

Catastrophe Risk Operational Framework (CROF)

Detailed Guidance

Where the CROF builds upon Lloyd's Minimum Standards these are referenced within each of the tables below.

Note on definitions:

The **View of Risk** refers to the Syndicate's representation of natural catastrophe risk, including all models (internal, vendor models etc), adjustments, and assumptions to get to the modelled risk profile. A **model** may refer to a single model that informs the view of risk or supports an application of exposure management.

Where non-EM teams are discussed, other **business functions** are defined as underwriting, claims and reserving, and capital, and any other area that makes active use of EM in informing commercial analysis and decisions.

Culture

Index	Component	Min Std Ref	Basic	Intermediate	Established	Leading
C1	Role of and oversight provided by the Board and senior management	MS6 EM: 6.1 MS4 GOV: 3.1 MS12 USE: 3.1	There is an established risk framework, which includes catastrophe risk and exposure management (EM). There is some but limited discussion on these areas by the Board and senior management ¹ .	There is an established and specific framework for EM, and specific reporting to senior management and the Board. Board and senior management use the view of risk for key decisions.	Senior management and the Board demonstrably understand the model and its limitations, challenging when making key decisions. EM committees meet regularly, have comprehensive and forward-looking coverage, and provide high quality reporting upwards.	The modelled view of risk is widely used in senior management and Board decision making. Senior management and the Board understands, challenges, and actively promotes the development of the view and management of catastrophe risk.
C2	Consistent model usage within the organisation	MS6 EM: 6.1 MS12 USE: 3.1	Awareness of EM varies across different commercial business functions (incl. underwriting). Functions may use high level aggregated model outputs in their calculations, but with little communication between users and the core modelling team. Consistency is considered in the management and approach to catastrophe risk modelling, however it is not well demonstrable.	Some detailed model outputs available across business functions (incl. underwriting) and by product line, with the ability to request additional outputs for specific requirements. Differences between models are understood and acknowledged in the decision-making process.	Internal culture of referencing View of Risk when assessing any risk in any business areas before making decisions. Processes in place to identify and address modelling inconsistencies across the business.	People and processes within team responsible for EM and other business functions are integrated, ensuring feedback loops apply to all areas. Model evolution and roll out of changes works in tandem across all areas. Technical View of Risk (model methodologies, assumptions and granularity) implemented consistently across business functions and purposes.
C3	Internal and independent² review	MS6 EM: 6.4	Independent review takes place as required under minimum standards. Internally, high level ad-hoc reviews take place of EM work.	Regular reviews and reporting processes supported by second or third line independent review. Results of reviews include clear suggested changes.	Regular risk-focused reviews and reporting processes, supported by strong independent review from the second or third line, conducted by appropriately qualified persons. Feedback loops from review actions demonstrably completed.	There is a cycle of targeted / forward looking / deep-dive reviews taking place, with regular follow-ups of all relevant findings to ensure recommendations and improvement points are adopted.
C4	Governance around change management and planning	MS6 EM: 6.2	Model change managed through general SII model change process.	EM model change process has some specific points that capture differences relative to Solvency II model change processes. Some high-level communication of changes and their effects ahead of any release. Well communicated timelines of release schedule.	Effects of internal/external cat model changes clearly documented, covering e.g. description of changes, likely impact on modelling scenarios and validation process and findings for new release. Senior management have sight of changes sufficiently ahead of release to assess potential impacts to pending decisions.	Holistic view of impact of model change on business e.g. solvency, risk appetite, price competitiveness. Any decisions that are made that could be impacted are reasoned with a detailed understanding of the potential impacts, the uncertainty of the changes and the limitations of any associated calculations.
C5	Risk appetite	MS6 EM: 6.1	Risk appetite statements including exposures are in place, aggregate exposures monitored against appetite and reported to senior management and the Board.	EM risk appetites are derived with consideration to View of Risk. Statements inform decision making, and there is a clear link between risk appetite and business strategy.	EM risk appetites are cascaded through the business, across all relevant business functions (incl. underwriting), supported by tolerances and limits, and associated breach management processes. Statements used to inform decision making at each level of the business, within the EM teams and other functions.	Risk appetites clearly embedded at each level of the organisation, changes communicated and used efficiently. Statements may be forward-looking, and reactive to external events, business plan changes, and feedback loops within the Syndicate.

¹ The definition of senior management throughout this framework depends on the business structure of the Syndicate but in general refers to the heads of underwriting, actuarial, finance and claims (or the equivalents of these roles). Heads of other departments (i.e. HR) should be included where it is deemed appropriate.

