



BERMUDA MONETARY AUTHORITY

CATASTROPHE RISK RETURN GUIDELINES

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I. INTRODUCTION

These guidelines are an update to the Catastrophe Risk Return (Cat Return) guidelines issued in July 2014. This has been amended to provide greater clarity to the concepts that were provided in the original consultation paper and final guidelines.

II. FOREWORD

1. The Bermuda Monetary Authority (Authority) is continuing its programme of regulatory development for the Bermuda marketplace. The objective is a regulatory regime appropriate for the Bermuda market and recognised as meeting or exceeding international standards.

Scope of Application

2. All Insurance Groups, Class 4 and Class 3B insurers¹ have been required to complete and submit to the Authority the Cat Return with an annual filing from 2010 year-end and beyond, except where granted a waiver. All Class 3A insurers writing property catastrophe business were also required to complete and submit the Cat Return from 2011 year-end and beyond. Based on changes to the process and reviewing these returns it was determined that an update to the guidelines was required to further clarify instructions and to make complying with the guidelines easier for insurers.

¹ In these guidelines, insurers include reinsurers.

Waivers

3. Insurers that do not retain catastrophe exposure may apply to the Authority for an exemption from filing or submit a “Nil Return”. In considering the application, the Authority will reflect upon the fact that a number of business lines, outside of property catastrophe, are also catastrophe exposed. Such was reflected in the design of the Bermuda Solvency Capital Requirement (BSCR).

III. CATASTROPHE RISK ASSESSMENT

4. The global insurance market and the Bermuda market in particular, significantly rely upon vendor models to assess catastrophe exposures. If the vendor models underestimate potential losses arising from events, the industry as a whole may have capital levels impacted to a greater extent than expected². Not only is this a strategic and risk management issue for an insurer, it also impacts its regulatory capital requirement since the Catastrophe Risk Charge is generally a significant contributor to this requirement.
5. The Cat Return should set out the extent of such reliance and highlight the actions insurers³ take to mitigate model risk, including a description of procedures and analytics in place to monitor and quantify exposure to vendor models. It also serves as a tool to assist the Authority to assess the reasonableness of inputs into the catastrophe component of the regulatory capital requirement, and whether standards are being applied evenly.
6. The Authority expects insurers to have in place procedures and analytics for monitoring model risk. This may include suitable capital leverage guidelines, based on aggregate information such as exposure, rather than modelled statistics like probable maximum losses (PMLs). All material input assumptions, including the testing of zonal, peril and other risk categorisation dimensions both within and between classes of business, should be challenged.

² The Authority published the “Survey of Economic Capital Modelling Practices in the Bermuda Insurance Market” in December 2008, which discussed vendor models in more depth

³ In these guidelines, henceforth insurer includes an insurance or reinsurance group. For the purposes of this return reinsurance of captives should be considered as insurance.

7. The Authority expects insurers to review their use of Catastrophe models to ensure they are relevant to the exposures written and the various perils and peril regions where catastrophe losses may occur. The validation process as outlined in the Commercial Insurer Solvency Self-Assessment (CISSA) under model(s)/tool(s) used to calculate the CISSA capital should include an assessment that demonstrates the insurers “own view of risk.” This validation can be informed by off-the-shelf vendor models, a properly calibrated open source model and/or an approved internally developed bespoke catastrophe model.
8. The Authority has worked with industry, to review standard metrics for assessing capital requirements. These will focus both on an absolute basis, independently of modelling, and on probabilistic scenarios from catastrophe models.
9. Examples of the types of measures and relationships that the Authority will review to assess catastrophe risk include:
 - a. Examining the rank of PML and Realistic Disaster Scenarios (RDS) against the relative rank of various other cat exposure metrics. Discrepancies may exist in relative ranking which may highlight factors such as:
 - i. Construction of a superior portfolio of risks.
 - ii. Relatively higher or lower attachment point, relative to other markets, and the possibility of exposure to greater model risk.
 - iii. The application of different model mixes by region-peril⁴ and different levels of loss modification applied to gross results.

⁴ Region-peril represents the concept that catastrophe models are built specifically to define catastrophes for a geographical region rather than for a specific country or on the basis that all perils for a region are constructed in one model. Examples of region-perils would include: Atlantic basin hurricane, North American earthquake and European windstorm. Vendor catastrophe models do not currently consistently model the entire region-peril. An example would be Pacific basin typhoon, which is currently not modelled in its entirety for any of the major vendor catastrophe models. While certain countries/regions are modelled, the correlated losses associated with a typhoon hitting successively the Philippines, Taiwan and Japan is not currently calculated.

- b. Assessing the exposure to catastrophes extends beyond the statutory property catastrophe line. The Authority will also look to assess potential for non-accumulated exposure to correlated catastrophe losses.
 - c. Considering an insurer's reinsurance or retrocessional protection against catastrophes, to assess the impact of reinsurance default.
 - d. Examining relative changes of exposure from one year to the next, for consistency and reasonableness.
- 10. The Authority will attempt to review responses in an unbiased manner, examining practice across industry and within peer groups, that seeks to address certain differences between modelling practices (such as the mixing of various vendor catastrophe model severity distributions), while preserving the effects of other factors (such as treatments for data quality, and unmodeled contractual obligations etc.).
- 11. In determining regulatory capital requirements, the Authority may require insurers to run catastrophe accumulations with various minimum multiplicative loss modification factors applied to ground up losses, to more fully account for the non-linear way losses to excess of loss programmes may cause such losses to be magnified (see the Appendix). This is only envisaged if an insurer appears to be deviating substantially from market practice with respect to the level of loss modification factors applied.
- 12. This Cat Return, in conjunction with other risk exposure information submitted in the Capital and Solvency Return, will also be used to assess liquidity. Liquidity risk is not always mitigated simply by holding additional capital. Claims paying ability is obviously an important factor that is perhaps more pronounced with catastrophe risk where large amounts of assets may have to be liquidated to pay claims at very short notice. Additionally, complexities arise with the currency mismatch that may exist between an insurer's assets and a subset of its potential catastrophe liabilities. An insurer should be able to demonstrate that it has considered potential challenges to liquidity, including the methodology and principles used to measure liquidity, contingency plans, access to new funding sources, and projected liquidity requirements.

