



BANK OF ENGLAND
PRUDENTIAL REGULATION
AUTHORITY

General Insurance Stress Test 2022

Scenario Specification, Guidelines and Instructions

To be finalised in May 2022

DRAFT FOR FEEDBACK FROM PARTICIPATING FIRMS

January 2022

Note: The Bank may decide to delay or not to run the exercise depending on market conditions.

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Introduction

This document provides instructions for completing the PRA's General Insurance Stress Test (GIST) 2022.

The previous exercise was conducted in 2019, with the results published in June 2020¹.

For the 2022 exercise, we have made some notable changes as set out below.

We have removed the following components:

- general insurers will not be asked to run an economic downturn scenario in 2022. Instead the GIST 2022 scenarios will only focus on the liability risks. All liability scenarios will be separate, with no additional overlays;
- general insurers will not be asked to provide details of their exposures by sectors.

We have reclassified the cyber scenario from “exploratory” to “core”:

- following an exploratory cyber scenario in GIST 2019, this exercise includes a set of core cyber underwriting scenarios. The implication of this reclassification is the intention to publically communicate aggregate sector results. Consequently, consistency and cross firm comparability will be important.

We have added a request for additional qualitative details that inform our view of a firm's stress test governance and risk management:

- in addition to the data templates, firms will be asked to provide the PRA with a “Results and basis of preparation” (RBP) report. The RBP report will require firms to set out their governance process and quality assurance in completing this exercise, as well as to provide a narrative around the results, including the conclusions, limitations, data or modelling issues and firms' own approach to validation of the results.

For completeness, the overall structure of the documents provided is as follows:

- this document provides the instructions for completing the quantitative templates;
- the quantitative templates provide participants with the output that needs to be provided for each material scenario;
- the RBP provides participants with the qualitative information that firms will need to submit.

¹ <https://www.bankofengland.co.uk/-/media/boe/files/prudential-regulation/letter/2020/insurance-stress-test-2019-feedback.pdf>.

Objectives

The PRA has three objectives in conducting this exercise:

1. **Assess sector resilience to severe but plausible adverse scenarios:** For life insurers, we are focussing on the consequences of severe disruption in financial markets, affecting both rates and market liquidity, followed by an additional longevity shock. For general insurers, we are focussing on natural catastrophes and cyber events.
2. **Guide supervisory activity:** the process of stress testing yields valuable information about a firm's potential vulnerability as well as modelling and risk management capabilities. It might for example, highlight shortcomings in excessive reliance on liquidity in particular financial markets or exposure levels for certain perils which have not been highlighted by the firm's monitoring systems. We will follow up any such findings in our assessment of key risks at firms and in setting supervisory priorities and work plans.
3. **Enhance the PRA's and firms' ability to respond to future shocks (support capacity building):** The information we gather enhances the PRA's ability to run desk based analysis of new shocks and be better prepared to assess sector resilience and respond in the event of similar scenarios occurring. Aggregating responses to questions about management actions will allow the PRA to plan better to mitigate the collective, systemic impacts of such actions, and will support firms in understanding the potential market implications of their decisions.

The GIST 2022 results will guide supervisory activity and focus; it is not a pass/fail exercise.

Entities in scope

Participants have been selected on the basis of expected significant exposure to one or more of the proposed scenarios. See **Annex 2** for entities in scope for this exercise.

Where firms have not received a request to participate, they do not need to submit a response. Should firms wish to be included in the exercise, they should contact their supervisor at the PRA, copying in IST.2022@bankofengland.co.uk.

Structure of the general insurance stress test

This exercise consists of two parts:

- Section A contains a set of three natural catastrophe scenarios;
- Section B contains a set of four cyber underwriting scenarios.

Section A: Natural catastrophe scenarios

Scenario A1: A set of US hurricanes scenario, comprising of three events.

Scenario A2: A California Earthquake scenario comprising of two severe earthquake events in northern California.

Scenario A3: A UK windstorm and flood scenario comprising of two UK windstorm events and one UK inland flood event.

Section B: Cyber underwriting scenarios

Scenario B1: A “cloud down” scenario exploring the impact of the largest Cloud Service Provider (CSP) suffering a catastrophic outage from a cyber attack.

Scenario B2: A “data exfiltration” scenario assessing the extent of underwriting losses triggered by large data loss across multiple sectors.

Scenario B3: A “systemic ransomware” event testing the impact of underwriting losses from a large ransomware event.

Scenario B4: A cyber attack on the shipping navigation systems causing disruption to global supply chains.

In addition, we will ask the firms to provide details of their own cyber underwriting scenario if the loss for such scenario is larger than in any of the PRA scenarios in Section B.

The PRA has designed these scenarios, including all parameters and calibrations, for the purpose of this stress testing exercise only. Firms should not interpret them as indicators of a PRA position on risk calibrations.

Accounting and reporting

Accounting Basis

Firms are requested to provide a separate submission, on a Solvency II basis, for their relevant legal entity as set out in **Annex 2**. Where firms are uncertain as to the scope of their submission, they should consult with and obtain the agreement of their PRA supervisor.

General description

The stress testing data templates have been developed in Microsoft excel. Data requested in the finalised templates will be submitted to the PRA via the BEEDS portal (see section “Process and Feedback”).

In the data template provided with these instructions, the following worksheets are included:

- firm info (basic information about the firm or Lloyd’s syndicate);
- summary (key metrics for each scenario);
- 2021 Balance sheet (Solvency II balance sheet and analysis of basic and eligible own funds);
- capital (diversified capital requirements allocated to standard formula risk categories);
- 2022 Projection (planned movement in basic own funds for the year ending 31 December 2022);
- 7 Scenario-specific data templates (recording the effect of the 3 cat scenarios and 4 cyber underwriting scenarios); and
- reinsurers (data on the participant’s top 40 reinsurers).

General basis of preparation

Unless otherwise stated, financial amounts should be stated in GBP millions. Other quantities should be given to the nearest whole number, and percentages to 1 decimal place.

The sign convention for the 2021 balance sheet and Capital worksheets should match the following quantitative reporting templates (QRTs) as applicable: S.02.01 (balance sheet), S.23.01 (own funds), and S.25 series (SCR analyses).

In the projection and scenarios:

- inflows, gains, and amounts which increase net assets should be recorded as positive;
- outflows, losses, and amounts which decrease net assets should be recorded as negative.

Translation of foreign currencies: The 2021 balance sheet and capital worksheets should be completed on the same basis used in the year end S.02 and S.23 QRTs. The 2022 Projection and scenario specific data templates should be prepared using the same method and assumptions used in the firm’s own base case projections and disclosed in the RBP report. The 2022 projection and scenario data templates include a row to record net foreign exchange translation gains and losses.

2021 Balance sheet

This is presented on a Solvency II basis and should match the amounts reported in the year end QRTs, except for differences due to rounding. The worksheet derives basic own funds from balance sheet net assets using adjustments which should match those recorded in the S.23 QRT. A

breakdown of basic, ancillary and eligible own funds by tier is also requested. The worksheet includes the row and column references of the relevant QRTs.

Capital

This analyses the SCRs at 31 December 2021 (opening) and at 31 December 2022 (closing) by risk categories and records the Lloyd's ECA if applicable. The opening SCR should be consistent with the SCR reported on the year end 2021 S.25 QRT. The closing SCR should be an estimate which is consistent with the base case projection for the year ending 31 December 2022. The closing SCR should be on a "best endeavours" basis and a model run for this recalculation is not mandatory. The risk categories specified are those of the standard formula SCR. Internal model firms should report an allocation to those risk categories which is consistent with their internal model outputs, representative of simulation outcomes around the 1 in 200 level.

2022 Projection

This shows the projected movement in basic own funds between 31 December 2021 and 2022, using a format based on UK GAAP financial accounting. The 2022 projection should be consistent with the firm's business plan and the basic own funds as at 31 December 2022 associated with that plan (Base case projection).

The movement is divided into three sections:

- a technical account which is to capture all items for which Solvency II requires the future cash flows to be included in the best estimate in claims and premium provisions, together with risk margin and discounting movements;
- a non-technical account to capture investment return, changes to pension obligations, any other items of non-technical operating income and expense, and taxation; and
- other movements in net assets. These include movements in own funds items issued or redeemed, and the costs of servicing own funds items (eg interest on sub-ordinated debt). The effect of any transitional measures and adjustments (where approved), and other adjustments which are specifically required by the Rulebook and delegated regulation in arriving at basic own funds (eg own shares and foreseeable distributions) should be made here.

The non-technical account in the projection would normally follow IFRS recognition and valuation because under the Solvency II regulatory framework, IFRS is the default treatment for most assets and liabilities other than technical provisions. Amounts in the non-technical account will therefore be similar to the equivalent amounts in the financial statements, except for a firm which does not use fair value in the calculation of unrealised gains and losses, and for movements in deferred tax.

The technical account will differ from the equivalent amounts in financial statements prepared under UK GAAP or IFRS4. Under Solvency II there are no adjustments for unearned premium or deferred costs; the best estimate of claims expected and expenses associated with the premium provision need to be included, and all costs associated with the administration of insurance contracts, including eg investment management expenses, need to be recognised on the same basis that they are included in the Solvency II best estimate.

Opening basic own funds from the working in the balance sheet worksheet are linked to the 2022 projection and added to the projected movement to give the projected closing basic own funds.

The 2022 projection is the baseline for the Natural Catastrophe scenarios against which the effects of these are to be assessed, and the projection is carried forward to the scenario worksheets (see “Scenario Specific Data Templates” section).

Scenario Specific Data Templates

A Scenario worksheet and a Specific data worksheet is provided with tabs for each scenario.

The scenario worksheet uses the projection format to record the impact of the scenario on basic own funds. Three columns are provided to analyse separately: the losses caused directly by the stress; any consequential reassessment of unexpired risk, and any management actions. The scenario worksheet is prepared on a Solvency II basis and the effect of discounting and of any adjustments to the risk margin and tax from the scenario are recorded on this worksheet.

Firms should calculate any adjustments to tax using their Solvency II basis, and use the RBP report to explain any material differences which would result if loss relief assumptions for IFRS purposes were used.

The natural catastrophe scenarios (Section A) are assumed to occur during 2022 and their impacts are assessed on the projected own funds at 31 December 2022. The starting point for these scenarios is therefore the 2022 base case projection.

The cyber underwriting scenarios (Section B) are assumed to be instantaneous and to occur at the beginning of 2022. The impacts of these scenarios are therefore assessed on the basic own funds as at 31 December 2021.

Unexpired risk which may require reassessing in the cyber underwriting scenarios will correspond to the premium provision carried in the balance sheet immediately after each instantaneous stress.

Unexpired risk in the natural catastrophe scenarios will correspond to insured losses arising between the catastrophe and 31 December 2022, together with the premium provision carried in the balance sheet at 31 December 2022.

Where there is likely to be a material change to the SCR post stress, firms are asked to provide an estimate of the post stress SCR on the scenario worksheet. Firms should make reasonable assumptions eg scaling is acceptable where it would not lead to materially different results to a more detailed calculation. Furthermore, changes in risk margin can be approximated when estimating the post stress SCR.

The specific data worksheets are to provide further analysis only of the losses caused directly by the stress. The loss data should be undiscounted and stated before any adjustments to the risk margin or tax.

Management actions

Firms should disclose in the RBP report what management actions they anticipate taking in the various scenarios and how this would impact their Own Funds and their projected SCR.

For example, these could include changes to their reinsurance programme and likely cost allowing for reinsurance rate increases where relevant, expected changes to their underwriting strategy, changes to premium rates they would charge and changes to their asset allocation. While some of these management actions will impact the year-end 2022 Own Funds, the full impact may not be captured.

