of capital erosion through syndicate loss should look through to a year of account level to ensure that profits on one year do not offset losses on another, where syndicate membership changes year on year are relevant.

In the event of significant insured or economic events close to or during a capital review period, it may be necessary for some syndicates to resubmit the LCR to reflect the impact of such events on their SCRs. Lloyd's will seek to adopt a pragmatic approach, but action and timetable will depend on the materiality and timing of any such event and the constitution of the syndicate's stamp. If required, instructions and revised timetable will be communicated at that time. Further details are available via the downloadable Market Turning Event guide on [Lloyd's.com](http://Lloyd's.com).

### **MDI 1.5 Adjustments to model output**

Where the calculation kernel is used, managing agents shall derive the SCR and SCR to ultimate directly from the output distribution generated by the calculation kernel.

Where outputs are produced outside of the distribution generated, Lloyd's may allow approximations to be used to calculate the SCR and SCR to ultimate. Where these approximations are used agents must:

- explain how risks are rescaled to 99.5% VaR over one year and one year to ultimate show that this process does not introduce any material bias;
- explain the reconciliation between the outputs of the calculation kernel and the distribution of Own Funds, where the latter is not produced directly from the calculation kernel;
- where a different time period than one year is used, justify the assumptions made in respect of dependencies between consecutive time periods; and
- consider them as part of the internal model.

The approximations referred to in Article 122(3) of Directive 2009/138/EC shall comply with the requirements set out in Articles 121, 124, 125 and 126 of Directive 2009/138/EC.

Lloyd's expects all managing agents to produce an output distribution generated from the calculation kernel, to derive the SCR and SCR to ultimate directly.

Lloyd's does not prescribe a particular method for the calculation of the output distribution by agents and allows approximations to be made. Where approximations are made, they must be clearly documented and justified. Justification should include reasons and the impact of the approximation; the approximation should not introduce any material bias. One example of where such an approximation could be made is in the derivation of one year risk from the ultimate.

Such adjustments could also be made on a temporary basis when e.g. certain risk profile changes cannot be implemented fully into the model in a short time-frame. The requirements above for adjustments to model output hold in such cases and managing agents should articulate a clear plan how adjustments are planning to be removed.

Where the distribution of Own Funds is not produced directly from the calculation kernel reconciliation will be required between the output distribution and the distribution of Own Funds. This demonstrates that there is a clear and transparent link between the calculation kernel and final SCR.

## Section 2: Statistical Quality Methodology

### MDI 2.1 Capital distribution

Managing agents shall ensure that the output distribution from the model should measure the change in own funds.

Managing agents shall ensure that the output distribution from the model shall assign probabilities to changes from best estimate in profit and loss of the syndicate.

Lloyd's expects all managing agents to produce an output distribution generated from the model which measures the change in own funds.

Lloyd's does not prescribe a particular method for the calculation of the output distribution by agents and understands that it may not be possible, or appropriate, to model all risks stochastically. A stress and scenario test approach can be applied for some risks e.g. operational risk, but these are expected to be the exception not the rule. It is key that for all model output, drivers of outcomes and change are understood and documented. If making adjustments to the output distribution refer to the standard Calibration 1.5.

### MDI 2.2 Appropriateness of methodology

Managing agents shall ensure that the methodology used to estimate the output distribution shall be based upon adequate, applicable and relevant actuarial and statistical techniques.

Managing agents shall ensure:

- that methodology used is based on techniques that are adequate, up-to-date and generally accepted market practice;
- they have a detailed understanding of the theory and assumptions underlying the methodology;
- the internal model captures all the relevant characteristics of the risk profile of the syndicate; and
- the techniques are consistent with the data used for the internal model.

Managing agents should ensure that all methodologies used within the model are appropriate, not simply those used to determine the output distribution. Lloyd's expects agents to provide detailed commentary on all areas including the following:

- approach for modelling losses over a 12 month horizon in line with the calibration standards of Solvency II;
- granularity of risk modelling;
- insurance claims, including both premium and reserve risk;
- treatment of exposure and business volumes;
- rating variability;
- treatment of reinsurance and associated credit risk;
- correlation, diversification and dependency structures;
- risk margin calculation;
- currency risk; and
- discounting.

The onus is on managing agents to demonstrate the methods used are based upon current and credible information, and to this end regular methodological reviews are required. Managing agents should also demonstrate that they have a process for keeping abreast of progress in modelling techniques and approaches. This requirement could be captured by

the validation exercise. Any issues arising from the validation process that cast doubt on the adequacy of the model should normally lead to a specific action or further review process.

The managing agent should demonstrate that they have detailed understanding of the theory and assumptions underlying the methodology. Lloyd's expects agents to adequately document their understanding as this will help to ensure that the methodology used is transparent and should reveal the logical connection between inputs and outputs, i.e. not a "black box".

The internal model should adequately reflect the risk profile of the syndicate. A managing agent should choose methods that are suitable to the modelling goals and accurately reflect the syndicate's risk profile. In addition to this Lloyd's may require an agent 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.

The data used within the internal model may not permit use of some methods; it is therefore important that the methodology is adapted towards the data. Any other data which may affect the methodological basis of the model and information on model assumptions should be collected in line with the model validation process.