13. Examples of the types of measures that the Authority may use to assess liquidity risk include:

- a. Examining Gross and Net PML and RDS returns as a function of quoted government investments adjusted for any encumbrances;
- b. The ratio of effective asset duration to effective liability duration; and
- c. Consideration of asset and liability correlation for certain scenarios where it is likely that the often assumed independence of these items will collapse. Examples might include terrorism events or large losses in Japan and the impact on the dollar-yen exchange rate.

IV. STRESS AND SCENARIO TESTING

13. Insurers should be capitalised at a level to withstand the impact of a combination of extreme but not inconceivable adverse events. A well run insurer will have comprehensive stress and scenario testing procedures to monitor capital adequacy in adverse scenarios as part of its risk management framework. These include procedures to undertake, review and, where appropriate, react to the results of rigorous, forward-looking stress and scenario tests that identify possible events or cyclical changes in market conditions that could adversely impact an insurer's earnings, liability or asset values.

14. The Authority's current regulatory reporting includes a number of standardised stress tests, and the BSCR model implicitly incorporates stress testing as well. These stress tests currently focus on economic and natural catastrophes. It was decided during the BSCR design phase in 2007 that manmade catastrophes (e.g. terrorist acts) would be assessed outside the model. The Authority will use the Cat Return as an instrument to augment its existing regime by introducing an assessment of terrorism exposure.

V. PUBLICATION

15. In addition to assessing the reasonableness of PML components generating the Catastrophe Risk Charge contribution to the regulatory capital requirement and liquidity risk arising from catastrophe risks, the Authority proposes to use the Cat Return as a source for the publication of aggregated catastrophe modelling practices within the Bermuda market.
16. The Authority believes that this would not only enhance its reputation as a leader in the regulation of catastrophe markets, but the increased transparency should benefit the Bermuda market generally as stakeholders are educated with respect to the quality of modelling on the island.

VI. COMPLETION OF THE CAT RETURN

17. The Cat Return will be embedded in the Capital and Solvency Return to eliminate duplication in the submission of information, and to simplify the annual regulatory reporting process by allowing companies to complete a single file template to satisfy their obligations for risk reporting.

VII. GUIDELINES FOR COMPLETING THE CAT RETURN

18. The Cat Return contains the following sheets:
 - a. Company information;
 - b. Exceedance probability curve sheets:

- i. EP Curve Total⁵; and
 - ii. EP Curve Insurance.
- c. Exceedance probability curve sheet for the following region-perils:
 - i. EP Curve Atlantic Basin Hurricane;
 - ii. EP Curve North American Earthquake;
 - iii. EP Curve European Windstorm;
 - iv. EP Curve Japanese Earthquake; and
 - v. EP Curve Japanese Typhoon.
- d. Region – Peril Exposure to Zones and Statutory Lines of Business;
- e. Accumulations Overview;
- f. Data Analysis;
- g. Reinsurance Disclosures;
- h. Insurance Terrorism Exposure;
- i. Reinsurance Terrorism Limits; and
- j. Assumed Exchange Rates.

19. Specific guidance notes in respect of each sheet are provided in the remainder of this document. Should an insurer have any questions on these guidance notes or any other aspect of the Cat Return, it may contact the Authority for further instruction. In addition to the guidance notes provided in this document there are comments inserted within the excel spreadsheet to aid companies in completing the return.

20. The following definitions relate to various sections of the Cat Return:

- a. “Modelable” - Exposure that can be run through a vendor catastrophe model or the insurer has built a proprietary model to specifically model the exposure.

⁵ It is anticipated that the EP Curve Total would include losses from all natural perils exposures assumed on a combined basis across all insurance, reinsurance and other risk assumption operations (such as ILS, cat swaps etc.).

- b. "Not-modelable" - Exposure that cannot be run through a vendor catastrophe model or where there are no catastrophe models that assess the region-peril under consideration.
- c. "Data deficient" - Data limitations that prevent the exposure from being run through a vendor catastrophe model. This may be due to the resolution of the data or the completeness of the data, which for other reasons is not good enough to produce credible modelling results.
- d. "Model deficient" - Vendor models cannot process the vast majority of the exposures.
- e. "Modelled" - Risks that the insurer was able to model, and so appear in its PML. Non-modelled would be the opposite and so does not appear in the PML apart from a loading to the catastrophe model.
- f. "Property catastrophe" means the "property catastrophe" statutory line of business.
- g. "Other" statutory lines of business refer to all statutory lines other than property catastrophe.
- h. "Proportional" - Throughout the Capital and Solvency Return means business written by an insurer (primary writer) and its reinsurer where the reinsurer's exposure attaches at the same layer as the insurer and losses are shared in a proportional manner, such as quota or surplus share contracts.

Exceedance Probability Curve Sheets

21. The Authority is requesting an Exceedance Probability (EP) Curve for the insurer covering exposure to loss from all insurance and reinsurance operations including the impact of any Insurance Linked Securities (ILS) investments, catastrophe swaps, Industry Loss Warranties (ILW) and other non-traditional risk assumption/mitigation techniques for the following:

- a. EP Curve Total (all natural perils combined);
- b. EP Curve Insurance (all natural perils combined); and

- c. EP Curve for the following region-peril:
 - i. Atlantic basin hurricane;
 - ii. North American earthquake;
 - iii. European windstorm;
 - iv. Japanese earthquake; and
 - v. Japanese typhoon.
22. The “EP Curve Total” shall consist of all natural perils combined. The responses from the “EP Curve Total” worksheet are carried through to the “EP Curve Insurance” worksheet as appropriate. Where there are differences in response, the insurer may modify the response on the “EP Curve Insurance” worksheet.
23. The Authority will require an EP Curve for insurance on aggregated region-perils when the percentage of insurance net premiums to total net premiums written is greater than 10%.
24. The Authority will require insurers to provide EP Curve information on all the region-perils outlined in paragraph 21c. The losses should include the total losses for each event considering the correlation of those losses. For instance, Atlantic basin hurricane losses should include the total losses for each event considering the correlation of losses from hurricanes from exposures within the Caribbean, Mexico, the USA and Canada (but not necessarily be limited to losses from these territories). This should include all sources of probable losses including, but not limited to, offshore energy and marine losses in the Atlantic and Gulf.
25. North American earthquake losses would include accumulated losses in an event from exposures within the US, Mexico and Canada (but not necessarily be limited to losses from these territories). This should include all sources of probable losses including, but not limited to, aviation exposures arising from business interruption caused by earthquakes rendering runways unusable at major airports in earthquake zones, workers compensation including personal injury caused by the earthquake and marine cargo losses at ports.