Where firms anticipate re-capitalisation plans, they should provide this information, but should not assume new capital will be in place before year-end 2022 unless existing contractual arrangements allow for this. Details of any such contractual arrangements should be included in the RBP Report.

Reinsurance

Firms should identify their top 40 reinsurers (ranked according to the expected recoveries following each of the scenarios in this exercise). For each identified reinsurer, firms will need to provide details of the LEI and LORS codes as well as the jurisdiction and LEI of the ultimate parent of the reinsurer.

The amount of expected reinsurance in each scenario should be reported in the individual scenario tabs.

Materiality

Firms should complete all scenarios unless they can demonstrate that, given their specific risk coverage, the impact is immaterial. In this case, immateriality is defined such that the loss before allowance for any reinsurance is less than 5% of total 2022 projected gross written premium at the reported entity level.

In addition, we expect any insurer writing standalone cyber to complete a minimum of two of the cyber scenarios, even if they fall below the threshold.

Process and feedback

Submission of data template

Participants will be expected to submit the data templates via the BEEDS portal. All firms should ensure that they are able to log onto and use BEEDS. Please refer to the [BEEDS User Guide on the Bank of England website](#) for details.

Post feedback / consultation phase of the GIST 2022 process, we will issue further guidance on firm-specific data templates submission.

Submission of Results and Basis of Preparation report

The RBP should be provided in either a Microsoft Word document or PDF. Additional supporting material (i.e. additional documentation or spreadsheets) can be submitted with appropriate cross-referencing to the main document.

Resubmissions

Firms should ensure that the quantitative and qualitative information provided is clear and sufficient. Where this is not the case, the PRA will ask for a resubmission to enable it to make an adequate assessment. Firms will need to provide a resubmission within two weeks of request.

Public Disclosure

The PRA will not publish any firm specific information as part of this exercise. Where there is a need to take firm specific supervisory action, the PRA will do so as part of our normal supervisory engagement with the firm.

The PRA intends to publish a Dear CEO letter containing our findings at an aggregate level, drawing attention to sectoral findings or learnings of interest at a market level.

Queries

All queries should be submitted to IST.2022@bankofengland.co.uk, copying in the firm's PRA supervisor. Please ensure that the Firm Name and FRN number is included in the subject of the email.

Enclosures

- | | | |
|----|-------------------------------|---|
| a) | GIST 2022 Template.xls | Structured data template |
| b) | RBP Report | Results and Basis of Preparation report |

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Section A – Natural catastrophe scenarios

1. Scenario A1: US hurricane set of events

The US hurricane scenario is comprised of three events. The first event impacts Florida with a significant surge component; the second is a tropical cyclone precipitation-induced flooding event in the Gulf; and the third is an Ike-like event with significant inland penetration. This scenario will assess firms' modelling capabilities for storm surge, precipitation-induced flooding, and hurricane losses stemming from inland states.

1.1 Event definition

This scenario is similar to the 2019 US hurricane scenario which includes three major hurricane events making landfalls in different regions along the US coastline in the same hurricane season. At today's values, the three hurricanes are specified to cause a total industry loss in excess of US\$210 billion, based on a range of vendor model event IDs. Firms are to assume that the hurricanes are sufficiently separated in time to be considered as three separate events for the purposes of reinsurance recoveries.

1.2 Assumptions

In estimating the gross loss, firms should allow for storm surge, precipitation-induced flooding, policy leakage (across different Lines of Business) and post loss amplification (demand surge). Firms should assume that the time between events maximises the potential for post loss amplification. For this scenario the estimate of post loss amplification should include any specific estimate of the impact from the Assignment of Benefits.

Where firms are using external vendor models, firms should adjust the model output to address any relevant model limitations to reflect firm's own views.

Firms should assume events fall under the same reinsurance treaty year, that any changes made to the reinsurance programme do not incept before the first event occurred, and should include the impact of both inwards and outwards reinstatement premiums. Where additional reinstatements or back-up covers are purchased, firms should quantify the likely rate increases and should not factor in reduced attachment points without adequate justification.

In modelling the gross and net impact of the scenario, firms should include the impact of both inwards and outwards reinstatement premiums and the impact of any profit commission clawback.

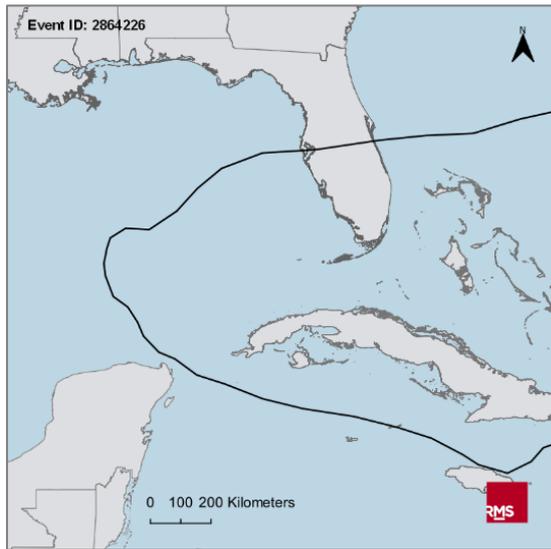
Firms should consider what management actions they may take following and between the events. These include changes to their reinsurance programmes, changes to their planned premium income or rating structures, and re-capitalisation plans. The cost of these actions, to the extent appropriate, should be allowed for in the estimation of the Own Funds as at the year-end 2022, with adequate descriptions in the RBP report.

1.2.1 First hurricane: Event impacting Florida with a significant surge component

The first hurricane is an event with significant surge losses near Tampa, Florida. The event forms in the Caribbean and makes landfall near Tampa as a category 3 storm on the Saffir-Simpson scale (description based on one vendor model provider - refer to **Annex 3** for figures illustrating tracks

from other model providers). The figure and table below provide further details of the hurricane’s landfall.

Figure 1.1: First hurricane track



Source: RMS. Refer to Annex 3 for figures from other model provider(s).

Indicatively, the resulting industry loss is assumed to be in excess of US\$60 billion according to the vendor model providers, with 18-20% of the overall industry loss stemming from storm surge. The closest matching vendor model event IDs, estimated industry losses, and details of the hurricane’s landfall are provided in the table below.² Loss estimates include demand surge/post-loss amplification. The PRA is aware that the event footprint, associated parameters and industry loss differ across vendor models.

Table 1.1: First hurricane – further details (wind and surge only)

	AIR	CoreLogic	RMS
eventID	270042404	17502	2864226
Gross Market Loss (US\$ billion)	69	64	60
Storm surge losses (%)	18	20	18
Saffir-Simpson Category	2	4	3
Central Pressure (mbar)	948.2	935.0	967.0
Maximum Wind Speed (mph)	126.5	140.0	116.0
Forward Speed (mph)	12.9	9.0	19.0
Landfall Longitude (degrees)	-82.74	-82.61	-82.74
Landfall Latitude (degrees)	27.97	27.55	27.80
State	FL	FL	FL
County	Hillsborough	Manatee	Pinellas

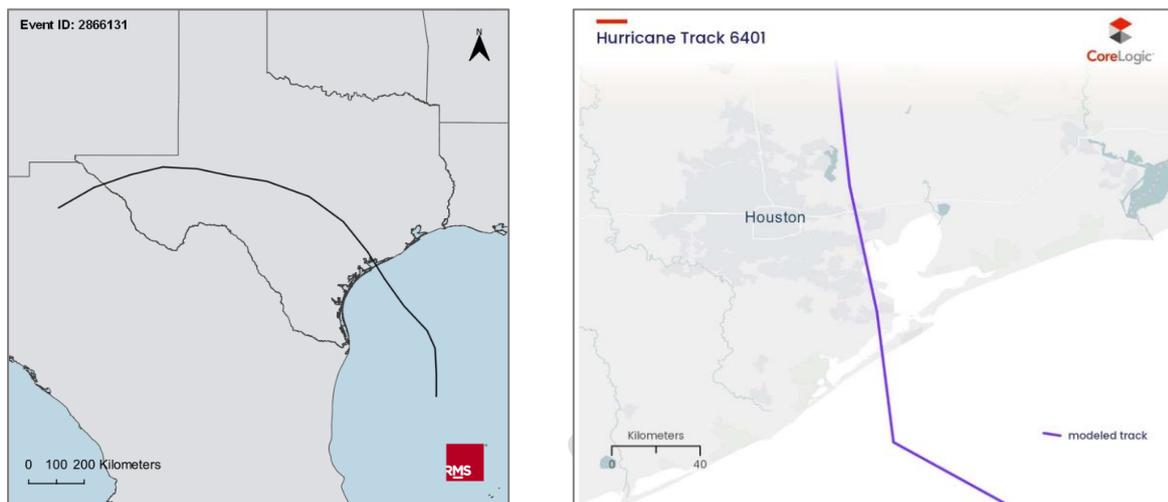
1.2.2 Second hurricane: A Tropical Cyclone Precipitation-induced Flooding event in the Gulf

The second hurricane is similar to the equivalent one included in GIST 2019, which permits the PRA to compare the evolution of firms’ resilience, modelling capability and exposure handling for a tropical cyclone precipitation-induced flooding event. This event makes landfall in Matagorda, Texas, as a category 4 (description based on one model vendor provider - refer to **Annex 3** for figures illustrating tracks from other model providers). The storm moves slowly across Texas with a duration

² The PRA may provide inputs from additional model vendors for the final version of the document.

of 54 hours, leading to a significant precipitation-induced flood losses along its path. The hurricane is assumed to cause losses across the Gulf of Mexico before making a US mainland landfall. Whilst the event is exploring the material precipitation-induced flood losses, the hurricane is also assumed to lead to surge and wind losses.

Figure 1.2: Second hurricane track



Source: RMS (left) and CoreLogic (right). Refer to Annex 3 for figures from other model provider(s).

Indicatively, the resulting industry loss is assumed to be in excess of US\$37 billion according to the model vendor providers, which is split between ~40% of wind and storm surge damage and ~60% of precipitation-induced damage. The closest matching vendor model event IDs, estimated industry losses, and details of the hurricane’s landfall are provided in the table below.³ Loss estimates include demand surge/post-loss amplification. The PRA is aware that the event footprint, associated parameters and industry loss differ across vendor models.

Table 1.2: Second hurricane – further details

	AIR	CoreLogic	RMS
eventID	270012741	6401	2866131
Gross Market Loss (US\$ billion)	37	40	40
Precipitation-induced Flood Losses (%)	55	46	61
Saffir-Simpson Category	4	4	3
Central Pressure (mbar)	929.2	942.0	975.0
Maximum Wind Speed (mph)	148.6	139.0	125.0
Forward Speed (mph)	5.9	16.0	13.0
Longitude (degrees)	-95.68	-94.93	-96.20
Latitude (degrees)	28.73	29.22	28.46
State	TX	TX	TX
County	Matagorda	Galveston	Matagorda

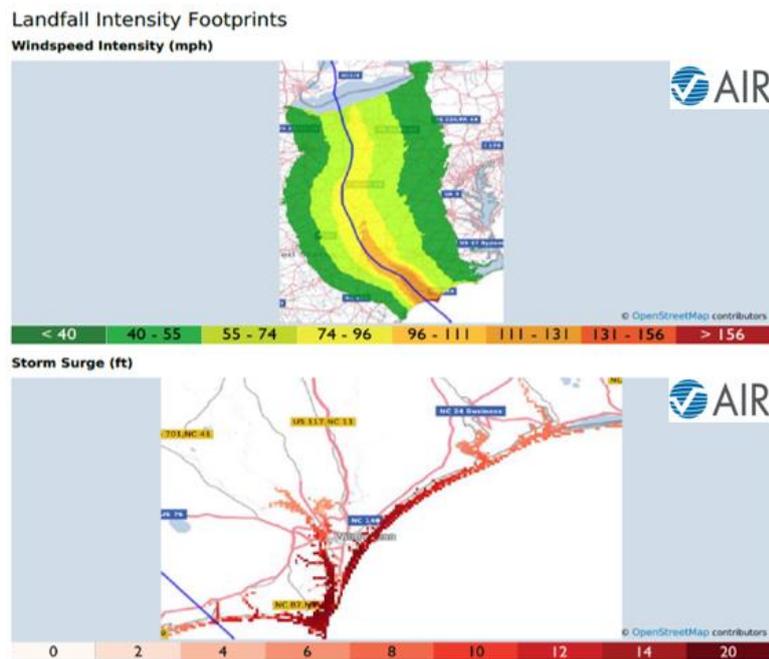
Where firms do not licence or use an inland flood model, firms may use alternative methods such as realistic disaster scenarios or pro-rate the wind and storm surge damage proportionally, providing an outline of the methodology adopted in the RBP report.