Managing agents are expected to provide evidence to Lloyd's that the basis underlying the methodology of the internal model is credible, based on appropriate criteria, which may include:

- Consistency: there are no internal contradictions;
- Objectivity: a sufficiently large set of information sources is used, characterised by a high degree of independence from the syndicate. Known exclusions are suitably justified;
- Reliability: the source and provider of the information are qualified and its quality is verified; and
- Transparency: the process of generating, processing and providing the information is well-documented, and any ambiguities in it are known.

In assessing the appropriateness of methodology managing agents and Lloyd's shall have regard to the principle of proportionality. Note that this principle applies on a per model, not per managing agent, basis and it is not acceptable for modelling to be directed by the largest syndicate in a managing agent if this doesn't allow reflection of risk profile characteristics of smaller syndicates.

The methodology document should identify the key sensitivities affecting the SCR and provide explanations of why the modelling approach is appropriate for quantifying these extreme outcomes. Regardless of the approach used, agents should be able to demonstrate that they have adequately accounted for the impact of parameter uncertainty on the SCR. Expert judgment will be relevant both in identifying where parameter uncertainty exists, and how to quantify it.

### **MDI 2.3 Diversification benefits**

Managing agents shall allow appropriately for diversification effects within the internal model.

Managing agents shall satisfy Lloyd's that methodology used to allow for diversification effects is adequate by ensuring that the approach used for measuring these within and across risk categories identifies the key variables driving dependencies and takes into account:

- any non-linear dependence or lack of diversification under extreme scenarios;
- any material restrictions of diversification which arise from the existence of ring-fenced funds;
- the characteristics of the risk measure used in the internal model; and
- Post-diversified outputs from the model need to be reasonable when allowing for these dependencies.

The appropriateness of the diversification credit should be demonstrated by justification of:

- I. The risk distributions used; and
- II. The dependencies between them.
- III. Validation testing of the diversification credit.

Managing agents should be prepared to provide detailed and explicit information on the impact of diversification within the model. I

A process to identify, quantify and review the dependencies within their business and those assumed within their internal model should be evidenced. This may take the form of periodic calculations of dependencies seen in historic data, assessment of possible dependencies by persons with relevant experience and use of market data or expert judgement.

For the main types of risks and between classes of business at each of the key aggregation steps in the model (e.g. combining risk types, classes of business) managing agents should consider whether tail correlations are present and should be allowed for within the model.

Syndicates' should ensure they consider whether they have ring-fenced funds. Lloyd's considers that overseas trust fund deposits do not fall within the definition of ring-fenced funds and therefore managing agents do not need to take these into account when considering diversification benefits.

Agents should use a dependency structure which is appropriate for estimating the capital based on a 99.5%ile VAR measure. They should also ensure it is appropriate at other percentiles of the balance sheet distribution, which may be more relevant to other considerations such as reinsurance purchase. Agents should justify why the structure is also appropriate for the to-ultimate and one-year time horizons

The key variables driving dependencies and syndicates' exposure to them should be identifiable. Depending on the chosen aggregation method, different variables come into consideration, e.g. risk factors, risk drivers for market, credit or insurance risk, economic indicators or overall profits and losses etc.

## MDI 2.4 Risk coverage and ranking

Managing agents shall ensure that all of the material risks to which the managing agent is exposed are modelled and that the model can rank risks.

Managing agents shall ensure that the SCR shall cover at least the following risks:

- insurance risk;
- market risk;
- credit risk; and
- operational risk;

Operational risk should exclude risks arising from strategic decisions, as well as reputation risks.

Managing agents shall also ensure that the model can rank risk consistent with the classification of risks used in the internal model and the classification of risks used in the risk management system.

### Risk ranking

Managing agents are required under Solvency II to ensure that their internal model is capable of risk ranking for all material risks covered by the internal model. Risk ranking can be defined as quantifying the materiality of sub-risks; it is the relative comparability between risks that is important, not the absolute amounts assigned to risks.

Lloyd's expects risk ranking to be performed at various levels, which may include:

- major risk category (e.g. premium risk, reserve risk, market risk, credit risk etc);
- business unit;

- class of business or product (and possibly at a currency level); and
- operational risk events.

One option is to start from the major risk category and consider the underlying core risk drivers. For example, for underwriting it should be possible to rank by class of business, for market risk rank by asset type and credit risk rank by reinsurer or perhaps reinsurance programme.

A number of approaches could be employed to rank risk, and Lloyd's recommends that more than one method is applied. This could include:

- capital allocation approach (a wide variety of methods can be applied);
- rank according to standard deviation / variance; and
- rank according to the stand-alone 99.5th percentile VaR or TVaR position (or other percentile).

Agents may find it helpful to consider risk in terms of quantum of total exposure, but also in terms of the risk per unit of exposure.

### **Risk coverage**

The managing agent should ensure that the Solvency Capital Requirement covers all material quantifiable risks to which the syndicate is exposed in order to adequately reflect the syndicates' risk profile. Lloyd's will expect that any additional risk taken by the syndicate will result in additional capital being required.

As per the SQS 1.4, the SCR should cover the following risks:

- insurance risk;
- market risk;
- credit risk; and
- operational risk.