26. Where the Authority has questions or concerns it may ask for additional information including permutations of the various perils, vendor models, business segment or gross/net perspective. The Authority may also request additional returns should comparability with other market participants be difficult.

Definitions and Illustrations on EP Curves

27. The following definitions and illustrations are associated with the EP Curves:

- a. “Gross per occurrence TVaR⁶ (USD \$M)” - This represents the Tail Value at Risk (TVaR) which should be calculated gross of reinstatement premiums due on inwards reinsurance business written and gross of any reinsurance recoveries. The occurrence loss distribution will be determined by:
 - i. Selecting the largest individual occurrence loss from each year from the catastrophe model for Schedules X(a), X(b) and X(c). Schedule X(a) refers to the entire portfolio, both insurance and reinsurance, Schedule X(b) refers to insurance only and Schedule X(c) refers to region peril events.
 - ii. Ordering the series of the largest annual occurrence losses in descending order.
 - iii. Allocating exceedance probability and return period according to the specifics of the catastrophe model used in the construction of the occurrence distribution.
- b. “Gross aggregate TVaR (USD \$M)” - this represents the TVaR which should include the creation of an aggregate distribution of losses for Schedules X(a), X(b) and X(c). Also this should be calculated gross of reinstatement premiums

⁶ TVaR is the conditional expectation of values at and beyond the stated return period requested. Gross TVaR should be gross of reinstatement premiums if any are due on inwards reinsurance business written and gross of any reinsurance recoveries. Net TVaR should be net of reinstatement premiums if any are due on inwards reinsurance business written and net of any reinsurance recoveries due (themselves net of any reinstatement premiums payable). In addition to including the impact of traditional reinsurance and retrocessional protection, net TVaR responses should include the benefits from catastrophe bonds, catastrophe swaps, industry loss warranties and other non-traditional risk mitigation transactions.

due on inwards reinsurance business written and gross of any reinsurance recoveries. For example for Atlantic hurricane the 50 year Gross aggregate TVaR (USD \$M) would be the expected gross loss in millions of US dollars gross of reinstatement premiums for all losses from Atlantic hurricane only. This should include all Atlantic hurricanes that occur in each year, considering the total annual losses from Atlantic hurricanes for all years equal to and less frequent than 50 years on the aggregate distribution.

- c. “Net per occurrence TVaR (USD \$M)” - this represents the TVaR which should be net of reinstatement premiums due on inwards business, if any, and net of any reinsurance recoveries due (themselves net of any reinstatement premiums payable). In addition to including the impact of traditional reinsurance and retrocessional protection, responses should include the benefits from catastrophe bonds, catastrophe swaps, industry loss warranties and other non-traditional risk mitigation transactions. Intra-group reinsurance protections should be considered such that where recoveries are received by one legal entity from another legal entity within a group structure, the losses are appropriately passed to the legal entity providing reinsurance from those receiving protection. The effect will be that only the aggregate group losses remains since the intra-group reinsurance will be netted off. The occurrence loss distribution is to be determined by:
 - i. Selecting the largest individual occurrence loss from each year from the catastrophe model for Schedules X(a), X(b) and X(c).
 - ii. Ordering the series of the largest annual occurrence losses in descending order.
 - iii. Allocating exceedance probability and return period per the specifics of the catastrophe model used in the construction of the occurrence distribution.
- d. “Net aggregate TVaR (USD \$M)” - This represents the TVaR which should include the creation of the aggregate distribution of losses for Schedules X(a), X(b) and X(c).

Also this should be net of reinstatement premiums due on inwards business, if any, and net of any reinsurance recoveries due. In addition to including the impact of traditional reinsurance and retrocessional protection, responses should include the benefits from catastrophe bonds, catastrophe swaps, industry loss warranties and other non-traditional risk mitigation transactions. Intra-group reinsurance protections should be considered such that where recoveries are received by one legal entity from another legal entity within a group structure, losses are appropriately passed to the legal entity providing reinsurance from those receiving protection. The effect is that only the aggregate group losses remains since the intra-group reinsurance will be netted off.

For example, for Atlantic hurricane the 50 year Net aggregate TVaR (USD \$M) would be the expected net loss (net of reinstatement premiums and net of any reinsurance recoveries (themselves net of any reinstatement premiums due)) for all losses from Atlantic hurricane only including all Atlantic hurricanes that occur in each year, considering the total annual losses from Atlantic hurricanes for all years equal to and less frequent than 50 years on the aggregate distribution.

- e. “Annual average aggregate gross loss (USD \$M)” and “Annual average aggregate net loss (USD \$M)” would be the annual average aggregate losses over the entire year from all contracts taking into consideration participation shares and reinstatement terms for the region-peril under consideration.
- f. “Standard deviation of annual aggregate gross loss (USD \$M)” and “Standard deviation of annual aggregate net loss (USD \$M)” would be the standard deviation of annual aggregate losses over the entire year from all contracts taking into consideration participation shares and reinstatement terms for the region-peril under consideration on a gross and net basis respectively.
- g. “Total statutory gross property catastrophe premium modelled (USD \$M)” and “Total gross all other premium modelled (USD \$M)” should be gross of upfront

reinsurance premiums paid and correspond to the statutory lines of business specified in the Capital and Solvency Return.

