



BANK OF ENGLAND  
PRUDENTIAL REGULATION  
AUTHORITY

# Life Insurance Stress Test 2019

## Scenario Specification, Guidelines and Instructions

To be finalised in June 2019

*DRAFT FOR FEEDBACK FROM PARTICIPATING FIRMS*

*April 2019*

*Note: The Bank may decide to delay or not to run the exercise depending on external factors.*

Prudential Regulation Authority | 20 Moorgate | London EC2R 6DA

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## INTRODUCTION

This document provides instructions for completing the life insurance stress tests, as well as details of additional data designed to assist the PRA in monitoring sector risks. The stress tests and the additional data collection are collectively referred to as the PRA's Life Insurance Stress Test ('LIST 2019').

In 2015 and 2017, the PRA conducted stress testing exercises for general insurers. This year, we will be running a stress test exercise for life insurers concurrently with the exercise for general insurers.

The PRA requests that firms complete the Excel workbook 'LIST 2019 Template.xls' ('LIST Template') to record the numerical results of each stress test and provide the additional qualitative information requested.

## OBJECTIVES

The PRA's objective in conducting this exercise is to inform our view of sector risks, and it will assist in the supervision of individual firms. For clarity, this is not a pass/fail exercise and it is not designed to set capital buffers.

OBJECTIVES: INSURANCE STRESS TESTING		
Sectoral	<b>Sector resilience</b>	Assess losses across the UK insurance industry to severe but conceivable scenarios to inform PRA's view of sector resilience.
	<b>Systemic risks/ Sectoral behaviours</b>	Assist in understanding the extent to which individual firms make business decisions that are appropriate for the firm but, taken across the entire sector, may result in strongly adverse outcomes (eg all switching into one asset class).
	<b>Counterparty dependencies</b>	Identify the extent to which the sector relies on a concentration of reinsurers and/or jurisdictions following an extreme scenario.
	<b>Exploratory risks/ horizon scanning</b>	Assist in exploring and raising industry debate around emerging risks to understand how firms are responding eg in relation to climate change or cyber risks.
Firm supervisory	<b>Effectiveness of risk management</b>	Provide an alternative view of balance sheet volatility to specified scenarios that inform our view of how firms are managing their exposures and whether this is in line with their risk appetite.
	<b>View on capital</b>	The PRA stress testing is not used for setting capital, It provides a complementary view on a firm's capital assessment with potential for identifying assumptions or approaches that are optimistic. <i>Note: The severity of some scenarios may be beyond a firm's one-year change in Own Funds at the 1 in 200 level. Further, one scenario is a reverse stress test intended to identify the point at which the SCR coverage ratio falls below 100%.</i>
	<b>Assessment of modelling approaches</b>	Assist in understanding how different firms address technical challenges in their assessment of extreme loss events eg severe adverse economic conditions affecting ring-fenced funds.

## SCOPE OF EXERCISE

The PRA requests that only life insurers with a significant exposure to annuity products participate in the 2019 stress test.

Where firms have not received a request to participate, they do not need to submit a response. Should life insurance firms wish to be included in the exercise, they should contact their supervisor at the PRA, copying in [IST2019@bankofengland.co.uk](mailto:IST2019@bankofengland.co.uk).

## STRUCTURE OF THE LIFE INSURANCE STRESS TEST

This exercise consists of two parts:

1. Sections A and B contain the core stress tests: a downturn in the economic environment, and a set of three life insurance specific scenarios.
2. Section C is not a stress test; instead it is designed to capture information how different firms are managing difficult-to-assess risks. For life insurers it comprises a climate change exploratory exercise.

Firms are requested to assess their year-end 2018 balance sheet against the following scenarios.

### *Section A: Deterioration in the economic environment*

*Scenario 1:* A parallel downward shift in risk free interest rates of 100 bps; a widening in corporate bond spreads dependent on their current credit rating (eg 150bps for AAA rated assets); a simultaneous mass downgrade of credit assets; and a fall in other asset values (including equities down 30%, commercial property down 40% and residential property down 30%).

*At this stage in the exercise, the PRA asks firms to provide feedback regarding the pros and cons of the two options outlined for the credit downgrade event included in Scenario 1. These options are outlined the Event Definition on page 7. Firms should plan for either of the two options being selected.*

### *Section B: Deterioration in the economic environment coupled with life insurance specific scenarios*

*Scenario 2:* Scenario 1 plus an additional stress to the assumed Fundamental Spread dependent on credit quality step (eg a 30 bps increase for those assets mapped to a CQS of 2).