In order for Lloyd's to be able to compare and aggregate results, syndicates' should cover risks as set out in the latest Internal Model SCR guidance.

Insurance risk should represent the diversified aggregate of premium and reserve risk. Managing agents should ensure that the 1:200 outcomes on premium and reserve risk should be consistent with the stress on an undiscounted basis.

Managing agents should ensure that premium risk captures the following:

- all underwriting exposures and associated risk from  $t_0$  (opening balance sheet position) for all years of account;
- catastrophe risk for all events occurring after  $t_0$ ; and
- the uncertainty in anticipated future underwriting profits.

If material, lapse risk should be included within premium risk in respect of new business bound from 1 January of the prospective YOA and within reserve risk where it relates to incepted business. If the risk is not considered to be material this should be noted and justified within the documentation. This applies to both life and non-life business.

Lloyd's expects insurance risk to capture the volatility in claims as well as the uncertainty regarding premiums, i.e. the variability concerning volumes, rates and contract terms and conditions – albeit not necessarily by modelling stochastic premiums. Moreover, Lloyd's expects syndicate to capture the impact of claims inflation and other trends such as latent claims, regulatory, legislative, societal and technological changes.

The aggregate credit risk should represent the diversified aggregate of reinsurance credit risk and other credit risk (but not on financial assets). Reinsurance credit risk should include dispute risk, but exclude reinsurance exhaustion, which should be modelled and reported within insurance risk. Reinsurance credit risk includes all group reinsurances. Credit risk excludes the default risk applying to financial investments, which should be reported within market risk.

Market risk should represent the net 1:200 deterioration from the opening balance sheet at t0. It should include the risk to the value of the assets and liabilities arising from volatility in the level or market prices of the following (Article 105 of the Directive):

- interest rates;
- equities;
- property;
- credit spreads over risk free interest rates;
- credit bond defaults; and
- currency exchange rates.

In addition, market risk should also include the following:

- risk from limited diversification in the asset portfolio or from default of a single issuer or group of issuers of securities;
- risk of changes to the net value of assets and liabilities arising from changes in the risk free rate; and
- liquidity risk.

The expected return in market risk is the total expected returns from the syndicate's assets, allowing for net nil balance sheet at t0 plus the new premium income, reduced by the total risk-free discounting already allowed for in the projected insurance liabilities. The discounting credit at t0 is expected to unwind to ultimate but any associated loss due to unwinding will not be included in insurance risk. Market risk should also include the risk that there are changes to the risk-free rate in the valuation of t1 technical provisions in the one year SCR. If not modelling on both a one year and ultimate basis, agents should state clearly the time horizon adopted for market risk when assessing the ultimate SCR and ensure this is consistently applied for expected returns and associated asset risk. Both expected returns and asset risk should exclude capital and surplus syndicate assets.

The risk-free discounting credit in the SCR should reflect the fact that existing assets may be depleted more quickly in a 1:200 scenario and consequently the risk-free return will reduce compared to best estimate projections.

Operational risk should be analysed between "stand-alone" risks e.g. business interruption through loss of the building or technology and risks associated more closely with other risk categories e.g. misreporting of case reserves or rogue underwriter. The delineation must be guided by the principle that risks which apply to a multitude of losses across classes and years should be modelled in other risk categories as to not underestimate the effect. For example, the risk of systemic underpricing (i.e. the risk that the mean loss ratio for a multitude of classes is understated at the same time) must be included in premium risk. However, mispricing of contracts due to operational factors (e.g. a wrong pricing model or a rogue underwriter) is related to human error and should therefore be allocated to operational risk. Group risk should be included within operational risk (this does not include credit risk from group reinsurance covers).

## MDI 2.5 Risk mitigation techniques

Managing agents shall take full account of the effect of risk mitigation techniques in their internal model.

Managing agents shall ensure:

- all modelled risk mitigation techniques align with the managing agent's risk management policies; and
- risks (e.g. credit risk) arising from the use of risk mitigation techniques are properly reflected in the internal model.

### Risk mitigation techniques

A managing agent should take full account of the effects of risk mitigation techniques (e.g. reinsurance, hedging) if their inclusion in the internal model reflects the following criteria:

- Economic form over legal form, i.e. they deliver a demonstrable transfer of economic risk;
- They are legally effective and enforceable and are adequately documented;
- They are liquid and can be valued under both normal and stressed conditions. They meet documented liquidity requirements under both normal and stressed conditions. They are capable of liquidation (or retention) in the event of counterparty default. They are not double-counted;
- Associated secondary risks (e.g. credit risk, concentration risk, basis risk, legal risk, operational risk), and the interactions between them, are identified, documented and included in the internal model;
- They provide a direct claim on the protection provider and the extent of cover is explicitly referenced to specific exposures or a pool of exposures. To the extent that the protection is not irrevocable or unconditional, this should be reflected in the model or, if not possible, the risk mitigation technique should be excluded from the model;
- Exposure is assessed at both the gross level and net of the effects of risk mitigation techniques;
- Where risk mitigation techniques are used to justify a reduction in the SCR, they should demonstrably reduce risk at 99.5% VaR over one year; and
- Equivalent requirements apply whether or not the protection provider is independent from the syndicate or is part of the same group.