³ The PRA may provide inputs from additional model vendors for the final version of the document.

1.2.3 Third hurricane: Ike-like event with significant Inland Penetration

The third hurricane is a major event with significant inland penetration. The map below illustrates a modelled track for this Category 5 hurricane making landfall in Brunswick, North Carolina. After making landfall, the storm is merged with an inland storm system (similar to storm Ike or Sandy), maintaining damaging wind speed tracking through Virginia as category 4, West Virginia as category 3 and continues on to Ohio. By the time this storm crosses the great lakes 24 hours after first making landfall, it has downscaled to a category 2. Please refer to **Annex 3** for figures illustrating other model provider's track. Details of the hurricane's landfall are provided in the table below.

Figure 1.3: Third hurricane track



Source: AIR. Refer to Annex 3 for figures from other model provider(s).

Indicatively, the resulting industry loss is assumed to be in excess of US\$100 billion including demand surge/post-loss amplification. The losses from the inland states accounts for ~20% of total industry loss. The majority of losses (>90%) from this hurricane result from wind.

The closest matching vendor model event IDs, estimated industry losses, and details of the hurricane's landfall are provided in the table below.⁴ Loss estimates include demand surge/post-loss amplification. The PRA is aware that not all model providers cover the modelling of inland states in their North Atlantic hurricane model and in those cases firms will need to undertake additional loss estimates to complement model coverage. Please note that the RMS event ID (2866131) does not cover all the states in the footprint, and CoreLogic provides one event ID (29351) for modelling coastal state losses and a second event ID (3251057) for modelling inland state losses. The PRA is aware that the event footprint, associated parameters and industry loss between vendor models will differ.

⁴ The PRA may provide inputs from additional model vendors for the final version of the document.

Table 1.3: Third hurricane – further details

	AIR	CoreLogic	RMS
eventID	270241858	29351/3251057 ^(a)	2853816 ^(b)
Gross Market Loss (US\$ billion)	109	114	86
Saffir-Simpson Category	5	4	4
Central Pressure (mbar)	894	936	942
Maximum Wind Speed (mph)	166.9	139.0	141.0
Forward Speed (mph)	22	15	12
Longitude (degrees)	-78.40	-76.48	-78.47
Latitude (degrees)	33.90	34.91	33.88
State	NC	NC	NC
County	Brunswick	Carteret	Brunswick

(a) CoreLogic event ID 29351 is from North Atlantic hurricane model, and event ID 3251057 is from severe convective storm model.

(b) RMS event ID does not cover all states in the footprint.

1.3 Reporting

This section sets out details of the quantitative requirements that support completion of template “Scenario A1”. In addition, firms will need to refer to the guidance as set out in the RBP report, which sets out the required qualitative information that will need to be submitted and that forms an integral part in completing this exercise.

1.3.1 Standard reporting for this scenario

Firms are asked to provide a breakdown of the gross loss estimate by:

- lines of business and coverage (eg residential property damage, commercial property; damage, business interruption, contingent business interruption, motor, marine and energy, liability);
- types of peril (eg wind, storm-surge, inland flood);
- post loss amplification breakdowns (eg loss adjustment expenses, increased material cost);
- their estimates of the secondary uncertainty (if any) included in their loss estimates.

Firms should provide details of their overall exposures and those that have been modelled (modelled number of risks and modelled sums insured), and the number of risks affected as part of the quantitative template. Firms may make reasonable assumptions to derive their estimates and should exclude immaterial claims if using vendor models.

For all three events, the PRA does not expect flood limits to be considered to be equal to wind limits, and instead intends for the firms to take into account the contractual terms and conditions.

For the first hurricane event, firms are expected to assess the impact of wind on personal lines properties using Section 706.1.1 of the Florida Building Code (25% roof rule) where it is legally applicable.

Data assumptions and adjustments made to the vendor model estimates to reflect firms’ own view of risk should be disclosed (see RBP report).

Firms are expected to calculate the net losses for each event individually and in aggregate taking into consideration reinsurance recoveries as described in **Section 1.2**.

1.3.2 Additional reporting for this scenario

For the second hurricane event, firms are expected to provide their policy 'leakage' assumptions in the RBP report. 'Leakage' refers to flood related losses (from both precipitation-induced flood and storm surge) paid by wind policies. This event also assesses the impact to off-shore energy and marine lines of business, thus firms are expected to report the losses from these lines in the quantitative template.

On the third hurricane event, for firms who license a model that does not cover the modelling of inland states, the PRA provides the hazard data (average wind speed)⁵ for all affected counties for firms to develop their own bespoke damage ratios to calculate losses for inland states. For instance, firms may decide to use a blended approach, applying an event ID for modelling coastal state losses and a damage ratio approach for inland state losses. The hazard data can be found in the quantitative template tab 'A1 Event 3 Hazard Information'.

Additional reporting requirements for the third hurricane event are:

- firms are expected to report the total sum-insured and total gross insured losses for both the modelled and non-modelled states in the quantitative template tab 'A1 Event 3 Loss Reporting';
- all firms are expected to report total sum-insured for inland states in tab 'A1 Event 3 Loss Reporting', but only firms with total sum insured for inland states higher than 5% of overall total sum-insured affected *by this event* are required to report gross insured losses for the inland states.

Note: Firms that have not relied on model vendor results to estimate inland flood losses, are also expected to specify the approach and assumptions used to estimate losses for the impacted inland states in the qualitative questions in the RBP report.

⁵ The average wind speed values are 1 minute sustained and after surface roughness has been applied, ie real terrain. The wind speeds are calculated at a high spatial resolution, then averaged to the county resolution, for the purpose of this exercise.

2. Scenario A2: California earthquakes

This scenario tests firms' resilience to two severe earthquake events in northern California affecting the San Francisco Bay area. This scenario also explores the model uncertainty with regard to the hazard component of catastrophe models through the adjustment of average ground motion estimation assumptions.

2.1 Event definition

This stress test is for two severe earthquakes in northern California affecting the San Francisco Bay area, a region that has been subject to material urbanisation in recent years. More specifically, this scenario comprises of a sequence of two correlated events, with the first Magnitude ~7 event rupturing the Hayward fault, followed by a second Magnitude ~7 event in the Rodgers Creek fault, triggered by Coulomb stress transfer from the first event. At today's values, the two earthquakes are estimated to cause a total insured losses in the order of US\$70-80 billion according to the model vendor providers.

The Hayward fault has the potential to trigger severe earthquake event impacting the Greater San Francisco area, especially when time-dependency effects are considered given that the Hayward fault is at the end of its cycle. The last major event on the Hayward fault occurred in 1868 which struck the San Francisco Bay area (magnitude 6.8).

The inclusion of a second correlated event in a plausible multi-event scenario follows the lessons learned regarding stress transfer mechanisms across different faults (eg New Zealand 2010 and 2011 events). Firms are to assume that the events are sufficiently separated in time to be considered as two separate events for the purposes of reinsurance recoveries.

2.2 Assumptions

In estimating the gross loss, firms are asked to allow for post loss amplification (demand surge), using their natural catastrophe modelling capabilities. Firms should assume that the time between events maximises the potential for post loss amplification.

Firms should estimate both the aggregate losses and the breakdown across the two earthquake events, taking into consideration any relevant primary or secondary loss drivers including – but not limited to – ground-shaking, liquefaction, landslide, escape of water and fire-following. Breakdown between physical damage, business interruption and contingent business interruption is also requested. Loss estimates are to be assessed across all relevant lines of business including – but not limited to – property and liability losses triggered by earthquake events. For instance, liability losses examples could include litigation for structural failure or hazardous biochemical release.

Where the firms deem that the modelling capabilities they have access to are incomplete to assess the full spectrum of losses, they are requested to estimate the non-modelled components (eg liability or contingent business interruption) using an alternative approach of their choice. The approach should be clearly described, along with key assumptions and expert judgements made to estimate relevant non-modelled components, in the RBP report.

Where firms are using external vendor models, firms should adjust the model output to address any relevant model limitations to reflect firm's own views.

Firms should assume events fall under the same reinsurance treaty year, that any changes made to the reinsurance programme do not incept before the first event occurred, and should include the impact of both inwards and outwards reinstatement premiums. Where additional reinstatements or back-up covers are purchased, firms should quantify the likely rate increases and should not factor in reduced attachment points without adequate justification.

In modelling the gross and net impact of the scenario, firms should include the impact of both inwards and outwards reinstatement premiums and the impact of any profit commission clawback.

Firms should consider what management actions they may take following and between the events. These include changes to their reinsurance programmes, changes to their planned premium income or rating structures, and re-capitalisation plans. The cost of these actions, to the extent appropriate, should be allowed for in the estimation of the Own Funds as at the year-end 2022, with adequate descriptions in the RBP report.

2.3 Earthquake sources

The map below illustrates the extent of the rupture for both events. The first event ruptures on the Hayward fault (note that RMS first event connects with the Calaveras fault), predominantly impacting San Francisco, San Jose, Oakland, Fremont and Hayward. The second event ruptures on the Rodgers Creek fault, predominantly impacting San Francisco, Oakland, Santa Rosa, Berkeley and Richmond. For firms not using any vendor model, the fault rupture characteristics for both events can be found in the table below. The epicentre of the first earthquake should be located reasonably close to 37.77 latitude and -122.14 longitude. The epicentre of the second earthquake should be located reasonably close to 38.27 latitude and -122.58 longitude.

Figure 2.1: California earthquake faults map



Source: AIR (left) and RMS (right). Refer to Annex 3 for figures from other model providers.

Indicatively, the resulting industry loss for the first event is assumed to be US\$35-60 billion, and the second event to be US\$20-35 billion based on vendor model providers. The closest matching event IDs and estimated industry losses are provided in table below.⁶ The PRA is aware that event footprints, associated parameters and industry losses differ between vendor models.

⁶ The PRA may provide inputs from additional model vendors for the final version of the document.

Table 2.1: First earthquake (Hayward Fault) – further details

	AIR	CoreLogic	Impact Forecasting	RMS
eventID	110015162	2304	277856	15008439
Gross Market Loss (US\$ billion)	56.6	53.0	41.0	39.6
Earthquake magnitude (Mw)	6.88	7.01	6.73	7.22
Depth (km)	6.80	7.72	6.5	Top: 2.7, bottom: 11 to 13.5
Rupture length (km)	55.3	65.0	42.0	127.0
Epicentre latitude (°)	37.77	37.62	37.73	37.31
Epicentre longitude (°)	-122.14	-122.01	-122.06	-121.78

Table 2.2: Second earthquake (Rogers Creek Fault) – further details

	AIR	CoreLogic	Impact Forecasting	RMS
eventID	110035580	2554	277896	15012329
Gross Market Loss (US\$ billion)	21.0	22.7	32.0	34.3
Earthquake magnitude (Mw)	7.10	7.05	6.97	7.33
Depth (km)	6.1	6.4	7.5	Top: 1.6, bottom:12.0
Rupture length (km)	78.5	70.0	60.0	135.0
Epicentre latitude (°)	38.17	38.18	38.62	38.27
Epicentre longitude (°)	-122.43	-122.47	-122.82	-122.58

2.4 Model uncertainty assessment

For a rare event that results in a severity that has not been recorded historically, such as the first earthquake event, catastrophe models are relying mostly on theoretical equations to drive loss estimates, making validation with observed data less reliable. The reliance on theoretical equations can result in model failures (eg Tohoku 2011).⁷ In this scenario, we will explore the model uncertainty in particular with regard to the potential underestimation of the ground motion estimation often used in catastrophe models.