- h. “Total statutory net property catastrophe premium modelled (USD \$M)” and “Total net all other premium modelled (USD \$M)” should be net of upfront reinsurance premiums paid only and correspond to the statutory lines of business specified in the Capital and Solvency Return.

Limits Exposed

For the “EP Curve Total” and “EP Curve Insurance” the Authority requests eight limits exposed one each for the permutations of gross/net, modelled/not-modelled and statutory property catastrophe/all other lines of business respectively.

Limits exposed should be calculated as the sum of all limits providing contractual protection, and all limits for insurance basis respectively. Where business is not subject to an aggregate or occurrence limit, the insurer should include the premium in the cells provided on a gross and net basis (“Total gross premium without an occurrence or aggregate limit”, “Total net premium without an occurrence or aggregate limit”).

Where total insured values are not determinable (for lines of business such as worker’s compensation for example) insurers should include the premium in the cells provided on a gross and net basis (“Total gross premium with non-determinable TIV”, “Total net premium with non-determinable TIV”).

For the following fields:

- a. “Total net statutory property catastrophe limits exposed (USD \$M) - modelled”;
- b. “Total net statutory property catastrophe limits exposed (USD \$M) – not modelled”;
- c. “Total net all other lines limits exposed (USD \$M) - modelled”; and
- d. “Total net all other lines limits exposed (USD \$M) – not modelled”.

Net exposure limits should only differ from gross limits for any proportional reinsurance placed. No consideration should be taken for any excess of loss reinsurance protecting an insurer's gross exposure.

EP Curve Total and EP Curve Insurance

28. For the “EP Curve Total” and “EP Curve Insurance” sheets the Authority requires insurers to provide additional information on the following:

- a. Significant sources of catastrophe risk and associated loss;
- b. Assumed reinsurance;
- c. Pools and assessments;
- d. Supplemental perils and model options; and
- e. Other adjustments information.

Significant sources of catastrophe risk and associated loss

29. The Authority would expect that all significant sources of catastrophe risk and associated loss are included in the loss estimation techniques employed by the insurer. The following factors can have significant impact on varying loss potential and as such it is important that the Authority clearly understands what is reflected within the insurer’s loss estimates and the variation in practice across industry.

- a. Allocated loss adjustment expense;
- b. Property – buildings;
- c. Property – contents;
- d. Additional living expenses;
- e. Business interruption;
- f. Auto physical damage;
- g. Workers’ compensation;
- h. Personal accident;

- i. Life insurance;
- j. Onshore Energy;
- k. Offshore Energy;
- l. Ocean marine;
- m. Inland marine;
- n. Flood;
- o. Crop; and
- p. Other primary insurance.

30. Consistent with the general closed form nature of the questions in the Cat Return, these factors all include drop down menus with appropriate choices. The Authority asks insurers to select the appropriate choice from the drop down menu that best describes the situation for the insurer. Depending on the factor, the following responses are felt as reasonable choices:

- a. Yes;
- b. Yes - supplementing vendor models where required⁷;
- c. Yes - only where vendor models incorporate;
- d. No - not material or applicable; or
- e. No.

31. The Authority would expect insurers to have a reasonable and objective method of determining whether items are not material or not applicable though may seek to understand this process from time to time. The Authority would also expect insurers to include in the validation of the catastrophe models in the CISSA a discussion of the methods used to supplement vendor models and in assessing whether vendor models incorporate all the insurers risk with sufficient robustness.

⁷ Vendor catastrophe models may not be able to model all exposures or all possible supplemental perils to a primary peril. For example, catastrophe exposure to per risk exposures can be difficult to model due to either insufficient detail on the individual exposures or because the region-peril is not supported in a catastrophe model. Similarly, 'fire following earthquake' may not be modelled in a country though there may be potential for this loss, or a peril may have the potential to cause correlated loss in countries that are not modelled as the modeller has only modelled those countries deemed to present the most significant risk.

32. For answers of “No” an additional question appears which seeks an explanation for why the factor has not been included.

Assumed Reinsurance

33. In general, with few exceptions, open market reinsurance (as distinct from intragroup transactions) includes contractual features which limits catastrophe exposure regardless of the form it is assumed⁸.
34. The Authority envisions that much of the intra-group reinsurance is structured around optimising capital structure. Often quota share transactions with parent or group affiliate companies are written with terms that are usually not available in the open reinsurance market, for example many intra-group quota share reinsurance covers have far higher occurrence caps for catastrophe exposures than are normally provided in intragroup transactions.
35. The Authority anticipates that each return provided by an insurer will include all exposures to catastrophe as appropriate for the various region-perils across all lines of business. This includes all the different products which may vary in their concentration to catastrophe exposure but nevertheless are exposed to these losses. Given the potential for capital adverse events to affect many contracts, it is important that the Authority understands the comprehensiveness of the return in this respect. As such the Authority explicitly asks whether quota share, surplus, catastrophe, per risk and any other forms of coverage are included in the return period distribution provided.

Pools and Assessments

36. For many reinsurance contracts, pools and assessments⁹ are an explicit contractually covered exposure. However the modelling of these exposures is slightly more

⁸ The main exceptions include some Japanese proportional property business (largely provided on earthquake specific quota share or surplus treaties) and some continental proportional property business (generally providing unlimited exposure only on European windstorm, not earthquake).

⁹ Voluntary/involuntary pools and assessments feature in many coastal states as a solution for homeowners who cannot get insurance for some reason. The specifics vary from state to state, but broadly insurers will receive an assessment every year for

complicated and requires diligent attention to detail by insurers and indeed may require approximations given the lack of detailed information available on the actual exposures of the pool. The Authority wishes to understand the comprehensiveness of the return in this respect given the disproportionate contribution to losses that these exposures can cause. For instance the tendency for pool exposures to consist of less well built construction and/or buildings with a closer proximity to the coast in the case of wind pools.