The risk mitigation techniques which satisfy the conditions above should align with the managing agent's risk management policies. Any deviations from the risk management policies should be documented and where appropriate the relevant policies should be updated to reflect the risk mitigation techniques included within the model.

### Recognition of risk mitigation

The primary source of risk mitigation is likely to be reinsurance although other mitigation activities such as derivative hedging are also used.

With regard to reinsurance, managing agents should demonstrate that the reinsurance contracts fully provide the protection that the internal model assumes. Areas to consider should include:

- reinsurance dispute and default;
- policy deductibles and excess points;
- reinsurance coverage (e.g. exclusions and geographical coverage);
- willingness to pay;
- loose policy wording;
- basis risk (e.g. for Industry Loss Warranties);
- matching of coverage (e.g. risks attaching versus losses occurring terms);
- currency mismatch between reinsurance terms and the underlying risk; and
- horizontal and vertical exhaustion; reinstatement provisions.

Agents should consider modifying their internal models to reflect potential shortcomings of reinsurance protection and/or including an allowance within their operational risk assessment.

In cases where the SCR takes credit for a material reinsurance arrangement or programme Lloyd's requires agents to clearly set out the SCR pre- and post- the reinsurance programme in the SCR report. Managing agents should document the premium and anticipated recoveries at the underwriting (or reserve) risk level, diversified insurance risk, the incremental reinsurance credit risk and at aggregate level after all diversification between risk categories. The use of such an arrangement may sufficiently change the syndicate risk profile to require assumptions relating to other risk types and/or their interaction to be revisited.

## MDI 2.6 Future management actions

Managing agents shall take account of future management actions that they would reasonably expect to carry out in specific circumstances.

Managing agents shall ensure:

- that all future management actions are allowed for where appropriate, documented, and approved by the Board of the managing agent; and
- assumed future management actions are realistic and consistent with each other and with the managing agent's current business practice and business strategy, including the use of risk-mitigation techniques.

Future management actions can be allowed for within the model where an agent would reasonably expect to carry this out in specific circumstances. Managing agents should document all future management actions which are modelled explicitly within a comprehensive future management actions plan.

### Modelling future management actions

Syndicates should not assume that future management actions would be taken that would be contrary to their obligations towards policy holders and beneficiaries, legal provisions applicable to the syndicate, and/or Lloyd's requirements. Future management actions should be consistent with any public statements that have been made.

Future management actions that could be modelled should reflect actions the managing agent will reasonably take and the time necessary to action these. This might include:

- withdrawal of cover or changes in policy conditions (e.g. for war business); and
- future purchase of reinsurance.

The future purchase of reinsurance may include some uncertainty for agents who assume that reinsurance will be bought in line with the business plan. The managing agent needs to evidence that the Board is involved in the review and approval of the anticipated reinsurance programme for the next year. The anticipated reinsurance programme is likely to have inception dates at various times of the year (for example 1st of January, 1st of April) and there is the risk that in the event of a series of large or catastrophe losses the planned reinsurance programme may not be placed or placed at a higher cost. It is expected that agents can support the planned reinsurance purchases in context of their business and the commerciality of the reinsurance arrangements.

When assessing whether it is appropriate to model a future management action, the agent should consider the materiality of future management actions by calculating their impact on the SCR where practicable.

### Future management actions plan

For any management actions that are assumed in the model, Solvency II requires that managing agents produce future management actions plan that should be documented in line with Solvency II documentation standards. It is the responsibility of the Board to approve the plan and ensure there is a process in place to maintain the action plan. These plans should include:

- Circumstances where the managing agent may not carry out the actions and how these are reflected in the model
- The order that the future actions will be undertaken
- Details of any ongoing work that needs to be completed before the future actions could be undertaken
- How the future actions are included in the Probability Distribution Forecast (PDF)

## Section 3: Statistical Quality Assumptions

### MDI 3.1 Modelling assumptions

Managing agents shall identify material relevant assumptions upon which the model is based.

Managing agents shall ensure that assumptions are realistic and justifiable to Lloyd's by satisfying the following conditions:

- the agent has a suitable and justifiable explanation for the use of assumptions and that this is documented; and
- understanding of when the assumption could be considered false.

In line with the documentation standard, Lloyd's requires all assumptions and expert judgements upon which the model is based to be explained and documented in detail and in a well-reasoned manner, including how expert judgement is challenged and reviewed/monitored against actual experience wherever possible. The extent to which judgement has been applied to assumptions should be clear along with the underlying rationale. The documentation should consider both the significance and uncertainty of the assumption.

Managing agents should identify those model assumptions which are particularly sensitive and critical to the overall SCR figure or other key output such as risk ranking, and the associated documentation should be commensurate with the impact of the model parameter. The process of determining the materiality of assumptions should be evidenced. Lloyd's expects agents to perform sensitivity tests reporting the impact of changes to key assumptions, reporting the results in numerical tables. The sensitivity testing will also form part of the materiality assessment.