After obtaining the losses using model providers' event IDs, firms are expected to assess the potential sensitivity of their modelled loss estimate should a fundamental assumption in hazard estimation be changed. We understand the ground motion prediction equations used by cat models provide a distribution of possible ground motion intensity levels for a particular event and location. Firms are asked to re-assess and report losses for the first earthquake event (ie the Hayward fault event), by assuming that the ground motion is one standard deviation above the average ground motion estimation for that event. Firms are asked to describe the methodology used in modifying the ground motion estimation and reflect on the sensitivity of the loss to such an assumption in the RBP report.

⁷ The national seismic hazard body, the Headquarters for Earthquake Research Promotion (HERP), did not contain events as large in magnitude as Tohoku in the region where it occurred. The main catastrophe models, which were based on HERP, similarly did not contain such a large magnitude event in that area.

2.5 Reporting

This section sets out details of the quantitative requirements that support completion of template “Scenario A2”. In addition, firms will need to refer to the guidance as set out in the RBP report, which sets out the required qualitative information that will need to be submitted and that forms an integral part in completing this exercise.

2.5.1 Standard reporting for this scenario

Firms are asked to provide the breakdown of the gross loss estimate by:

- lines of business and coverage (eg residential property damage, commercial property; damage, business interruption, contingent business interruption, motor, marine and energy, liability);
- types of loss driver (eg liquefaction, fire-following);
- post loss amplification breakdowns (eg loss adjustment expenses, increased material cost);
- their estimates of the secondary uncertainty (if any) included in their loss estimates.

Firms should provide details of their overall exposures and those that have been modelled (modelled number of risks and modelled sums insured), and the number of risks affected as part of the quantitative template. Firms may make reasonable assumptions to derive their estimates and should exclude immaterial claims if using vendor models.

Data assumptions and adjustments made to the vendor model estimates to reflect firms’ own view of risk should be disclosed (see the RBP report), including for example:

- the allowance made for uncaptured exposures or data limitations (eg locations not geocoded); and
- the allowance made for non-modelled secondary perils (eg liquefaction, escape of water), non-modelled coverages (eg contingent business interruption) and non-modelled lines of business (eg energy, motor).

Firms are expected to calculate the net losses for each event individually and in aggregate taking into consideration reinsurance recoveries as described in **Section 2.2**.

2.5.2 Additional reporting for this scenario

For the model uncertainty test, firms need to provide the updated loss estimate in the quantitative template tab ‘Scenario A2’, and set out the methodology and assumptions used to allow for this higher than average ground motion estimation as part of the RBP report.

3. Scenario A3: UK windstorm and UK flood

This scenario includes two UK windstorm events and one UK inland flood event, generating c. £20 billion of gross insured loss. The first event is a 1987J-like windstorm event causing significant wind losses in the South of England. The second event is a UK windstorm causing significant storm surge losses along the West coast of England. The third event results in extensive inland flooding, with widespread geographic footprint – similar to 2007 – impacting an area from Devon to North Yorkshire. This scenario will assess firms’ modelling capabilities to assess storm surge losses beyond the east coast of the UK.

This scenario is stand alone and is not superimposed on other scenarios.

3.1 Event definition

This scenario comprises of a set of three large UK events generating some £20 billion of insured losses in aggregate in the United Kingdom. Firms may ignore losses generated by this event in other countries.

Firms are to assume that the events are sufficiently separated in time to be considered three separate events for the purposes of reinsurance recoveries. The three events are not explicitly correlated but conceptually are occurring within the same windstorm season, something that recent research has highlighted as being plausible.⁸

The return period for aggregate wind, surge and flood losses of this size to the UK is estimated to be approximately 200 to 280 years according to RMS and AIR. Firms are asked to comment whether they assume the correlated – or uncorrelated – nature of those events when reporting the return period for this scenario’s losses.

3.2 Assumptions

Firms are asked to estimate the size of the loss per event and in aggregate using their natural catastrophe modelling capabilities. In estimating the gross loss, firms should provide their own view and allow explicitly for all material non-modelled risks and for post loss amplification (demand surge). Firms should assume that the time between events maximises the potential for post loss amplification.

Where firms are using external vendor models, firms should adjust the model output to address any relevant model limitations to reflect firm’s own views.

In modelling the gross and net impact of the scenario, firms should include the impact of both inwards and outwards reinstatement premiums and the impact of any profit commission clawback.

Firms should assume events fall under the same reinsurance treaty year, that any changes made to the reinsurance programme do not incept before the first event occurred, and should include the impact of both inwards and outwards reinstatement premiums. Where additional reinstatements or back-up covers are purchased, firms should quantify the likely rate increases and should not factor in reduced attachment points without adequate justification.

⁸ [It’s windy when it’s wet: why UK insurers may need to reassess their modelling assumptions – Bank Underground.](#)

Firms should consider what management actions they may take following and between the events. These include changes to their reinsurance programmes, changes to their planned premium income or rating structures, and re-capitalisation plans. The cost of these actions, to the extent appropriate, should be allowed for in the estimation of the Own Funds as at the year-end 2022, with adequate descriptions in the RBP report.

3.2.1 First UK windstorm event

A severe extra tropical cyclone crosses the south of England, causing strong winds in South and East of England predominantly. The strongest winds occur slightly south of the Greater London area, similar to the Great Storm of 1987. This event causes an industry gross loss around £8.5 billion in the UK. For the purpose of this stress test, losses outside the UK are assumed to generate negligible losses.

The maps below illustrate footprints for the closest matching RMS and AIR events. Refer to **Annex 3** for figures from other model provider(s).

Figure 3.1: First UK windstorm event footprint



Source: RMS (left) and AIR (right). Refer to Annex 3 for figures from other model provider(s).

The closest matching vendor model event IDs and estimated industry losses are provided in the table below. The PRA is aware that event footprints, associated parameters and industry loss estimates vary between vendor models.

Table 3.1: First UK windstorm event – further details

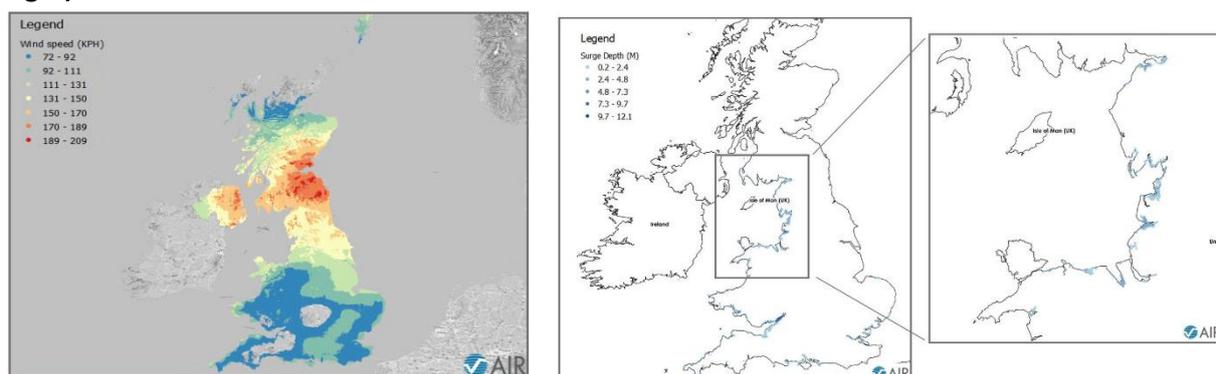
	AIR	CoreLogic	RMS
eventID	410030903	10688	3189151
Gross Market Loss (£ billion)	8.7	8.6	8.5

3.2.2 Second UK windstorm event

An extra tropical cyclone that sweeps across Northern England and Southern Scotland results in significant surge across the west coast. The wind field from this storm is wide ranging, with the strongest winds impacting the swath between North Yorkshire and Angus in Scotland. The major loss driver of this event is the significant storm surge to the UK west coast with material severity within the Bristol Channel and some parts of Dumfries and Galloway. This event causes an industry gross loss in excess of £5.8 billion across the UK, with more than half resulting from the storm surge.

The maps below illustrate footprints for the closest matching AIR events. Refer to **Annex 3** for figures from other model provider(s).

Figure 3.2: Second UK windstorm event area impacted by wind (left) and storm surge (middle and right)



Source: AIR. Refer to Annex 3 for figures from other model provider(s).

The closest matching vendor model event IDs are provided in the table below. The PRA is aware that not all model providers cover the modelling of storm surge for the UK west coast and in those cases firms will need to undertake additional loss estimates to complement model coverage. Please note that the RMS event ID (3184230) covers wind only, and Fathom event ID (93875) and JBA Risk Management event ID (E60467/62501) cover storm surge only. The PRA is aware that the event footprint, associated parameters and industry loss between vendor models will differ. Firms are encouraged to assess the adequacy of the vendor event ID to cover this event in its entirety, recognising that variations may occur between models.

Table 3.2: Second UK windstorm event – further details

	AIR	CoreLogic	Fathom	JBA Risk Management	RMS
eventID	410056187	11849	93875 ^(a)	E60467/62501 ^(a)	3184230 ^(b)
Gross Market Loss (£ billion)	5.8	7.1	n/a	2.9	2.5

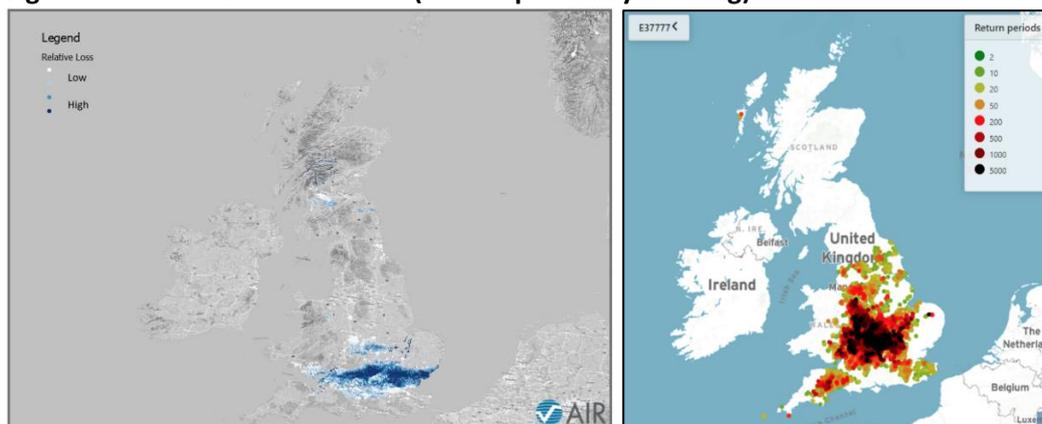
(a) Fathom and JBA Risk Management event IDs cover storm surge only.

(b) RMS event ID covers wind only.

3.2.3 Third UK inland flood event

The event is similar to the 2007 flood in terms of the extensive footprint, resulting in widespread inundation from Devon to North Yorkshire with the worst impacts in Oxfordshire, Worcestershire, Herefordshire, Buckinghamshire, and Hertfordshire. The duration of inundation for this event is a minimum of 4 weeks. The event causes a gross loss in the order of £5-6 billion. The map below illustrates the area impacted by flooding from AIR and JBA Risk Management. Refer to **Annex 3** for figures from other model provider(s).