Supplemental Perils and Model Options

37. The Authority considers that, under best practices, loss estimates provided and considered by an insurer would ideally include as comprehensive an attempt as possible of correctly assessing the true impact of correlated losses associated with a given peril. These include considerations for model features such as supplemental perils¹⁰ and model options as well as considerations to overcome the limitations of catastrophe models.
38. The Authority recognises that catastrophe models have limitations in the ability to model supplemental perils and some exposures or policy types. However, the Authority is mindful that some insurers have considered and constructed methodologies for addressing these limitations¹¹. For example, when Hurricane Katrina produced losses associated with the flooding of Lake Pontchartrain, none of the major vendor models modelled this at the time.
39. Given the potential magnitude of supplemental perils and the non-uniform treatment of these perils across industry, it is important for the Authority to understand the specific

losses associated with this pool based upon their market share. These pools have a tendency to be populated with the above average risks from either a construction or hazard perspective.

¹⁰ Supplemental perils are perils that are possible consequences of a “primary” peril which have the potential to cause correlated losses from an event. For the primary peril earthquake, fire-following and sprinkler leakage are supplemental perils that are modelled, however it can be argued that tsunami is also a supplemental peril which is not currently modelled by the major vendor modellers. For the primary perils of hurricane and European windstorm, storm surge is a supplemental peril. Like fire following and sprinkler leakage, storm surge is not modelled in all region-perils nor for all geographical exposures nor for all policy types within some region-perils.

¹¹ The Authority published the “Survey of Economic Capital Modelling Practices in the Bermuda Insurance Market” in December 2008. Appendix 3 “Modelling for Property Catastrophe Business” discusses methods to overcome these and other vendor models limitations.

practice of each insurer. As a result the Authority requests information on the detail of how insurers are handling supplemental losses and non modelable exposures.

40. The “Atlantic Multi-decadal oscillation selection”, enquires on whether an insurer has used near-term event sets or long-term event sets. Near-term event sets reflect the perception of a prolonged period of higher than average temperature for the Atlantic Ocean, associated with the heightened phase of the Atlantic Multi-decadal Oscillation (AMO). Long-term event sets average over several cycles of the AMO and have a lower frequency of hurricanes than near-term event sets.

Secondary uncertainty is a part of the total volatility of the loss estimates and is associated with the distribution around the estimate of damages caused to an exposure in a modelled loss event.

The Authority would expect insurers to use Secondary uncertainty as the default position.

Deviations from the default position would be expected to be justified in the validation of portion of the CISSA under models(s)/tool(s) used to calculate the CISSA capital.

Other Adjustments Information

41. The Authority recognises that insurers make a variety of adjustments to catastrophe model exposures to address several factors such as non-modelled contractual obligations, perceived model deficiencies and perceived data deficiencies.
42. Adjustments for “insurance to value” might be made where an insurer feels the submission it has received is exposed to underinsurance for whatever reason.
43. The following definitions /examples are associated with other adjustments:
- a. “Adjustments for exposure growth” - for a risk or portfolio where no prospective change is expected, this might just be an adjustment in insured values for the impact of inflation. For risks or portfolios proposing significant growth or contraction this would contemplate the growth/contraction and any impact of inflation.
 - b. “Supplemental losses for non-modelled line of business” - certain vendor models do not incorporate the ability to run all types of exposure through the model or data is not received in a format that allows the models to be run. In these cases,

companies may use various methods to incorporate this exposure within the vendor model framework, allowing consistent consideration and treatment to other exposures. Examples might include aviation and marine exposure to earthquake, hurricane or fire following, or property per risk exposures where individual location information is not available or where a vendor model does not have a detailed model.

- c. “Adjustments for model deficiencies – severity” - certain vendor models do not incorporate the ability to model all possible sources of loss associated with an event. In these cases insurers may use various methods to incorporate the potential for loss within the vendor model framework, allowing consistent consideration and treatment of exposures. Examples might include fire following earthquake in most of Europe, losses associated with auto exposures, user tables for workers compensation severities or other supplemental perils where not modelled by a vendor model.
- d. “Adjustments for model deficiencies – frequency” – recognition of the AMO was scientifically introduced in 2005 but was not considered pertinent in the context of catastrophe modelling until after the middle of the 2005 hurricane season. Several insurers implemented frequency adjustments to their implementations of hurricane risk in advance of the catastrophe modelling companies’ implementation in mid-2006. This would qualify as a pertinent example of “Adjustments for model deficiencies – frequency”.

In situations where a significant change of risk is perceived, such as the recognition of the heightened potential exposure to terrorism after 9/11, the change in the view of hurricane risk after 2005, and the recent changes in US earthquake risk by the US Geological Survey (USGS), it is anticipated that insurers will use the frequency and severity adjustment sections to reflect any changes insurers may make in advance of the release of new vendor models versions which incorporate this new view of risk.

- e. “Average loading factor applied to ground up loss for all adjustments applied” - This ideally would be calculated as the ratio of:

$$\frac{\text{Ground up loss including all insurer adjustments applied to insurer's share of losses}}{\text{Ground up loss excluding all insurer adjustments applied to insurer's share of losses}} - 1$$

Assessment of these adjustments is aimed at capturing the aggregate impact on a ground up basis of:

- a. Adjustments for exposure data quality deficiencies;
- b. Insurance to value adjustments;
- c. Adjustments for exposure growth;
- d. Supplemental losses for non-modelled line of business;
- e. Adjustments for model deficiencies - severity;
- f. Adjustments for model deficiencies – frequency;
- g. Additional demand surge loadings; and
- h. Other factors for prudence.

44. It is also recognised that certain factors may be handled in a variety of ways¹². For example, adjustments for exposure data quality deficiencies may be carried out on the underlying exposure data or on results. Data cleansing procedures carried out on the exposure data that corrects a lack of information in the base exposure data should be treated as being part of the baseline model. Data quality deficiencies that are compensated for by changing the results of a model simulation should be reported as part of the modification factor.