When assumptions are set for new business or new risks modelled (including any secondary impacts) then agents consider the impact to the capital required solely for this new business/risk and ensure that additional risk results in additional capital required. The methodology used to derive the assumptions should be clearly documented with the level of detail proportionate to the materiality of the assumption. To ensure the assumptions remain appropriate, a process should exist for assessing the assumptions at regular intervals and updating the documentation where necessary.

Model assumptions regarding diversification effects are regarded as key assumptions and are therefore subject to the requirements of material assumptions. Diversification effects are typically challenging to estimate and validate. The assumptions underlying the approach used for measuring diversification effects on an empirical basis are often based on expert judgement which will require further validation. Sensitivity analysis and stress testing should be performed as part of the validation process. The results of the validation exercise and any additional justification for the assumptions should be clearly documented and readily understood by those responsible.

### **MDI 3.2 Future management actions assumptions**

Managing agents shall be able to verify that assumptions about future management actions are realistic.

Managing agents shall demonstrate that assumptions are realistic by completing the following actions:

- a comparison of assumed future management actions with management actions taken previously by the managing agent; and
- a comparison of future management actions taken into account in the current and past calculations of the internal model.
- Considering the impact of any changes in assumptions on the value of the technical provisions

Agents shall document and be able to explain any relevant deviations in relation to the above points.

Assumptions for future management actions in the internal model should be objective, realistic and verifiable. The assumptions should take account of the time needed to implement the management actions and any expenses caused by them.

Future management actions which are allowed for in the model should be validated, agents should compare assumed future management actions currently allowed for in the model with those undertaken historically. Where these differ, Lloyd's would expect these to be documented and justified.

Significant deviations from planned future management actions should be reported to Lloyd's, along with details of the reasons for the deviation and its consequences for the syndicate's SCR. Lloyd's would expect the model to be re-run in such circumstances, however if the model is not re-run then capital add-ons may apply where additional risk is perceived. Agents should note that such deviations may be deemed inconsistent with the Use Test. Previous deviations from planned management actions will be considered by Lloyd's in deciding whether to approve a new or changed set of future management actions.

## Section 4: Statistical Quality Consistency

### MDI 4.1 Consistency of methodology and assumptions

Managing agents shall use consistent methodology and assumptions.

Managing agents shall ensure that the methodology used for completing the following are on a consistent basis:

- SCR;
- SBF;
- LCM;
- Assets and liabilities for the Solvency II balance sheet; and
- Technical Provisions including contract boundary definitions.

Managing agents should ensure that the methodologies and assumptions used to calculate the output distributions are consistent with methodologies and assumptions seen in other areas. Any inconsistencies should be identified and justified with the potential impact detailed.

The premium volume within the SCR submissions should be consistent with the relevant SBF they accompany. However, the loss ratio assumptions need not be the same as those in the business plan. The principle underlying the business plan review is that loss ratios are "realistic and achievable". The principle underlying the expected loss ratio selection for capital setting is that of a best estimate (i.e. mean) outcome. Although these two concepts have similar goals, the Solvency II best estimate basis for the capital setting loss ratios should not incorporate improvements in performance unless the measures taken have been shown to be effective. Lloyd's considers that only syndicates with a consistent track record of performing to plan can justify the use of SBF assumptions for capital setting purposes. Even with the occurrence of large, isolated events (that are difficult to plan for) average performance should still be shown to be in line with plan over a series of years if the plan assumptions are proposed for use.

The assets in the opening balance sheet in the model should be consistent with the projected balance sheet as at the year end. The volatility in the modelling should allow for the uncertainty associated with the projection of this balance sheet. The methodology used to project the opening balance sheet should be consistent with the reserving practices of the syndicate. Technical provisions should also be subject to discounting at the risk-free rate and after inclusion of the risk margin.

Lloyd's expect that modelled insurance premiums and claims for contracted business (excluding any risk margin) will run-off at the mean at the projected figures included in the opening balance sheet – i.e. no gain or loss arises. Part of the net nil opening balance sheet requirements mean there should be no "reserve margins" on the balance sheet as the Solvency II technical provisions are assumed to be set at pure best estimate and these should be treated as a surplus asset and excluded from the calculation of the SCR.

Agents must have in place a process by which the consistency of methodologies and assumptions can be verified (in particular with respect to business plans and the technical provision calculation process). This process must highlight the areas where there are inconsistencies and should ensure that these are justified and their impact detailed. This process should also review the methodology to ensure credibility is maintained.

## Section 5: Model Results

### MDI 5.1 Reasonable results

Managing agents shall ensure that the model is capable of producing results that are reasonable and respond appropriately to changes in the risk profile over time.

Managing agents shall ensure the following conditions are met:

- in running the model more than once there is stability in results;
- there is a validation process that supports the modelled outputs;
- modelled output can be tailored to different stakeholders and explained sufficiently for Board understanding; and
- there are formal processes to communicate material uncertainties to the Board.

The outputs of the internal model should reflect the risk profile of the syndicate and reflect changes to the risk profile.

Managing agents are required to produce an analysis of change which identifies the drivers of changes in the capital requirement year on year. This ensures that small changes in the input data do not result in large changes to the capital requirement. It also helps demonstrate that the results are reasonable and increases transparency.