Figure 3.3: UK inland flood event (area impacted by flooding)



Source: AIR (left) and JBA Risk Management (right). Refer to Annex 3 for figures from other model provider(s).

The closest matching vendor model event IDs and estimated industry losses are provided in the table below. The PRA is aware that event footprints, associated parameters and industry loss estimates vary between vendor models.

Table 3.3: UK inland flood – further details

	AIR	Fathom	JBA Risk Management	RMS
eventID	920020742	37938	E37777 / 37289	3620656 (HD) / 1945607 (RiskLink)
Gross Market Loss (£ billion)	5.7	n/a	5.7	6.0

3.3 Reporting

This section sets out details of the quantitative requirements that support completion of template “Scenario A3”. In addition, firms will need to refer to the guidance as set out in the RBP, which sets out the required qualitative information that will need to be submitted and that forms an integral part in completing this exercise.

3.3.1 Standard reporting for this scenario

Firms are asked to provide the breakdown of the gross loss estimate by:

- lines of business and coverage (eg residential property damage, commercial property damage, business interruption, contingent business interruption, motor, marine and energy, liability);
- types of peril (eg wind, storm-surge, inland flood);
- post loss amplification breakdowns (eg loss adjustment expenses, increased material cost);
- their estimates of the secondary uncertainty (if any) included in their loss estimates.

Firms should provide details of their overall exposures and those that have been modelled (modelled number of risks and modelled sums insured), and the number of risks affected in the quantitative templates. Firms may make reasonable assumptions to derive their estimates and should exclude immaterial claims if using vendor models.

Data assumptions and adjustments made to the vendor model estimates to reflect firms’ own view of risk should be disclosed, including for example:

- the allowance made for uncaptured exposures or data limitations (eg locations not geocoded); and
- the allowance made for non-modelled secondary perils (eg storm-surge), non-modelled coverages (eg contingent business interruption) and non-modelled lines of business (eg energy).

Firms are expected to calculate the net losses for each event individually and in aggregate taking into consideration reinsurance recoveries as described in **Section 3.2**.

3.3.2 Additional reporting for this scenario

For the second UK wind-storm event, for firms who license a model that does not cover the modelling of storm surge for the UK west coast, the PRA provides the hazard data (surge depth) for all affected postcodes so that the firms can develop their own bespoke damage ratios to calculate losses from storm surge. Damage ratios should include rebuild costs taking into consideration historic and/or modelled claims data. For instance, firms may decide to use a blended approach, applying a vendor model event ID for modelling wind losses and a damage ratio approach for modelling storm surge losses. The hazard data can be found in the quantitative template tab 'A3 Event 2 Hazard Information'.

Additional reporting requirements for this event are:

- firms are expected to report total sum-insured for a number of categories in tab 'A3 Event 2 Loss Reporting' in the quantitative template, but only firms with gross total sum insured for storm surge higher than 5% of overall total sum-insured affected by this event are required to report gross insured losses for storm surge;
- firms are expected to report the gross insured losses for wind and storm surge in the tab 'A3 Event 2 Loss Reporting' in the quantitative template. Those firms which assess their surge exposure as immaterial are asked to report only their wind losses.

Section B – Cyber underwriting scenarios

4. Scenario B1: Cloud down scenario

This scenario assesses the extent of underwriting losses from a cloud outage of a week for a major Cloud Service Provider. Insureds' activities might be disrupted for a longer period as they need to check their data and systems once the cloud is back in operation.

4.1 Event definition

The largest Cloud Service Provider (CSP) suffers a catastrophic outage for a week (7 days) from a cyber attack facilitated by an insider. Its customers lose access to the cloud worldwide, with ensuing business interruption. Firms are asked to select the CSP that they believe has the largest representation for their portfolio.

Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) are all impacted.

When access to clouds is re-established, most firms need to check their data and systems to ensure these have not been corrupted. Some firms have poor back-up systems that lengthens this verification. This scenario results in business interruption to the global supply chain, as many firms supply key components on a just in time basis.

4.2 Assumptions

Firms are asked to assume that:

- the CSP has a 35% market share;
- once the CSP is up and running, 40% of firms restore their access to the cloud immediately, but 30% of firms take 9 days to restore access and the remaining 30% take 12 days to restore access;
- where insurers do not have sufficient information to assess the reliance of firms' business critical functions on CSPs, they may use the assumptions provided in **Annex 4** for the percentage of revenue that is dependent on CSPs and the proportion of that revenue that is lost;
- at market level, 20% of US firms that take longer than a week to restore their cloud access face D&O claims, of which 15% are successful. 10% of non US firms that took longer than a week to restore access, face D&O claims of which 10% are successful; and
- while it is feared that the threat actor may benefit from the tacit support of a nation state, this cannot be proved and so firms should assume that war exclusions cannot be applied.

Firms are asked to allow for the costs of restoring access where covered and for the business interruption losses subject to the deductibles and limits in place.

Firms should assess where contingent business interruption coverage provided is expected to respond.

For D&O losses, firms should estimate both defence costs and claim costs.

Given the scale of the access to the cloud being compromised, firms should consider the potential for some loss in their Professional Indemnity book. This could be in terms of where policyholders are not able to discharge their professional responsibilities or where they are not able to meet contractual commitments. Losses could also arise from cover given to technology providers.

Firms should allow for losses on any other classes they believe would be impacted.

4.3 Reporting

This section sets out details of the quantitative requirements that support completion of template “Scenario B1”. In addition, firms will need to refer to the guidance as set out in the RBP, which sets out the required qualitative information that will need to be submitted and that forms an integral part in completing this exercise.

Firms should estimate the impact on Basic Own Funds (BOF) and Solvency Capital Requirements (SCR) assuming the stress occurred at the beginning of the year 2022.

Firms should estimate gross, ceded and net losses, providing a breakdown of ceded losses by reinsurer (largest 40 reinsurers only) in the quantitative templates. Firms should provide details of their reinsurance programme including any specific cyber reinsurance protections in the RBP report.

A breakdown of gross losses by type of loss is required to help the PRA better understand the impact of each scenario. Gross losses for stand-alone cyber coverages should be broken down by forensics and remediation, ransomware payments, notification costs, fines, liability for data loss, business interruption, contingent business interruption, and other losses.

Losses should be estimated not only for stand-alone cyber coverages but also for affirmative cyber coverages and for non-affirmative cyber coverages in other product lines.

Supporting information should be provided in terms of exposures and number of claims for the claim frequency, claim severity and severity relative to average line sizes to be determined. This will assist the PRA validation of the results and comparison of responses across firms.

For the cloud down scenario, a sectoral breakdown of exposures and losses will be required for the stand-alone cyber exposures and losses.

Aggregate information should be provided for the clauses and exclusions that are significant in the estimation of the gross and net losses.

Where firms have sufficient information to assess the reliance of business critical functions on CSPs, they should provide the % of policyholders and Total Sum Insured dependent on each of the main CSPs.

5. Scenario B2: Data exfiltration scenario

This scenario assesses the extent of underwriting losses triggered by a large data loss across multiple sectors.

5.1 Event definition

An easily made misconfiguration to a major cloud service provider is made by a large number of firms. This leads to threat actor exploiting the misconfiguration to gain access to large volumes of customer data. Customer data is exfiltrated across some major firms in the three key sectors of healthcare, retail and professional services (including legal). The attackers publish the data on the dark web. The motivation of the hackers is both ideological and financial but there is no link to any nation state.

5.2 Assumptions

Firms are asked to assume that:

- their largest 5% of policyholders by exposure in each of the following sectors are impacted: healthcare, retail and professional services (including legal);
- all impacted policyholders incur notification costs of the data breach to their customers and face class action suits for the privacy breach;
- 20% impacted policyholders (ie 1% of policyholders in the impacted sectors), are fined for the data loss at 1% of revenue for contributory negligence;
- no ransomware is asked for or paid;
- the CSP had published configuration guidelines that might have averted the data loss but the guidelines were unclear and misunderstood. The CSP refuses to indemnify the impacted firms; and
- war exclusions cannot be applied.

Firms should allow for the breach management costs, loss notification costs, business interruption and contingent business interruption losses. Firms should also allow for both defence costs and claim costs for the class action suits for privacy breach.

Where firms also have D&O exposures, they should estimate both defence costs and claim costs.

Firms should allow for some loss in their Professional Indemnity book where they believe they may have exposures as well as losses on any other classes they believe would be impacted.

5.3 Reporting

This section sets out details of the quantitative requirements that support completion of template “Scenario B2”. In addition, firms will need to refer to the guidance as set out in the RBP, which sets out the required qualitative information that will need to be submitted and that forms an integral part in completing this exercise.

Firms should estimate the impact on Basic Own Funds (BOF) and Solvency Capital Requirements (SCR) assuming the stress occurred at the beginning of the year 2022.

Firms should estimate gross, ceded and net losses, providing a breakdown of ceded losses by reinsurer (largest 40 reinsurers only) in the quantitative templates. Firms should provide details of their reinsurance programme including any specific cyber reinsurance protections in the RBP report.

A breakdown of gross losses by type of loss is required to help the PRA better understand the impact of each scenario. Gross losses for stand-alone cyber coverages should be broken down by forensics and remediation, ransomware payments, notification costs, fines, liability for data loss, business interruption, contingent business interruption, and other losses

Losses should be estimated not only for stand-alone cyber coverages but also for affirmative cyber coverages and for non-affirmative cyber coverages in other product lines.

Supporting information should be provided in terms of exposures and number of claims for the claim frequency, claim severity and severity relative to average line sizes to be determined. This will assist the PRA validation of the results and comparison of responses across firms.

Aggregate information should be provided for the clauses and exclusions that are significant in the estimation of the gross and net losses.

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6. Scenario B3: Systemic ransomware

This scenario assumes ransomware claims increase significantly as a result of a large systemic ransomware event. It tests for the impact of underwriting losses from a large systemic ransomware event, differentiating impact based on the size of the insured firm.

6.1 Event definition

A ransomware group (threat actor) exploits a vulnerability in the update mechanism of a commonly used software to deliver its malicious software payload, using trusted applications as cover.

The impacted firms' files are encrypted with a ransom demanded for the decryption.

A number of firms refuse to pay any ransom and rebuild their systems with varying levels of downtime. Most of the firms need to check their data and systems to ensure these have not been corrupted. Some firms have poor back-up systems that lengthens this verification.

The vulnerability is patched 3 days later. However, those firms already impacted still suffer from the encryption. Some firms take longer than 3 days to implement the patch and others never patch, remaining vulnerable to the attack.

6.2 Assumptions

Firms are asked to assume that:

- of firms that have purchased cyber insurance, 7.5% of large firms with revenue exceeding US\$1 billion, 10% of medium sized firms with revenue between US\$50 million and US\$1 billion, and 5% of small firms with revenue between US\$50 million and US\$10 million suffer the ransomware attack;
- to decrypt a firm's encrypted data, the threat actor or associated threat actors, demand US\$5 million for large firms, US\$500 thousand for medium sized firms, and US\$50 thousand for small firms;
- 40% of firms pay the ransom but the remaining 60% decide to rebuild their systems. However, despite paying the ransom, the threat actor is not able to scale up and provide the decryption keys to most of the firms having paid the ransom;
- for large firms, 50% are able to rebuild their systems from backups within 3 days, 30% take 1 week and 20% take 2 weeks. For medium sized firms, 30% take 3 days to rebuild their systems, 40% take 1 week and 30% take 2 weeks. For small firms, 20% only are able to rebuild their systems from backups within 3 days, 30% take 1 week and 50% take 2 weeks;
- 20% of US firms that took more than a week to rebuild their systems, face D&O claims of which 15% are successful. 10% of non US firms that took more than a week to rebuild their systems, face D&O claims of which 10% are successful; and
- while it is feared that the threat actor may benefit from the tacit support of a nation state, this cannot be proved and war exclusions cannot be applied.