*Scenario 3:* Scenario 1 plus an increase in longevity expectations represented by a 15% fall in base mortality rates.

*Scenario 4:* Scenario 1 plus firms are requested to provide details of what level of percentage fall in the base mortality table would result in a SCR coverage ratio of 100% (ie a reverse stress test).

***Note: The PRA has designed these stress tests, 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 or interactions.***

### *Section C: Climate change scenario*

This section is not a stress test. Instead it is designed to capture information to help understand how different firms are managing difficult-to-assess risks – in this case climate change related risks. We expect that market feedback will enhance developments in this area, increase Board awareness, and will supplement supervisor's knowledge of the firms' overall governance and culture. These findings will also support the climate related activity of the Bank's Climate Hub in assisting the Network for Greening the Financial System (NGFS).

*Climate Change:* firms are requested to consider the impact of three hypothetical greenhouse emission scenarios on selected metrics of their business models and asset valuations. These scenarios are expressed by their climatic and financial impacts. The set of assumptions underlying each scenario is developed for illustrative purposes only, to ensure that firms complete the return on the same basis and should therefore not be taken as a precedent for future domestic or international exercises. **The assumptions in Section C do not represent a PRA forecast neither do they represent scenarios that have been built bottom-up by the PRA based on a view of future carbon price.**

We also ask firms to provide qualitative and quantitative information on any climate scenarios that the firms have already developed.

Section C is on a best endeavours basis.

## ACCOUNTING AND REPORTING

### Accounting Basis

Firms are requested to provide a separate submission, on a Solvency II basis, for each UK solo legal entity within the scope of the exercise. Where firms are uncertain as to the scope of their submission, they should consult with and obtain the agreement of their PRA supervisor.

### Opening Balance Sheet

Firms are required to provide their Balance Sheet as at year-end 2018, their Solvency Capital Requirement (SCR) and their available Own Funds to meet the SCR. The LIST Template provides the necessary Solvency II QRT references, where relevant.

### Production of the Balance Sheet following each scenario

Life Insurance firms are asked to stress their year-end 2018 balance sheet and provide a breakdown of Own Funds, SCR and SCR coverage ratios, assuming the stress is an instantaneous shock.

Firms are asked to estimate how their SCR would change in the event of each stress, providing a breakdown between the different categories of risk. Firms are not expected to recalculate the biting scenario or re-parameterise their SCR calculation post-stress (ie if the strength of 99.5 percentile equity stress is currently  $-x\%$ , then firms may assume the 99.5 percentile equity stress is  $-x\%$  post-stress).

Firms may make reasonable assumptions in estimating the SCR and risk margins post stress. Scaling is acceptable where it would not lead to materially different results to a recalculation.

It should be noted that the PRA expects firms to complete this exercise on a 'best endeavours' basis and to provide a reasonable estimate of Own Funds, SCR and SCR coverage numbers after each stress scenario. However, we do not expect that firms should use proxy models to estimate the post-stress balance sheet position (ie this should be a 'bottom up' exercise).

### Management actions

Firms should disclose what management actions they anticipate taking in the various scenarios and how this would impact their Own Funds and estimated SCR. This includes those that are already anticipated within the SCR calculation.

Non-exhaustively, management actions might include changes to asset allocation, changes to reinsurance programmes, and re-capitalisation plans.

Where firms assume management actions over and above those already anticipated within the SCR calculation, the impact of the stress pre-management action and post-management action on both the stressed balance sheet and stressed SCR should be provided.

## Materiality

Firms should complete all scenarios unless they can demonstrate that, given their specific risk coverage, the impact is immaterial.

Firms should include details of exposures to each reinsurer relating to business within the MA fund where the value of the reinsurance asset is more than 5% of the (gross) MA fund Best Estimate Liability (either in base or stress).

## Internal Models (IM)

Firms with an approved IM need only provide the IM SCR view. For firms in IMAF and likely to make an IM application before year-end 2019, firms should agree with their Supervisor the basis/bases on which results should be presented. For all other firms on the Standard Formula, including firms intending to make an IM application after 2019, the SCR should be based on the Standard Formula.