Simulation error is common to all models. Lloyd's will not prescribe a minimum number of simulations to be run or a specific way how managing agents should deal with simulation error. However, syndicates are required to ensure that the outputs of the internal model are stable in relation to input data that does not correspond to a relevant change in risk profile. This can mean running a very large number of simulations and minimising simulation error. Syndicates can also run several seed runs and Lloyd's would expect managing agents to select from the "middle of the range" when compiling their SCRs. Lloyd's strongly recommends using a spread-VaR approach to calculate capital requirements and all other numbers in the capital return, using the methodology document to outline the impact of selecting alternative runs / random seeds. Lloyd's would expect managing agents to select a mean or median SCR when finalising their figures.

Lloyd's expects models to demonstrate stability in results.

Validation of the model results, including reverse stress tests is important and ensures that the results are reasonable.

In order to ensure senior management awareness and understanding of the potential for uncertainty there needs to be a formal process to provide an indication of the nature and extent of any material uncertainty inherent in the modelled results which will tend to be presented as point estimates. The uncertainty inherent in point estimates could be indicated through the use of ranges, sensitivity analyses or other quantitative means.

Although the SCR is the key model output used by Lloyd's it is expected that a range of model results are produced and analysed to satisfy reporting requirements and internal analysis.

## Section 6: Internal Model Data

The data standards fall under two categories – the MS11 Cyber Security and Data Management standard and internal model data standards. It should be noted that the first set of standards are contained in MS11 and will not be duplicated here. The standards below purely refer to the internal model data.

### MDI 6.1 Quality Control

Managing agents shall have processes in place to review the systems and controls framework ensuring internal model data is accurate and complete.

Managing agents shall ensure that:

- there is regular exception reporting to identify potential variances or control failures in recording and producing internal model data and these are investigated and escalated as appropriate;
- the quality of internal model data is continuously assessed to ensure accuracy, completeness and appropriateness; and
- the systems and controls framework for internal model data is subject to regular and appropriate internal audit review.

Throughout the production process of data, from recording to reporting, there must be controls in place to ensure the accuracy, appropriateness and completeness of data, which can include, for example, data error reports, validation reports and exception reports. As a further example, exception reports may address unusually large data items, entries with unusual currencies for the syndicate, or blank data fields where information would be expected to have been entered. Many other types of exceptions will be identified by managing agents.

There should be a process of checking the quality of data on a timely, frequent and ongoing basis with due regard to the materiality and the potential risk associated with inaccuracies. Where data entry is outsourced, accountability and responsibility remains with the managing agent who should also have a process of quality checking.

Managing agents are expected to have an appropriate internal audit programme in place. Internal Audit are required to undertake regular reviews of the systems and controls for data for the production of management information and returns to Lloyd's and other appropriate external regulatory and accounting returns. This programme should include:

- Data validation and consistency;
- Data completeness;
- Effectiveness of analysis procedures; and
- Process of converting data to Management Information;

EIOPA guidance gives some insight into the meanings to be ascribed to completeness, accuracy and appropriateness, as applied to data used in internal models and technical provisions.

Accuracy requires freedom from material error, consistency over time and timely and consistent recording.

Completeness requires sufficient granularity and adequate historical information to identify trends and assess data characteristics. Such data must be available for all key risk groups and all relevant data must be utilized.

Appropriateness requires consistency of the data with its uses, that there is sufficient data to exclude undue estimation error. Moreover, the data must not be able to falsify the assumptions made in the internal model or technical provisions calculations, and must appropriately reflect the risks to which the syndicate is exposed.

## MDI 6.2 Data Policy and Directory

Managing agent shall establish, implement and maintain both a written data policy and a data directory for the internal model.

With regard to data used in the internal model, managing agents shall have a data policy and data directory which:

- defines complete, accurate and appropriate in relation to data management;
- defines the frequency of data updates;
- defines the process of using and documenting expert judgement; and
- includes all items of data used in the internal model and calculation of the technical provisions and specify at a minimum:
  - source;
  - characteristics; and
  - usage.
- include explicit reference to other data frameworks, processes and procedures.

### Data Policy

Managing agents must establish a data policy, setting out requirements on data quality and data update. As with all other policies this sits under each managing agent's documentation governance process and changes to this should be informed to Lloyd's based on each managing agent's model change policy. The minimum requirement for the data policy is to cover the scope of the internal model and also technical provisions, if they are not included within the scope of the internal model. It is the choice of the managing agent to define the internal model and the degree to which data standards are applied outside the internal model. Solvency II requirements imply that the data policy should be extended to cover the wider flow of data that feeds the internal model, including source systems and databases.

The data policy should include explicit reference to detailed frameworks, processes and procedures for the collection, processing and application of data. For example, a data policy could specify the requirements that data processes outside the internal model need to meet, in order to feed that data into the internal model. Where the internal model does not include technical provisions, a separate document on the data policy for technical provisions would also be required. Lloyds expects agents to consider whether it may be appropriate to prepare a separate policy for different applications of the data or to create an overarching data policy.

The data policy is a key document and the guidance below provides further detail on the potential contents. This guidance is not intended to be prescriptive but instead provides an example of the potential content.