Firms should allow for remediation costs even when firms refuse to pay the ransomware.

For the data exfiltration element, firms are expected to estimate the notification costs, any fines levied, and potential D&O costs (if they also participate on the impacted policyholders D&O programme).

For D&O losses, firms should estimate both defence costs and claim costs.

Firms should consider the potential for some loss in their Professional Indemnity book. Losses could arise from cover given to technology providers. It could also be in terms of where policyholders are not able to discharge their professional responsibilities or where they are not able to meet contractual commitments.

Firms should allow for losses on any other classes they believe would be impacted.

6.3 Reporting

This section sets out details of the quantitative requirements that support completion of template “Scenario B3”. In addition, firms will need to refer to the guidance as set out in the RBP, which sets out the required qualitative information that will need to be submitted and that forms an integral part in completing this exercise.

Firms should estimate the impact on Basic Own Funds (BOF) and Solvency Capital Requirements (SCR) assuming the stress occurred at the beginning of the year 2022.

Firms should estimate gross, ceded and net losses, providing a breakdown of ceded losses by reinsurer (largest 40 reinsurers only) in the quantitative templates. Firms should provide details of their reinsurance programme including any specific cyber reinsurance protections in the RBP report.

A breakdown of gross losses by type of loss is required to help the PRA better understand the impact of each scenario. Gross losses for stand-alone cyber coverages should be broken down by forensics and remediation, ransomware payments, notification costs, fines, liability for data loss, business interruption, contingent business interruption, and other losses.

Losses should be estimated not only for stand-alone cyber coverages but also for affirmative cyber coverages and for non-affirmative cyber coverages in other product lines.

Supporting information should be provided in terms of exposures and number of claims for the claim frequency, claim severity and severity relative to average line sizes to be determined. This will assist the PRA validation of the results and comparison of responses across firms.

Aggregate information should be provided for the clauses and exclusions that are significant in the estimation of the gross and net losses.

7. Scenario B4: Cyber attack on shipping navigation systems

This scenario is more exploratory than the other three cyber underwriting scenarios. It explores the potential for loss in the event of a cyber attack on cargo ships, with some uncertainty as to which other ships are at risk. The ensuing policy action by port authorities globally magnifies the disruption to maritime trade. Supply chains are disrupted with wide business interruption to firms.

7.1 Event definition

A threat actor gains access to the bridge system of commercial seagoing vessels, compromising the control systems.

The intrusion goes undetected for weeks until the threat actor locks the rudder and propulsion system of a container ship causing it to hit a quay in the port of Singapore. A day later, the threat actor causes another container ship to hit a quay and cranes in the port of Los Angeles.

Physical damage is caused to the quay and cranes, there is some loss of cargo and some hull damage. The threat actor threatens further accidents unless a US\$50 million ransom is paid by each of the top 5 cargo shipping companies (as measured by twenty-foot equivalent units (TEU) capacity).

As a precautionary measure, many ships stop their journeys and all container port authorities close their ports until the bridge systems of impacted ships are checked, disrupting the maritime supply chain accounting for 90% of world trade in goods.

It takes three days to determine which elements of the bridge system have been compromised and two more days to develop a solution. The motivation of the attackers are more political than financial with the ransom demand adding to confusion.

7.2 Assumptions

Firms are asked to assume:

- the two cargo ships have 10,000 TEU; that 25% of the cargo is lost and that 25% of the hull value is lost;
- US\$30 million of damage to the ports of Singapore and Los Angeles;
- 2% or more of cargo ships are feared to have elements of the bridge systems at risk, an estimated 1000 ships at least;
- seaborne traffic is disrupted for 5 days with loss of business for all container ports, and causing some US\$250 billion of trade to be disrupted;
- contingent business interruption (where there is cover) could last longer than 5 days; and
- while it is feared that the threat actor may benefit from the tacit support of a nation state, this cannot be proved and war exclusions cannot be applied.

Marine insurers are asked to estimate:

- their likely share of the cargo, hull, salvage and liability losses of the two ships hitting the quays;
- their share of the damage to the ports of Singapore and Los Angeles;
- the loss of revenue to the container ports they insure for the period of seaborne traffic disruption;

- the costs of delays including fuelling and rerouting costs as well as any cargo damage for perishable goods, where covered; and
- losses under affirmative coverages provided for cyber.

Insurers should assume their average line size is exposed.

Cyber insurers should estimate losses for the top 5 cargo shipping companies and the possibility that their cyber insurances pay out.

All firms should estimate loss of hire policies for marine policies and contingent business interruption exposures for relevant classes of business including property insurance and reinsurance.

Where exclusions are relied upon, details should be provided. Where the wording is ambiguous, details should be provided of the different possible interpretations.

Firms should allow for losses on any other classes they believe would be impacted.

7.3 Reporting

This section sets out details of the quantitative requirements that support completion of template “Scenario B4”. In addition, firms will need to refer to the guidance as set out in the RBP, which sets out the required qualitative information that will need to be submitted and that forms an integral part in completing this exercise.

Firms should estimate the impact on Basic Own Funds (BOF) and Solvency Capital Requirements (SCR) assuming the stress occurred at the beginning of the year 2022.

Firms should estimate gross, ceded and net losses, providing a breakdown of ceded losses by reinsurer (largest 40 reinsurers only) in the quantitative templates. Firms should provide details of their reinsurance programme including any specific cyber reinsurance protections in the RBP report.

A breakdown of gross losses by type of loss is required to help the PRA better understand the impact of each scenario. Gross losses for stand-alone cyber coverages should be broken down by forensics and remediation, ransomware payments, notification costs, fines, liability for data loss, business interruption, contingent business interruption, and other losses.

Losses should be estimated not only for stand-alone cyber coverages but also for affirmative cyber coverages and for non-affirmative cyber coverages in other product lines.

Supporting information should be provided in terms of exposures and number of claims for the claim frequency, claim severity and severity relative to average line sizes to be determined (see quantitative templates). This will assist the PRA’s validation of the results and comparison of responses across firms.

For the cyber attack on shipping management systems scenario, a sectoral breakdown of exposures and losses is required for the business interruption and contingent business interruption exposures and losses.

Aggregate information should be provided for the clauses and exclusions that are significant in the estimation of the gross and net losses.

Annex 1 Responses to firm feedback from the first part of request for technical input (General Insurance)

Questions / issue raised		The PRA response
Natural Catastrophe scenarios		
1.	We are concerned about the number of sub-elements in the Natural Catastrophe scenarios.	GIST 2022 includes three nat cat scenarios with eight sub elements, while the 2019 exercise included four nat cat scenarios with eight sub elements. Given that not all firms have material exposure to all of those sub-elements, we believe that the effort required to complete GIST 2022 is broadly comparable to GIST 2019 for most insurers.
2.	What is the climate change - related science that is informing the PRA's calibration of the natural catastrophe stresses?	GIST 2022 does not aim to assess financial impact from climate change. The scenarios represent severe but plausible realisations of current climate conditions chosen to reflect firms' exposures and business models.
3.	For <i>Set of US Hurricanes scenario</i> , third event (inland penetration), appears too severe, given no history of similar events in the Great Lakes	This hurricane track is leveraging validated catastrophe models that simulate plausible hurricane events. Recent events (eg Hurricane Ida) have demonstrated the loss propensity of hurricane inland tracks.
4.	For each of the <i>US Hurricane events</i> , please clarify whether or not flood limits should be considered equal to wind limits, and if wind versus flood losses need to be segmented.	We do not expect flood limits to equal wind limits, and instead intend for firms to determine their own view on limits in line with their contractual terms and conditions. The firm's RBP should explain the assumptions and approach made.
5.	For the second <i>Hurricane event – Cyclone precipitation-induced flood</i> – please clarify if there is a requirement to seek divisibility in the property versus marine losses incurred.	Yes, a break-down by line of business is required in the data reporting template (see page 14).
6.	What is the reason for inclusion of the <i>Earthquake Scenario</i> given a tenuous link between climate change and seismic activity?	GIST is not focused on climate change-related scenarios as opposed to CBES. The scenarios represent severe but plausible stresses chosen to reflect industry exposures.
7.	For <i>Earthquake Scenario</i> , it would be helpful in further guidance to provide some additional direction regarding role of sub-perils as well as earthquake shake.	Yes, please refer to Section 2.2 (page 16) of this document.
8.	We question meteorological plausibility of the combination of events in the <i>UK Wind and Flood scenario</i> .	Addressed within the guidance document (see page 20).
9.	For the <i>UK Wind and Flood scenario</i> , sub-element UK West Coast Storm Surge, recommendation for the PRA to provide damage ratios.	The PRA has now provided hazard information, permitting firms to estimate their own damage ratios based on their exposure characteristics
10.	For the <i>UK Wind and Flood scenario</i> the level of PLA in 2007 is not known, and can only be estimated.	The firms are asked to use historic as well as modelled PLA observations on a best endeavours basis. The RBP should be used to explain the firm's approach.

Questions / issue raised		The PRA response
11.	For the <i>UK Wind and Flood scenario</i> , please provide further advice on how insurers are expected to calculate rebuild costs.	As part of standard business practice, in estimating insured losses, firms need to consider a range of variables including rebuild costs. PRA is not prescribing a set approach in the calculation of insured losses, however, it is common practice that variables such as labour costs, material costs, and constructions costs are included in the insured loss estimation. Firms should comment on their key data, assumptions and methodology they have adopted within the RBP.
12.	Should liability lines be excluded as not being directly relevant for nat cat scenarios?	Liability lines should be included – as recent historic events have demonstrated (eg hurricane Harvey 2017, California Wildfires 2019) these can result in losses to liability lines.
Cyber underwriting scenarios		
13.	We are concerned about increase in number of cyber scenarios from 1 in GIST 2019 to 4 in GIST 2022.	<p>Given the increase in cyber exposures over the last few years, and the evolving nature of the underlying cyber risk and ensuing coverage changes, the PRA believes it is important to explore a range of scenarios.</p> <p>To keep the overall scope of the exercise comparable to GIST 2019:</p> <ul style="list-style-type: none"> • general insurers will not be asked to run an economic downturn scenario in 2022. The GIST 2022 scenarios will instead focus on the liability risks. All liability scenarios will be separate scenarios, with no additional overlays; • general insurers will not be asked to provide details of their exposures by sectors. <p>After taking feedback, we have also removed the need to provide the insurer’s own largest cyber scenario if one or more of the other 4 defined scenarios are at least as material as the internal scenarios.</p> <p>We have further simplified the reporting template for the cyber scenarios by asking for the Solvency Ratio impact on the starting balance sheet for the year.</p>
14.	All four cyber scenarios are based on intentional/malicious cyber attacks. We believe broadening causes beyond non-malicious factors would enhance the scope of the exercise overall.	We welcome further comments from the industry to better understand the proposed change and its impact, and we will continue to reach out to experts in this area.
15.	Do the cyber scenarios assume any impact on financial markets?	Unlike 2017 and 2019, in 2022 the general insurance component of the Insurance Stress Test does not include an asset shock. The exercise is focussed on underwriting shocks across all scenarios.
16.	Which covers are included in the cyber scenarios – eg does the cloud scenario cover only business interruption or also includes physical damage?	The cyber scenarios are primarily exploring affirmative cyber and non-affirmative cyber losses. While we are expecting business interruption losses in the scenarios, the scenarios have not been designed to explore physical losses.