45. The Authority recognises that there are a variety of modifications that can be made to modify the data for any number of conditions. The modification factors that are reported are used to understand how the model is used and perform benchmark comparisons on model usage. Definitions as to what is included in the modification factors are important to ensure consistency in how the Authority interprets the reported modification factors. It

¹² In this regard, insurer adjustments would not include supplemental perils modelled by a vendor model, but would include modifications for supplemental perils which are contractually covered but not modelled by a vendor model. Similarly demand surge, as modelled by a vendor model, or secondary uncertainty, as modelled by a vendor model without adjustments would not be included in this consideration. For the Atlantic basin hurricane peril this would not include the change in loss implied in moving from a long-term frequency assessment to a near-term frequency assessment.

is expected that the baseline includes all appropriate exposures and switches for fire following, storm surge ... as would be appropriate for the exposures modelled. The base should also be calculated with unmodified damageability functions. If an open source model is being used, this would be the base damageability supplied with the model or in the absence of it, a comparison to the base functions of a vendor model used to inform/calibrate the internally used damageability functions.

46. The Authority recognises that this item may be difficult to assess for some companies on an exact basis due to the different systems and data captured across industry. To the extent this is not answerable for certain permutations (such as for the insurer as a whole - all perils and insurance) or is not able to be determined strictly on an exact basis, the Authority would like insurers to estimate this quantity and note the method accordingly in “Is this average loading factor determined analytically or estimated?”

Region-Peril Exposure to Statutory Zones and Lines of Business

47. The Authority requires insurers to indicate which statutory zones and statutory lines of business they are exposed to with regards to the region-perils (paragraph 21c) by way of “Yes/No” selection. Data validation messages have been included to assist insurers in completing this section.
48. The Authority does recognise that the zonal definitions do not provide an exact match to the underlying region-peril catastrophe exposures. For example Atlantic hurricane exposure may emanate from offshore energy exposures may be included in Zone 13 as might Mexico. Consequently, all exposures not included in zone 1 to 12 should be included in Zone 13.

Accumulations Overview

49. This worksheet is aimed at getting an overview of the accumulation methodologies main features, including which catastrophe models are used, how frequently accumulations are conducted, etc. In most cases, the Authority feels the questions are relatively straightforward. However some clarification is appropriate for some questions, e.g. “Are

insurer's pricing and accumulations fully consistent?" is asking whether the annual expected loss that is implied in the accumulations is identical and equal to the annual expected loss pick made at the time of underwriting.

50. Blended portfolios refer to the creation of a portfolio view of risk by combining multiple catastrophe model results. Blending will typically also occur at the time of underwriting and may include the creation of a blended model expected loss to each contract¹³.
51. The Authority recognises the possibility that various regions, lines of business or even insurance and reinsurance operation practices may have different approaches within an insurer.

Data Analysis

52. Objective data quality assessment methodologies or tools may not be in place for all region-peril models provided by a vendor model provider. As such, while the Authority recognises that assessing data quality has been considered in a number of ways, it feels it is more important at this point to understand the comprehensiveness of data capture by insurers and their corresponding ability to consider the data in their accumulations and pricing. For the purposes of this worksheet, insurers should answer on a basis consistent with their accumulation practice queried and presented elsewhere in this return.
53. This section of the Cat Return aims broadly to capture how much risk is modelled by insurers versus not modelled. For both modelled and non-modelled exposures, an understanding of how the exposures are considered in the accumulations is sought. The quality of modelled exposure data is also queried, examining factors on a contract count basis and on a limits basis.
54. The Authority feels that the appropriate splits on which to examine data capture are as follows:
 - a. US-specific contracts: all exposures - This would consider all exposures included in an insurer's returns under statutory zones 1, 3, 4, 5, 6, 7 and 11; and

¹³ Blending might involve having individual specific catastrophe model choices for each region-peril (e.g. AIR for US hurricane, RMS for European windstorm and EQECAT for worldwide earthquake etc.) or having specific proportions defined by region-peril or for each specific contract (e.g. 50%:50% AIR:EQECAT for US hurricane, 100% RMS for European windstorm, 25%:75% AIR:EQECAT for worldwide earthquake, etc.).

- b. All other contracts: all exposures - This would consider all exposures included in an insurer's returns under statutory zones 2, 8, 9, 10, 12 and 13.
- 55. The Authority recognises that this may be a difficult worksheet for companies with internal systems that have not been designed to record and handle the type of information requested. The Authority supports the recent emphasis on data quality and capture, and believes that monitoring this information is important.
- 56. Given the desire to examine this information, but acknowledging the difficulty for some insurers currently to analyse and report on their data in this way, the Authority will allow insurers to complete this worksheet to the best of their ability.
- 57. Where an insurer is unable to answer a data return point¹⁴, the Authority requests that the insurer input a statement of explanation. The Authority anticipates that it may not be able to foresee all potential issues insurers may have and is thus open to discussion on insurer approaches if this outlined solution is difficult.
- 58. The Authority will tend to look more favourably on insurers that are able to provide either answers to this worksheet or similar management assessment reports.
- 59. For business that does not include an occurrence cap, the Authority suggests that insurers should include the total insured value if known. If the total insured value is unknown or the insurer feels that a more appropriate method of including this exposure exists than including the total insured value, it is asked to explain how these exposures are included in the return information provided.

Reinsurance Disclosures

- 60. The Authority seeks to understand for reinsurance or retro purchased the types of purchases that are made. In particular, the Authority seeks information on whether protection against natural catastrophe loss is obtained by:

- a. Insurance-Linked Securities (ILS) protection;

¹⁴ For example, insurers may not be able to provide the modelable contract count for US-specific contracts, or perhaps can only respond on a total basis without the ability to separate responses into what are effectively US all exposures and all other exposures.

- b. Industry loss warranties (ILW) contracts;
- c. Other contracts and non-traditional methods of risk mitigation/assumption;
- d. Property catastrophe contracts;
- e. Catastrophe swaps;
- f. Property per risk contracts;
- g. Property retro contracts;
- h. Quota share contracts; or
- i. Surplus share contracts.

61. The Authority feels that the appropriate splits on which to examine data capture are as follows:

- a. US-specific contracts - This would consider all reinsurance or retrocession where the contracts are exposed to statutory zones 1, 3, 4, 5, 6, 7 and 11 only;
- b. Worldwide contracts - This would consider all reinsurance or retrocession where the contracts are exposed to statutory zone 12 only; and
- c. All other contracts - This would consider all reinsurance or retrocession where the contracts are exposed to statutory zones 2, 8, 9, 10 and 13 only.