A data policy document should outline, at a high level, the overall intent of the data within the managing agent. The policy need not cover detailed processes provided that the processes which the agent has in place for checking and validating data quality are documented elsewhere in detail. It would, for example, be reasonable for a managing agent to have one data policy over a number of syndicates so long as the features and issues pertaining to that data were relatively similar.

### Example Data Policy Format

Proposed section header	Example fields
Title page	With managing agent/Syndicate name
Approval record and document history	Document owner, author, date and version number. Person(s) approving the Policy, date and version. Version history, changes made, date and author.
Table of contents	Summary of all headings and sub-headings with applicable page number.

Purpose and scope of the Policy	Why the Policy is needed and its desired outcome? What is in scope of the data policy?
Executive summary	Background (explain the need for the Policy). Business objectives for the Policy. Policy ownership. Key stakeholders, signatories and period for Policy review. Communicating key uncertainty.
Terminology	Interpretation of the following terms to managing agent: Materiality; Consistency; Proportionality; and Accurate, complete, appropriate.
Ownership & controls	Data ownership. Data controls / checks.
Policy maintenance	Policy update process & frequency.
Expert judgement	Definition of expert judgement. Overall view on reliance on expert judgement. Details of who has authority to act in the capacity of an expert, and where the expert judgement can be applied. Details of independent review process.
Data quality and deficiency	Data quality management: <ul style="list-style-type: none"> <li>• Data quality criteria to be applied (including accuracy, completeness and appropriateness);</li> <li>• Details of data limitations;</li> <li>• Data thresholds;</li> <li>• Roles and responsibilities;</li> <li>• Details of data audit processes;</li> <li>• Detailed processes for monitoring and validating data quality;</li> <li>• Data deficiency process;</li> <li>• Roles and responsibilities; and</li> <li>• Reference to other data frameworks, processes and procedures not covered here.</li> </ul> Detailed process for application to external data.
Data update processes	Data update frequency standards: <ul style="list-style-type: none"> <li>• For regular data updates; and</li> <li>• For unscheduled data updates.</li> </ul> Details of process for recording and auditing data updates and adjustments.
Evidencing	Methodology for the validation of data.

	Guidance on appropriateness of validation test.
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The process specifications should include a precise description of the various methodologies in use, the determination of responsibilities and the frequency of application.

### **Data Owners**

It is unlikely that managing agents will be able to achieve and sustain acceptable levels of data quality without formal accountability for data quality. Responsibility for the quality of specific data items and data sets should be assigned to specific "Data Owners". A Data Owner should be someone who understands the meaning and daily uses of the data, with sufficient authority to ensure adequate quality procedures and processes are implemented and followed.

### **Data update**

Data updates should be related to the frequency of model use, but all data must be reviewed at least annually and updated where appropriate. Normally, more frequent updates will be required.

The data update process should be a well-defined and consistent process for refreshing or updating all data items in line with the data policy. The process must include appropriate change controls (automated or manual) that take into account any material impact (individually or in aggregation) on the internal model. MI should be produced to evidence the data update process.

The data policy should include details of the data update process, roles & responsibilities, triggers and any dependencies which may impact the update frequency.

### **Implementation of the policy**

Managing agents should also be able to evidence the practical implementation of the policy across the organisation and the governance around the policy. This should include the frequency of the review of the data policy, associated procedures and standards.

The managing agent should be able to demonstrate that the data policy has been approved by management and has received an appropriate degree of challenge and oversight prior to approval. Where there is inadequate oversight of the development and implementation of the data policy, there is an increased risk of poorly informed decision making and non-compliance with the required quality and standards.

Managing agents must establish and maintain a data directory in order to meet Solvency II standards. It should cover all data used to operate, validate and develop their internal model, specifying source, characteristics and usage at a minimum.

### **Data Directory**

The minimum requirement for the data directory is to cover the internal model related data, however so defined. It is the choice of the managing agent to define the internal model, and the degree to which data standards are applied outside the internal model. However, the data standards, including the data directory, should also apply to the data used in the calculation of the technical provisions. This guidance is not intended to be prescriptive but instead provides an example of the potential content.

The table below summarises the possible template column headings for a managing agent's Data Directory divided into the required elements:

Data directory field	Description
Source	<p>Data Origin: Where the data originated from e.g. broker, assured.</p> <p>Data Storage: Where is the data stored e.g. data warehouse and if there are multiple copies.</p> <p>Data Owner: The Owner of the Data (this may change at varying stages of data use/transformation).</p>
Characteristics	<p>Granularity of the data e.g. line of business level, by year of account and currency.</p> <p>Data Type: What form the data is in e.g. frequency and severity.</p> <p>Currency of data: what currency to store data in, and relevant exchange rates to apply.</p> <p>Data Quality Standard.</p> <p>Data Quality Judgement / Comment: Commentary on quality of the data set i.e. completeness, accuracy and appropriateness.</p> <p>Materiality: A comment of how material is that data set in relation to the total model output e.g. significant driver of the SCR.</p>
Usage	<p>Risk Type: What risk type is this data used to quantify / validate / develop e.g. Insurance Risk.</p> <p>Model Area: More granular use of data e.g. Gross Underwriting Losses.</p> <p>Data Usage: What is the data used for in relation to the internal model i.e. operate, validate or develop.</p> <p>Data transformation: aggregation, augmentation, enrichment and derivation processes.</p>

Lloyd's expects agents to perform a risk and impact (sensitivity) assessment for each data set to identify:

- Whether the impact of poor quality data (individually or in aggregation) on the internal model is material;
- The points in the data flow from source to internal model where likelihood of data errors is the greatest, and therefore, what specific data quality controls are required; and
- Tolerance threshold beyond which a data error could become material (individually or in aggregation).