² Internal is defined as within the team responsible for EM, and independent is defined as outside of this team. The latter may constitute internal audit, or review from individuals in other functions who have sufficient knowledge and experience

Technical

Index	Component	Min Std Reference	Basic	Intermediate	Established	Leading
T1	Model validation including sensitivity testing	MS6 EM: 6.3, 6.4 MS14 VAL: All	Validation exercises are conducted as required under Solvency II standards and requirements, and on an annual basis.	The use of alternative models and assumptions are regularly considered, and model choice decisions are demonstrably validated.	Programme of model change continuously updated, driven by validation work, and material progress made where possible against this programme. Implications on areas of uncertainty from the sensitivities of the model(s) used are well understood.	Feedback from validation (e.g. limitations) linked back to other parts of business such as pricing/reserving/risk management to help with decision making.
T2	Stress and scenario tests	MS14 VAL: 4.4	Mandatory Lloyd's scenarios (e.g. RDS) applied and reported on time. Stress and scenario tests conducted in accordance with Solvency II requirements.	EM stress and scenario tests are designed around risk appetites, includes additional scenarios to prescribed RDS.	Design and use of stress and scenario tests well considered against risk appetite and Syndicate's View of Risk. Implication of results well understood and acted upon. Set of SSTs regularly reviewed.	Design and use of stress and scenario tests supports forward looking assessment of modelling. Stress and scenario tests incorporate input from other business functions and senior management, and support assessment and understanding of EM modelling applications within other functions.
T3	Use of expert judgement	MS13 IM:	Where used, material expert judgement (EJ) is documented and governed in accordance with SII standards.	A wide range of suitable experts are consulted and implemented judgements are reviewed at an appropriate frequency (e.g. if assumptions made for a judgement no longer hold)	Use of EJ is comprehensively governed, with a materiality framework. Material EJs are challenged and justified with reference to alternatives. There is a clear understanding by model users of where EJ is relied upon.	EJs are assessed for appropriateness and included in sensitivity testing. Areas of modelling that utilise EJ are focus areas for future modelling improvements. Consideration/review of accuracy prior EJs, plus forward-looking risk profile considerations, informs current selections.
T4	View of Risk – Approach and Calculation	MS6 EM: 6.1, 6.2, 6.3	View of Risk largely externally-derived and calculated (e.g. direct from external model vendor or broker) along with any mandatory adjustments or based on simple actuarial methods, e.g. frequency and severity curves. If the View of Risk is determined by another entity within the group, it's applicability to the syndicate is understood and challenged appropriately.	Where View of Risk is externally driven (e.g. latest model releases), it is additionally informed by limited analysis of risk profile and loss history.	View of Risk informed by comprehensive analysis of risk profile and loss history, and strong understanding of methodology and assumptions used. The View of Risk develops with loss experience and emerging market and Syndicate issues.	View of Risk is continually being developed/researched, with a programme of work prioritised and continuously linked to material model limitations, emerging issues and new academic research.
T5	View of Risk - Completeness	MS6 EM: 6.1, 6.2	Model completeness is assessed and incorporated into EM modelling and the internal model. Simple approaches used, limited scope (e.g. to standard lines and major geographies).	View of Risk is demonstrably complete. Additional modelling or adjustments take place for key perils, with simpler approaches used in other instances. Approaches are documented and understood.	Modelling or adjustments takes place using EM data for all material perils, supported by comprehensive justification (including of materiality, without reliance on model output).	There is a comprehensive process in place to address data and model completeness, and to ensure the list of modelled perils is appropriate. The process is forward looking and reacts to a changing risk profile or external information, including emerging risks and developing issues.