62. For business without an occurrence or aggregate cap, the Authority requires insurers to provide details on each specific contract in the data entry point provided, detailing for each the premium ceded, a description of the underlying lines of business covered, territorial coverage limitations and details of the natural, manmade and pandemic perils covered under the contract.

63. To the extent a contract will not fit into the aforementioned categorisation, insurers should assign the contract to the most appropriate category, and describe the nature of the contract and where it has been assigned.

Terrorism

64. The Authority believes it is appropriate to consider terrorism exposure, in both absolute terms and for realistic scenarios of loss. For purposes of this return, the Authority seeks to measure absolute exposure with realistic scenarios of loss requested in other documentation.

Insurance Terrorism Exposure

65. For insurance business that has terrorism exposure, the Authority requests exposure on conventional terrorism exposure and on Nuclear, Biological, Chemical and Radiological (NBCR) terrorism exposure separately at different levels of geographical resolution reflecting the differences in perceived size of footprints of these events.

66. For conventional terrorism, the Authority requests exposure information on the ten largest 150m accumulations of exposure to conventional terrorism losses on a gross basis. The exposure calculation should include all exposures within the 150m radius and assume a total loss to insurance commitments within the 150m radius¹⁵. For the purposes of determining the largest exposure from a ranking perspective, insurers should consider the “Direct terrorism property exposure (\$'s M) – gross” for conventional acts of terrorism in determining the descending list of exposure to select the top ten exposures. For conventional terrorism exposures information is requested on:

- a. Latitude of accumulation centroid;
- b. Longitude of accumulation centroid;
- c. Zip code/Postcode;
- d. State/Province;
- e. Country;
- f. Direct terrorism property exposure;

¹⁵ The largest total insured value is to be determined by successively moving a 150m circle across the exposure portfolio to determine the maximum amount of exposure within a circle of 150m radius to all exposures on a gross basis.

- g. Total gross exposure¹⁶;
- h. TRIP or other sovereign terror pool recoverables if any;
- i. Reinsurance recoveries if any; and
- j. Target location.

67. For NBCR terrorism, the Authority requests exposure information on the ten largest US states or countries outside of the USA for accumulations of exposure to NBCR terrorism losses. The exposure calculation should include all exposures within the US states or outside of the USA and assume a total loss to insurance commitments within the area. For the purposes of determining the largest exposure from a ranking perspective, insurers should consider the “Total gross exposure” in determining the descending list of exposure to select the top ten exposures.

For NBCR terrorism exposures information is requested on:

- a. US State or country outside of the US;
- b. Direct terrorism property exposure;
- c. Total gross exposure;
- d. TRIP or other sovereign terror pool recoverables if any; and
- e. Reinsurance recoveries if any.

¹⁶ Total gross exposure would be the sum of:

- a. Direct terrorism property exposure;
- b. Indirect terrorism property exposure - standard fire policy states;
 - i. Historically, a policy form was developed and widely adopted for fire insurance which became known as the standard fire policy. Currently this policy is available in 28 states and originally allowed no exclusions on the cause of fire. Subsequent to the September 11 2001 attacks insurers realised the potential losses that may accrue through these policies given the inability to exclude fire following a terrorism event on this policy form. Substantial lobbying by various insurers and industry groups has had limited legislative success with ten of the standard fire policy states allowing exclusions for fire following a terrorism. However there is still terrorism exposure on standard fire policies issued in California, Georgia, Hawaii, Illinois, Iowa, Louisiana, Maine, Missouri, Nebraska, New Jersey, New York, North Carolina, Oklahoma, Oregon, Rhode Island, Washington, West Virginia and Wisconsin. The term "indirect property exposure - standard fire policy states" refers to the fact that while not necessarily the direct focus of a terrorist attack there is indirect terrorism exposure in these states that should be considered.
- c. Indirect property exposure – other;
 - i. “Indirect property exposure – other” would include exposures where there is no explicit terrorism exclusion on the insurance policy.
- d. Value of lives exposed; and
- e. Other insured exposures.
 - i. “Other insured exposures” would include any other form of insurance offered where the insurer might reasonably anticipate a terrorism loss.

68. Information should be provided on a gross basis with possible recoveries from TRIP¹⁷ and other reinsurance on a separate basis in order to consider both gross and net exposures. For the purposes of this worksheet, insurers should assume that any reinsurance is in force as if no terror events had occurred previously in the preceding year.
69. Where insurers are uncertain of loss the exposure (e.g. due to issues with data quality within a given 150m radius for the conventional terror return, or within a US state or country for the NBCR terror return) this should be included within the accumulations on a best effort basis.
70. Direct terrorism property exposure would include all terror specific insurance written.
71. For any benefits that are dependent on the value of life, assume all benefits are death benefits appropriate for the exposure under consideration. Where death benefits are not provided include the benefits with the largest coverage provision.
72. Target location¹⁸ information is requested to allow the Authority to easily identify the approximate location of concern. While there is considerable debate as to which targets might or might not be at heightened risk of terrorism, the Authority does acknowledge these concerns. If there are no perceived targets, insurers should note accordingly in this field.
73. Where the information submitted, includes multiple values (such as zip code/postcode), insurers should include all possible data if possible.
74. It is intended that the “TRIP or other sovereign terror pool recoverables if any” column should be completed for other terror pools where there is sovereign government backing which would ensure the recoverability of this form of reinsurance¹⁹.

¹⁷ TRIP is the Terrorism Risk Insurance Programme enacted on 26th December 2007 when the Terrorism Risk Insurance Programme Reauthorization Act of 2007 was signed into law. This extends the Terrorism Risk Insurance Act through 31st December 2014.

¹⁸ In this context target location can be considered the nearest target location as defined by any of the vendor models or other internal/external databases of locations perceived particularly prone to terrorism risk. Often these are considered “trophy” locations (such as the Rockefeller centre, Trump tower, US Capitol building etc.) or have other factors which make them significant from a terrorism perspective (such as bridges, power stations etc.).