In addition to the items above, there should be further documentation working through the detail of how data has been adjusted, parameters selected and methodologies chosen.

The directory should be used to help demonstrate other internal model requirements, including but not limited to:

- The consistency of data through clear definitions of data sets (no internal contradictions);
- Identifying data sets for focused demonstration of complete, accurate and appropriate data; and
- Data transparency.

It is important that there is a clearly defined link between the data directory and model change to ensure the data directory remains consistent with model design and development.

Using and producing the data directory should help agents understand the uses and hence the materiality of each data item to the final modelling process and result. This should help ensure that efforts in relation to data cleansing are focused on areas where the most material benefits can be gained. Such a directory should also help agents to understand where data is updated or adjusted using judgement.

The lineage of data is an important concept in demonstrating an understanding of data within the agency. Data directories may include details of this lineage to explain fully the journey that data goes through from the original data entry through to use in the internal model. Each managing agent will decide the most appropriate format for the data directory depending on its specific requirements. The following are all possibilities: relational database, flowcharts, spreadsheets, word-processed documents.

With regards to the data journey, it would be reasonable to draw a dividing line between data up to and including a data warehouse and data used after that point through to use in the internal model. The distinction between the two is the former should be factual with little by way of judgement or interpretation. The latter is subject to these adjustments. Major system / data flows from source databases into the internal model should be understood and documented as part of the overall internal model documentation.

Managing agents may or may not choose to include the former element in the data directory itself. Notwithstanding this, the data warehouse would still be subject to data requirements on documentation and it cannot be assumed that data within the data warehouse is exempt from data validation.

### **MDI 6.3 Data Consistency**

Managing agents shall ensure the consistency of data assumptions used throughout the internal model and in the calculation of technical provisions.

Managing agents shall ensure that:

- assumptions made in collection, storage, processing and application of data must be consistent;
- data is used consistently throughout the internal model and in the calculation of the technical provisions;
- they document where there are inconsistencies in the use of data and justify these; and
- data is used consistently over time.

It is important that data required for different uses is consistent. For example, it is evident that capital requirements are impacted by the size of the balance sheet, and so insurance reserves must be calculated consistently with capital, which includes a requirement for consistency of data across the two areas. The assessment of data accuracy should include appropriate cross-checks and tests as to its consistency with other relevant data and with the same data at different points in time. The expectation is that the same data sets will be used for both the internal model and technical provision calculations.

Lloyd's undertakes validation on data submissions received to check for the consistent use of data. Queries are raised with agents where this is not the case and consideration is taken as to the impact on the agent's compliance with the Solvency II requirements and remedial action needed.

## MDI 6.4 Data Limitations

Managing agents shall document appropriately any material limitations of the data used in the internal model and any resulting adjustments or approximations made via expert judgement.

With regard to data used in the internal model, managing agents:

- shall document data limitations, which will include both weaknesses in data and absence of data;
- may adjust the data to overcome weaknesses, in which case they shall store the original data and document the nature of and reason for the adjustments;
- may use data approximations to overcome limitations, in which case they shall document the nature of and reason for such approximations;
- ensure that expert judgement is appropriately documented and justified; and
- shall ensure that limitations and any resulting adjustments or approximations are subject to appropriate governance oversight.

The data used in the internal model and technical provisions may present limitations and where material these limitations should be documented appropriately. The documentation of limitations shall include:

- A description of the limitation, including information of materiality, duration and impact;
- How such limitations will be remedied where possible; and
- The functions within the governance system of the syndicate responsible for this process and date.

Managing agents are required to document all data limitations both in terms of weaknesses and absences of appropriate data.

In considering the appropriate use of data, in particular where limitations are present, there may be instances where data needs to be adjusted or approximated via expert judgement. Where data is adjusted or approximated, this should be documented – this includes the reason and the nature of these adjustments, as well as documenting and justifying the expert judgement. The managing agent also needs to ensure that adjustments/approximations are subject to appropriate governance oversight.

In particular, data is likely to be adjusted as part of the internal modelling process by way of making historical data appropriate for prospective use.

Some possible reasons for this are:

- past or future management action affecting the portfolio;
- allowance for past and expected future trends;
- changes in terms and conditions of business written;
- changes in the legal environment; and
- changes in inuring reinsurances.

Where data is adjusted or approximated for use in model development, parameterisation or validation the documentation should include the details of the adjustments made and the reasoning behind them. For example:

- what data has been included / excluded and why?; and
- what adjustments have been made for trend, line size etc. and the reasoning behind these.

Where adjustments are required to the data or expert judgement used, then these adjustments should be documented as to the rationale for the adjustment and appropriateness of the expert where judgements are being used.