Questions / issue raised		The PRA response
17.	Non-affirmative cyber events will be idiosyncratic to each firm's exposure – further details would be needed to ensure consistent responses between firms.	We have provided additional assumptions and guidance to reduce the level of inconsistency.
18.	Please confirm whether participants are expected to assess their own operational risk impact of the events.	We do not require firms to capture operational risk losses.
19.	Please confirm whether you would like participants to assess the silent cyber exposures and any assumptions we should make around successful challenges to exclusions or wordings.	Yes, we would like firms to consider silent cyber exposures. This will be made clear in the specifications; the data template also captures stand-alone, affirmative and non-affirmative losses. In addition, the reporting template will also capture firms' view of losses if exclusions did not work as expected, and aggregate details of exclusions for the different lines of business.
20.	Does the materiality threshold of Gross Loss (before Reinsurance) of 5% of GWP relate to the GWP of the main UK regulated entity?	We will make clear in the Instructions that the GWP measure is at reporting entity level.
21.	Are there assumptions around credit security of reinsurers given the severity impact of the scenarios?	The cyber stress does not specify reinsurer downgrades or defaults but does capture reinsurer details for the largest cessions.
22.	Is there the expectation that the firms need to use the PRA stated assumptions or also develop and apply their own assumptions?	To ensure comparability of firms' responses, the firms are requested to use assumptions specified in the scenarios.
23.	Are coverages in scope only those for a sub-set of classes (e.g. D&O, PI and CBI) or for a broader range of insurance classes?	We expect the firms to consider all lines of business in respect of both affirmative and non-affirmative covers and will ensure that this is reflected in updated Instructions.
Other		
24.	What will be the format of the Results and Basis of Preparation Report?	Firms should adopt the structure recommended in our document setting out the requirements for the RBP report (see page 9).
25.	Will firms have the chance to run their Results and Basis of Preparation reports past the PRA towards the end of the submission window to check whether it meets the PRA's expectations?	No. The PRA will not review RBP reports before submission. However, dialogue channels will remain open during the period before and during the submission window in order to discuss any queries. The PRA is also planning to maintain a Q&A log covering questions received from firms during the exercise period for all firms to be able to refer to.

Annex 2 Institutions invited to take part

Large UK general insurers

- Admiral (Group)
- Ageas Insurance Limited
- AIG UK Limited
- Allianz Holdings plc
- Aspen Insurance UK Limited
- Aviva Insurance Limited
- AXA Insurance UK plc
- Convex Insurance UK Limited
- UK Insurance Limited
- Flood Re Limited
- Hiscox Insurance Company Limited
- Lloyds Bank General Insurance Limited
- The National Farmers Union Mutual Insurance Society
- QBE Insurance UK Limited
- RSA (Group)
- XL Catlin Insurance Company UK Limited
- TransRe London Limited

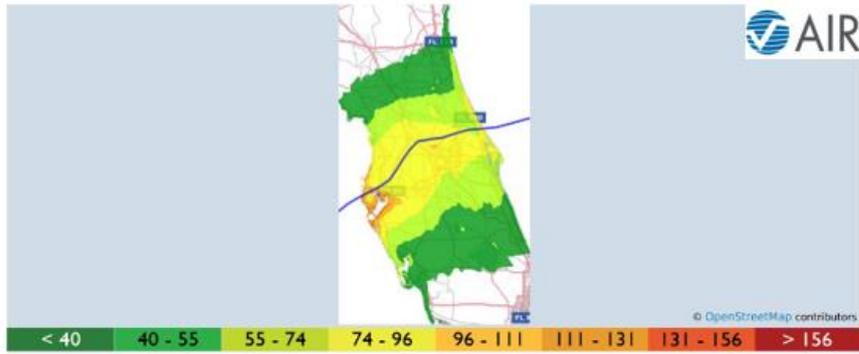
Society of Lloyd's (21 selected Managing Agents)

Annex 3 Natural catastrophe scenarios – additional information

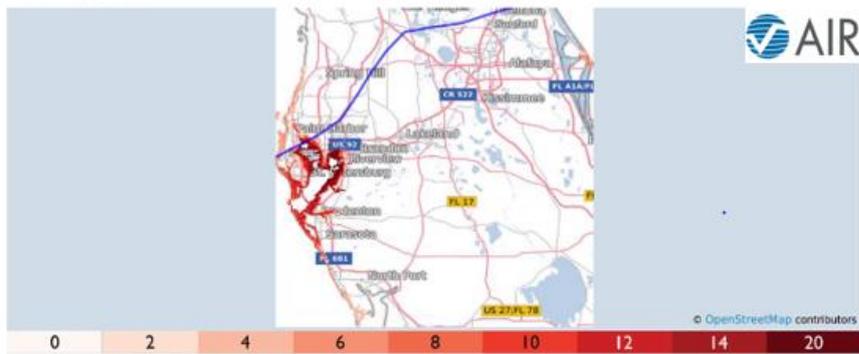
US Hurricane set of events

First hurricane event

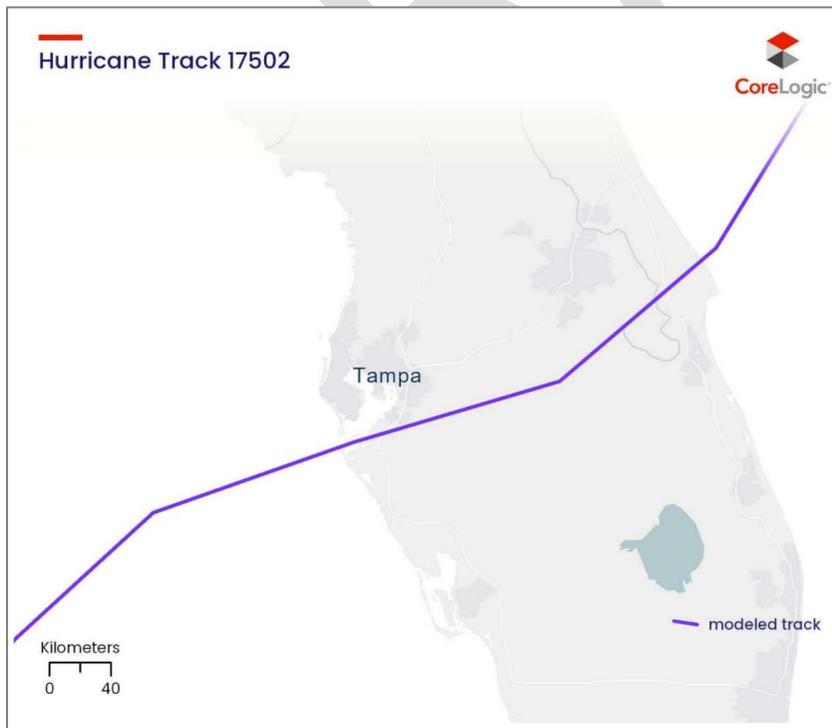
Windspeed Intensity (mph)



Storm Surge (ft)



First hurricane track as modelled by AIR.

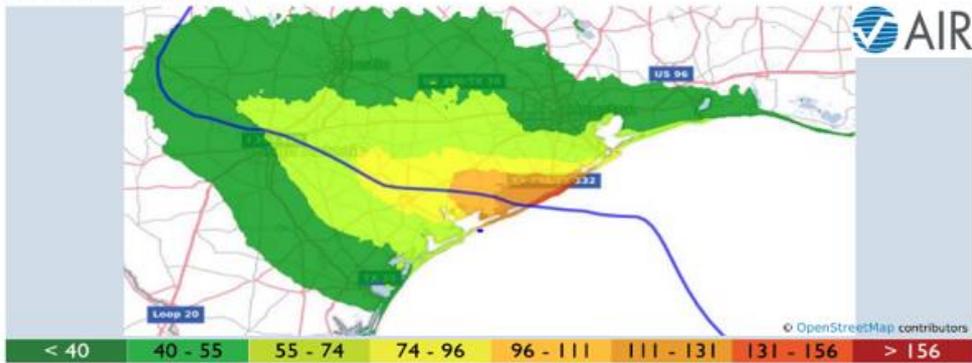


First hurricane track as modelled by CoreLogic.

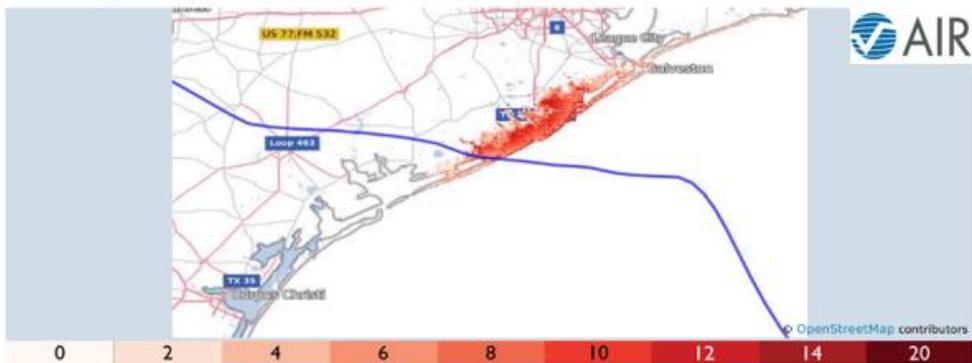
Second hurricane event

Landfall Intensity Footprints

Windspeed Intensity (mph)

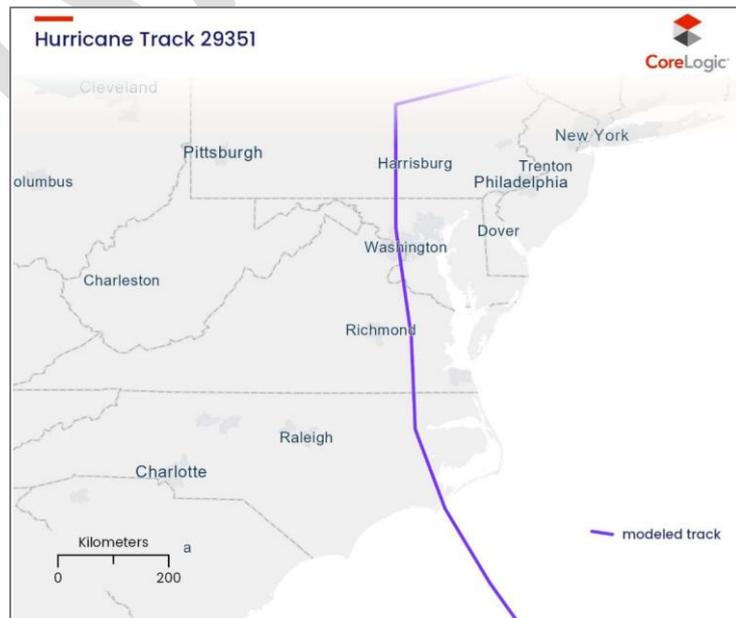


Storm Surge (ft)



Second hurricane track as modelled by AIR

Third hurricane event



Third hurricane track as modelled by RMS (left) and CoreLogic (right).