Application

Index	Component	Min Std Reference	Basic	Intermediate	Established	Leading
A1	Post event processes	MS6 EM: 6.3	Little or simple high-level analysis performed. Loss estimation process is ad-hoc and reactive and estimates and may be difficult/lengthy to produce. Views of likely loss may be inconsistent throughout the Syndicate.	Simple event-response plan in place; analysis of exposures performed, linked to loss projections, and compared to Syndicate's View of Risk Initial reserve estimates are informed by an understanding of model limitations.	Full event-response plan, with clear roles, responsibilities and timelines in place; integration of response and analysis between underwriting, claims and EM staff. Lessons learnt from an event loss implemented.	Additionally: a range of potential outcomes explored; uncertainty communicated; loss estimates typically/reasonably accurate. Event response plan may include elements of model review and a feedback loop to other perils/geographies/coverages.
A2	Reporting	MS6 EM: 6.4	Internal reports are high-level, simplistic and not always timely/regular. External reports inconsistent with or not aligned to internal views. Regulatory returns may be late or contain reporting errors, with governance only applied as required by law/Minimum Standards.	Regular internal reporting to some degree of granularity (class, peril-region etc.), consistent with Risk Appetite framework and considering suitability to audience; external reporting is efficient, timely and/or error-free, with some internal review applied; regulators are informed in advance of issues or missed deadlines.	Regular, timely internal reporting by line of business/class/portfolio and such peril-regions deemed material, with views of multiple metrics, gross and net; external reporting an extension of internal, well-governed and reviewed by multiple levels of management. Modelling and data uncertainties are clearly explained in relation to the intended audience.	(Near) Real-time internal reporting, which can be refreshed and "sliced and diced" ad hoc, possibly showing multiple methodologies and/or views of risk, including projection of future positions. Key uncertainties developed in internal reports. External and regulatory reporting is always timely and accurate, consistent with internal reporting, and reviewed for implications.
A3	Exposure Controls	MS6 EM: 6.4	Exposure controls and limits are in place. Exposure is measured against limits manually and periodically.	Well defined MI and monitoring framework for exposure controls which is linked to risk appetite. Linked to underwriting and underwriting input into the controls.	Additional early warning indicators, clear escalation and defined, governed response in the event of breach.	(Near) Real-time assessment of exposures against limits, including at the point of underwriting. Exposure controls are developed on a forward-looking basis, informed by adherence to risk budgets, comprehensive view of risks on the slip, and including emerging risks.
A4	Risk Transfer / Outwards RI	MS7 RI: 1	Risk transfer decisions are made without explicit reference to risk appetite; impacts are modelled post-placement.	Detailed analysis performed pre-purchase to verify that the net position is consistent with risk appetite.	Feedback loop between analyses and risk appetite and reinsurance strategy. Where structures commercially available, detailed analysis of alternative structures performed pre-purchase to inform decision-making.	Detailed modelling performed to optimise all aspects of risk transfer; range of possible solutions analysed with reference to internal model / capital requirements and business planning, and consistent with portfolio management and risk selection.
A5	Risk Selection & Pricing	MS11 Rate: 3.1, 4.2	Catastrophe risk is included in the pricing of relevant risks.	Catastrophe risk is analysed pre-underwriting for material lines of business and for material peril-regions. Sufficient understanding of the implications of catastrophe model uncertainties by underwriters on deal pricing.	All peril-regions are considered when selecting and pricing risks; catastrophe and exposure analysis is integrated into the underwriting process. Underwriters may feedback to catastrophe modelling team with own view and commercial factors such as competitor pricing.	View of Risk applied comprehensively across underwriting, supported by detailed modelling, and consideration of completeness and emerging perils. Integrated modelling process with other applications, including portfolio management and capital modelling.
A6	Capital Modelling	MS6 EM: 6.2; MS13 IM:	Capital is assessed when required; Internal Model catastrophe risk is parameterised annually, is materially complete, and	Internal Model results are reviewed at regular intervals and where changes in the catastrophe risk profile are identified. Demonstration of Internal Model	Capital implications are an intrinsic part of decision making throughout the Syndicate. Impacts of alternative	Capital implications of catastrophe risk are widely understood and can be modelled ad-hoc and expediently, at portfolio or individual risk level,

			methodology and assumptions meet Solvency II standards	development, or continued appropriateness of methodology as a result of these reviews.	representations of catastrophe risk are modelled before changes are made.	supporting integration with other applications Catastrophe risk within the Internal Model reacts on a forward-looking basis to changes in underwriting strategy.
A7	Portfolio Management and Optimisation	N/A	Portfolio management analysis does not occur or is limited to strategic decisions within the ordinary business planning process.	There is a portfolio management process providing analysis of strategy and profitability. Results inform exposure controls and risk appetite, capital allocation, and underwriting decisions.	Assessments are used by senior management, and updated with changes in the risk profile and external environment. Analysis supports active decisions to optimise portfolio.	Portfolio management analysis embedded into business decisions. May be produced at high level of granularity, and on a near real-time basis, includes analysis being undertaken at point of risk section (i.e. marginal portfolio impact is considered).

Infrastructure

Index	Component	Min Std Reference	Basic	Intermediate	Established	Leading
I1	Technology	N/A	Internal solutions are typically manual processes. There is no central technology architecture design and there is a siloed approach to managing tools.	Tools have been created to access data by stakeholders across different business functions and there is some overlap of functionality of tools created internally by different departments.	There is a well-documented technology architecture design and strategy, with implemented solutions that significantly reduce or replace manual processing.	The Syndicate considers advanced technology solutions to enhance their modelling and MI capabilities (e.g. cloud computing and automated dashboards). There is constant review for improvements and possibilities to future proof processes and functionality. Collaboration between the team responsible for EM and internal and/or third parties to explore solutions development.
I2	Data	MS6 EM: 6.2; MS11 Data: 3.1, 4.2; MS12 Use: 2.1, 4.2	Policies and procedures are in place covering data accuracy, appropriateness, and completeness. Data owners are defined, and some data controls are in place.	Data policy, standards, and procedures exist in more detail. Data quality tools and controls are in place. There is understanding of the potential impacts of data quality issues on modelling and applications.	Data considerations are comprehensively supported throughout the Syndicate, including how to address data limitations across applications of each business function.	Comprehensive and proactive data processes are in place from slip to portfolio level and across business applications. This may be supported by an advanced data quality toolkit and/or (near) real time MI. Syndicate trials and uses new technological solutions to enhance date capture, storage, and quality.
I3	Resourcing	MS6 EM: 6.3; MS4 Gov: 2.2	EM staff have limited experience, or activities are performed by staff with other "day-jobs". Timely/accurate reporting may not always be possible.	EM team members demonstrate good understanding of models and their limitations; resourcing is adequate to meet deadlines, but there may be insufficient resource for longer-term or strategic projects.	Team is well resourced for existing and some future projects, and there is a good mix of skills. Key person dependencies have been identified.	Team is sufficiently and effectively resourced to allow research and development as well as efficient day-to-day activities; key man risks are mitigated, and succession planning considered.