¹⁹ For the purposes of this return exposures covered under Pool Re or other similar industry solutions where ultimately there is an explicit sovereign government backstop should be considered sovereign recoverables. All other industry pools without a sovereign government backstop should be included in “Reinsurance recoveries if any”.

Reinsurance Terrorism Limits

75. For reinsurance business that has terrorism exposure, the Authority requests information on the ten US States or countries outside of the US with the most reinsurance limit at risk to terrorism when considered across all lines of business exposed on a gross basis. For the purposes of determining the largest exposure from a ranking perspective, insurers should consider “Total gross reinsurance limits exposed to terrorism” in determining the descending list of exposure to select the top ten exposures.
76. The Authority does acknowledge that the information capture by insurers and the transfer of that information to reinsurers may not be transparent especially with respect to details on the exposures assumed. Therefore, reinsurers offer terrorism coverage that could expose them to theoretical potential of loss contractually. Where strict determination of the geographical limitations of exposure from terrorism to a reinsurance contract cannot be determined or is not contractually excluded the Authority requests that reinsurers include 100% of the terrorism limit provided within each US state and outside of the US for the purposes of this aggregation exercise.
77. Details on the ten largest exposed US States or country outside of the US are requested separately for conventional and NBCR acts of terrorism. The Authority requests details on:
- a. The US State or country outside of the US;
 - b. Direct reinsurance limits exposed to terrorism;
 - c. Total gross reinsurance limits exposed to terrorism²⁰;
 - d. TRIP or other terror pool recoverables if any; and
 - e. Reinsurance or retro recoveries if any.

²⁰ Total gross reinsurance limits exposed to terrorism would be the sum of:

- a. Direct reinsurance limits exposed to terrorism – gross;
- b. Indirect property reinsurance limits exposed to terrorism - standard fire policy states;
- c. Reinsurance limits exposed to terrorism – other;
 - i. “Reinsurance limits exposed to terrorism - other” would include all limits where there is no explicit terrorism exclusion on the reinsurance policy for all underlying subject business (so including but not limited to property, worker’s compensation, life, personal accident etc.).
- d. Direct life exposed reinsurance limits; and
- e. Other reinsurance limits exposed to terrorism.
 - i. “Other reinsurance limits exposed to terrorism” would include any other form of reinsurance offered where the reinsurer might reasonably anticipate a terrorism loss.

78. “Direct reinsurance limits exposed to terrorism” includes all terror specific reinsurance coverage provided by the reinsurer²¹.
79. Information on limits exposed should be provided on a gross basis with reinsurance and other protections to be accounted for separately in order to consider both gross and net exposures. For the purposes of this worksheet, insurers should assume that any reinsurance is in force as if no terror events had occurred previously in the preceding year.
80. It is intended that the “TRIP or other sovereign terror pool recoverables if any” column should be completed for other terror pools where there is sovereign government backing which would ensure the recoverability of this form of reinsurance²².
81. For any benefits that are dependent on the value of life, assume all benefits are death benefits appropriate for the exposure under consideration. Where death benefits are not provided include the benefits with the largest coverage provision.

Assumed Exchange Rates

82. The Authority is aware that significant changes in exchange rates may occur throughout the course of a year. In order to avoid distortions associated with exchange effects, the Authority requests information on all exchange rates assumed in compiling the “Exceedance probability information” section of the “EP Curve Total” sheet.

Exchange rates should be input for:

- a. \$:EUR
- b. \$:GBP
- c. \$:Yen

²¹ This would include all terror specific reinsurance protections, including but not be limited to all property specific reinsurance, worker’s compensation specific reinsurance and other life specific reinsurance contracts specifically providing reinsurance for terrorism. Additionally terror specific reinsurances protecting multiple lines of business should be included here, for example a TRIP retention protection or a property and life combined protection within one reinsurance contract should be included here.

²² For the purposes of this return exposures covered under Pool Re or other similar industry solutions where ultimately there is an explicit sovereign government backstop should be considered sovereign recoverables. All other industry pools without a sovereign government backstop should be included in “Reinsurance or retro recoveries if any”.

d. \$:CHF

For any other currency please use \$:Other (specifying Other in column B) as appropriate.

Please input rates in the form such that the \$:GBP rate on December 31, 20XX, was

\$1:GBP1.447.

VII. APPENDIX – ILLUSTRATION

Losses as calculated by catastrophe models are considered from a number of financial perspectives. The first financial perspective that is calculated is the gross loss. An example of this is the total financial loss to a building, ignoring any terms of an insurance policy. The first financial perspective to consider insurance policy terms is the "ground up loss". This will consider the impact of any deductible, limit and co-insurance that are contractually part of the insurance for an individual insurance policy. Catastrophe models will aggregate the ground up losses from multiple buildings and associated insurance policies that are covered in a portfolio (for example the entirety of an insurer's book of business) in order to calculate the total losses associated with an event. This is the loss before catastrophe reinsurance.

Reinsurance companies apply various loading factors to address components of loss they anticipate either for contractual reasons (e.g. allocated loss adjustment expense is contractually payable but not modelled by the catastrophe models) or to address their perceived deficiencies in the catastrophe models (e.g. fire following earthquake where this is not modelled). These factors have a non-linear impact on reinsurance losses - so a 10% increase in ground up losses will not necessarily cause a 10% increase in losses to a reinsurance treaty.

Numerical example:

An earthquake causes a gross loss of \$100,000 on a \$1,000,000 building. Given an insurance policy with a 2% deductible this equates to a \$20,000 deductible with \$80,000 being subject to the insurance policy.

Looking at all the policies in the insurer's book of business, the catastrophe model calculates a total loss of \$100M from the earthquake. No losses are calculated for fire following, though these losses are anticipated. A reinsurer might include a 7% load for allocated loss adjustment expense and a 10% load for anticipated fire following losses (increasing ground up losses by 17.7% in total) resulting in a total ground up estimated loss of \$117.7M.

To illustrate non-linearity, a reinsurer providing cover of \$50M XS \$90M, this cumulative loading of 17.7% may increase its obligation from \$10M to 27.7M or a 177% increase in losses.