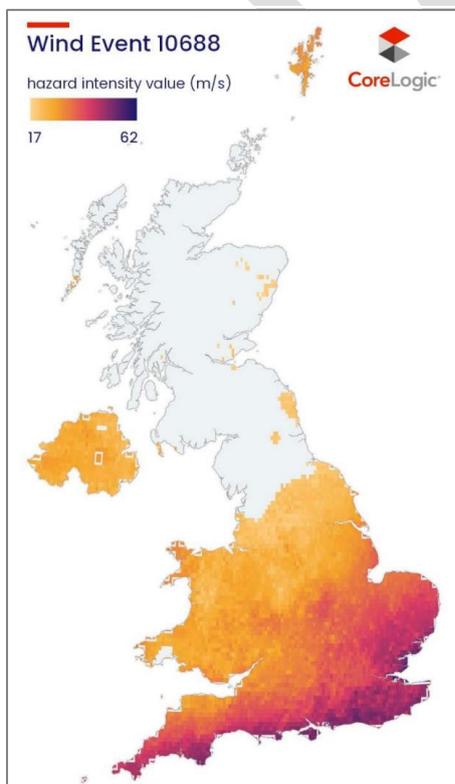
California earthquake



California earthquake faults as modelled by CoreLogic

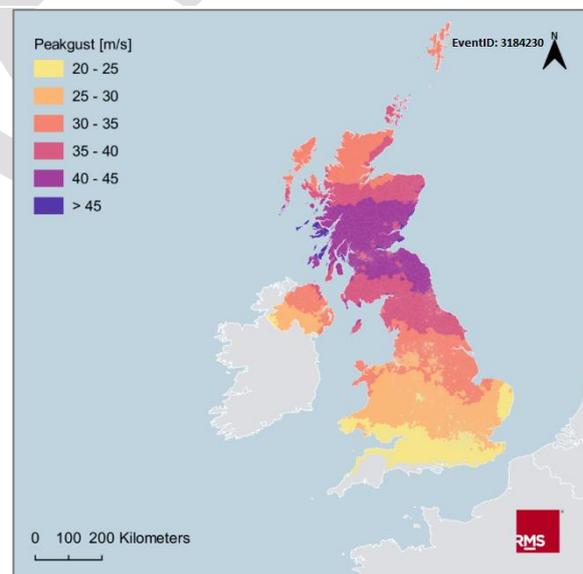
UK windstorm and inland flood

First UK windstorm



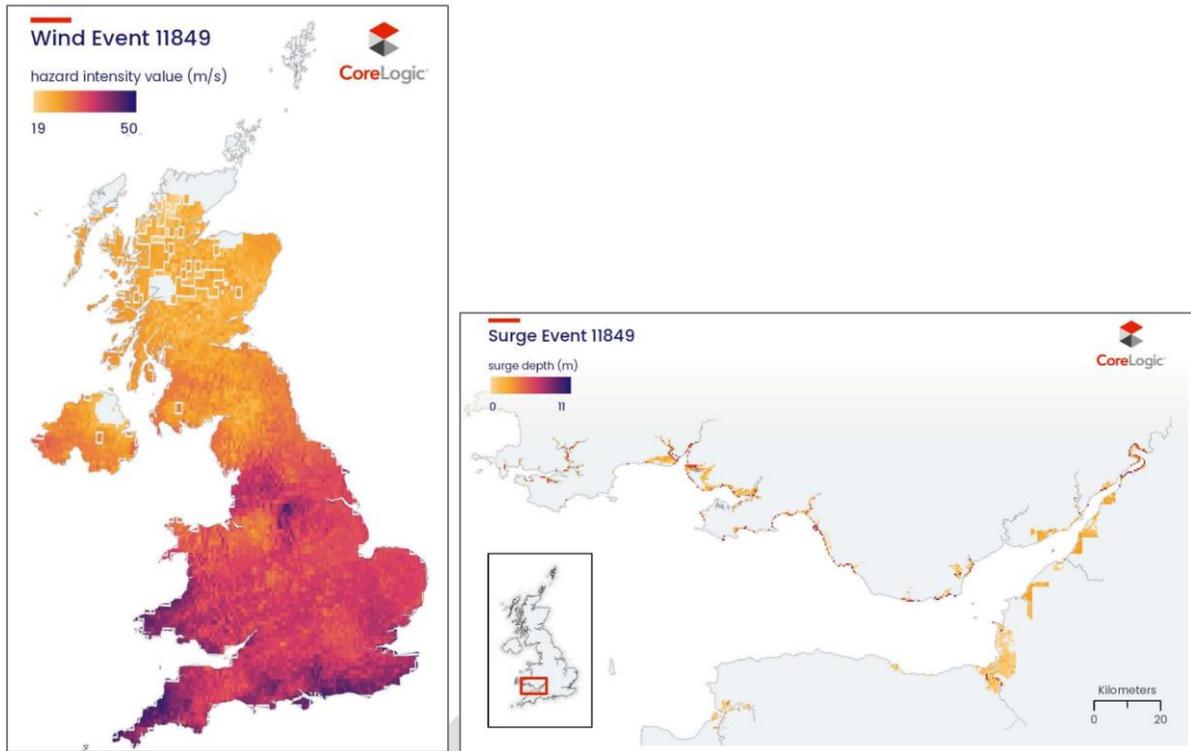
First UK windstorm as modelled by CoreLogic.

Second UK windstorm

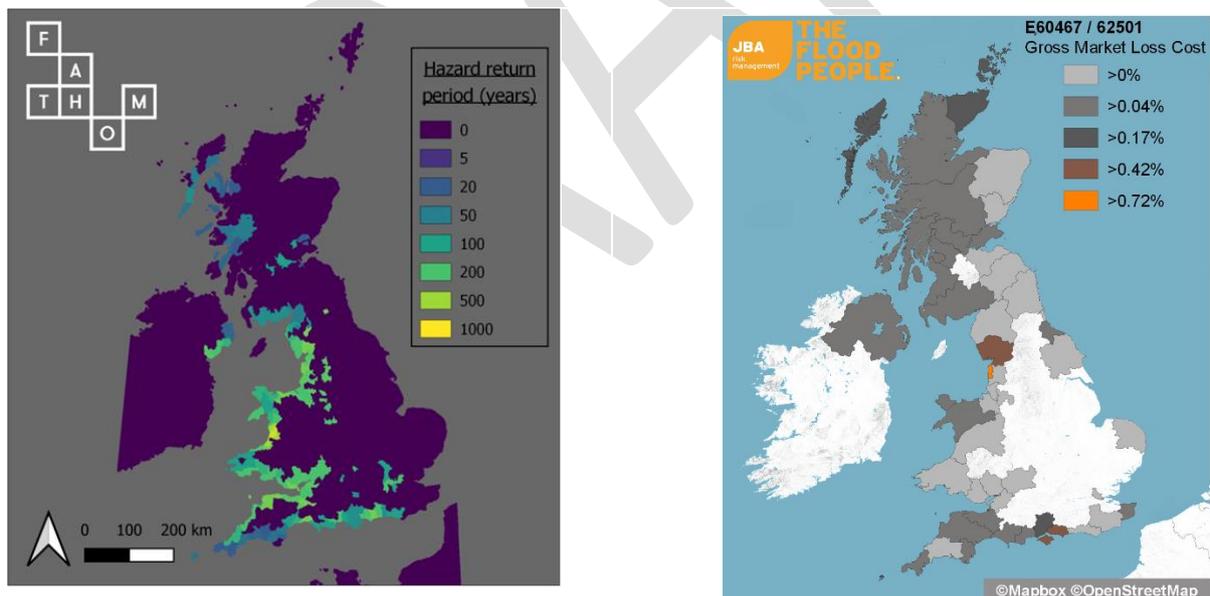


Second UK windstorm as modelled by RMS.

Second UK windstorm (continued)

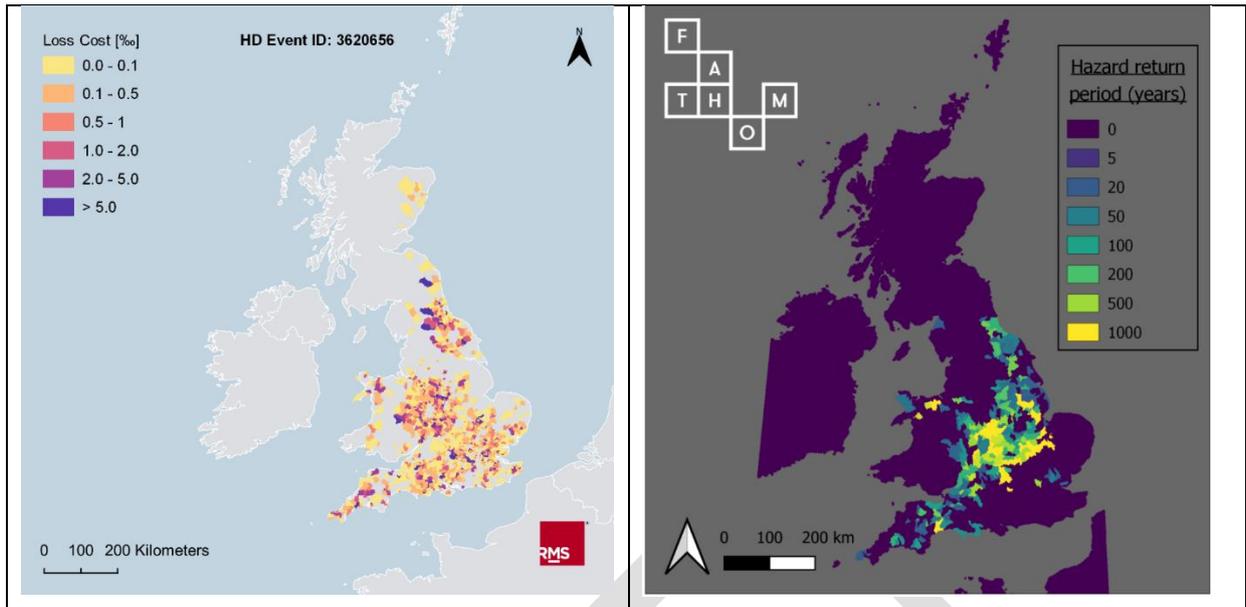


Second UK windstorm (left) and corresponding storm surge (right) as modelled by CoreLogic.



Storm surge associated with the second UK windstorm as modelled by Fathom (left) and JBA Risk Management (right).

UK inland flood



UK inland flood as modelled by RMS (left) and Fathom (right)

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Annex 4 Cyber underwriting scenarios – additional information

Unless firms or syndicates have an in-house view of the dependence of their policyholders on cloud services and the consequential business interruption losses, they should use the following assumptions.

Table IV: Reliance on cloud service providers and consequential BI losses

Economic Sector	% of revenue reliant on Cloud Service Providers	% of the cloud dependent revenue lost
Agriculture & Mining	10%	50%
Manufacturing	20%	50%
Pharmaceuticals	20%	50%
Energy and Utilities	10%	50%
Construction and Real Estate	50%	50%
Consumer Retail	50%	50%
Wholesale Trade	25%	50%
Marine	10%	50%
Aviation	25%	50%
Other transportation	25%	50%
Hospitality	80%	50%
Technology	75%	50%
Financial and Insurance	80%	50%
Professional Services	80%	50%
Other services	25%	50%
Public Administration	50%	50%
Education	50%	50%
Healthcare	70%	50%
Other	25%	50%

Annex 5 Abbreviations used

BOF	Basic Own Funds
CBES	Climate Biennial Exploratory Scenario
CSP	Cloud Service Provider
ECA	Economic Capital Assessment
D&O	Directors & Officers
FRN	Firm Reference Number
GIST	General Insurance Stress Test
GWP	Gross written Premium
GBP, £	British Pound Sterling
IM	Internal Model
IST	Insurance Stress Test
LEI	Legal Entity Identifier
LORS	Lloyd's Outward Reinsurance Scheme
Nat Cat	Natural Catastrophe
PLA	Post event loss amplification
PRA	Prudential Regulatory Authority
QRT	Quantitative Reporting Templates
RBP	Results and Basis of Preparation report
SCR	Solvency Capital Requirement
SII	Solvency II
TEU	Twenty-foot Equivalent Unit
US\$	United States Dollar

Annex 6 Acknowledgements

The PRA is grateful for the following organisations for valuable discussions held in the design and parameterisation stage of this exercise:

ABI
AIG
AIR Worldwide
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Brit
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Cybercube
Fathom
Guidewire
Guy Carpenter
Howden
Impact Forecasting
IUA
JBA Risk Management
Maximum Information
Kovrr
LMA
Munich Re
Oliver Wyman
Plymouth University
RMS
Temblor
University of Plymouth (Maritime cyber threats research group)