## Reporting of Ring Fenced Funds

In the LIST Template, the PRA asks firms to provide details of the Balance Sheet, Own Funds, Long Term Guarantee impacts and SCR using the QRT format for the base case and under each scenario. The PRA requests that firms add additional columns to each tab to separate out the reporting of material ring-fenced funds. This is to allow more granular analysis of the stress impacts on each fund. Firms should add an additional column for each material ring-fenced fund, with one column for non-modelled ring-fenced funds and one column for the remainder of the business. The sum of these columns should equal the reported SII value for each QRT once ring-fencing restrictions are taken into account.

# PROCESS AND FEEDBACK

## *Submission template*

For each stress scenario, firms are required to submit a number of outputs that are standard across scenarios within the Excel template provided – the LIST Template.

In certain scenarios, we ask for additional information that will allow the PRA to assess the calculation and impact of each stress in greater detail.

## *Deadline for submission*

Submission of the completed Excel template is required by **17:00 on Monday 30 September 2019**.

The Excel workbook should contain the **Firm Name** and **FRN number** in the file name and the subject of the email. Firms should send submissions to [IST2019@bankofengland.co.uk](mailto:IST2019@bankofengland.co.uk).

## *Governance requirements*

**On submission, the Board of directors is required to confirm they are satisfied with the submission and that the information provides a reasonable estimate of own funds and their SCR after each stress scenario. The results do not need to be audited.**

## *Presentation of the Stress Test results to the PRA*

The PRA encourages firms to present their stress test results shortly after the formal submission date to help our understanding of the impact of the stresses and any issues that arose in completing this exercise. This need not contain any additional information, but reflects the value of a two-way dialogue to help understand the thought process and the underlying issues in greater depth. Following our previous stress test exercise, some firms shared their Board presentations – these were very constructive in supporting our understanding of their stress test results.

### ***Resubmissions***

Individual firm supervisors will be using the stress test submission as part of their ongoing supervisory reviews and the stress test results will inform the firm's supervisory risk score.

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 2 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 during Q1 2020, drawing attention to sectoral findings or learnings of interest at a market level.

### ***Queries***

Firms should submit all queries to [IST2019@bankofengland.co.uk](mailto:IST2019@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) **LIST 2019 Template.xls** to record results

## SCENARIO SPECIFICATION

This section outlines the details of the scenarios for Life insurance firms. The 'Event Definition' outlines the movements in key macroeconomic variables and market indices in each scenario. Further detail is included in sections on 'Assumptions' and 'Reporting' to outline to firms how to apply the stresses.

### SECTION A

#### SCENARIO 1: INSURANCE ASSET SHOCK (IAS)

This asset shock has been designed to stress both life insurance and general insurance companies, with a fall in interest rates and risk free yield curves, a widening of corporate bond spreads coupled with a downgrade event, and falls in equity markets and real estate.

#### Event Definition

This section sets out the movements in key macroeconomic variables or market indices.

<u>Interest rates</u>	<p>All interest rate spot curves experience a <b>100bps absolute fall</b> at all tenors (including the Ultimate Forward Rate).</p> <p>This stress is likely to lead to negative rates at shorter durations. Where this is the case, and firms have the capability to model negative rates they should do so. For firms without the capability to model negative rates, these should be floored at zero, but this should be made clear in the response and firms should attempt to quantify on a best efforts basis the impact were negative rates modelled explicitly.</p> <p>The interest rate stresses should also apply to all assets whose valuation is interest rate sensitive in addition to the stresses outlined below (eg derivatives, corporate bonds, illiquid assets).</p>												
<u>Gilt-swap spread</u>	Firms should assume that there is <b>no stress</b> to gilt-swap spreads.												
<u>Sovereign and Central Bank Bonds</u>	Firms should assume that there is <b>no stress</b> to sovereign assets.												
<u>Credit Downgrades</u>	<p>For Central Government and Central Bank bonds, firms should assume that the Credit Quality Step (CQS) remains unchanged post stress.</p> <p>Option 1: For all other assets, firms should assume that there is a <b>2 notch downgrade</b>.</p> <p>Option 2: For all other assets, firms should assume that 75% of each asset experiences a 1 CQS downgrade and the remaining 25% of each asset experiences no movement in credit rating. For avoidance of doubt, all assets should be notionally split into 75%/25% parts.</p>												
<u>Credit Spreads</u>	<p>For fixed income assets, firms should apply the following stresses to credit spreads. For avoidance of doubt, the credit rating and Credit Quality Step (CQS) referred to in the table below is the <b>pre-stress</b> rating/CQS.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Credit Rating (non-MA fund)</th> <th style="text-align: left;">Credit Quality Step (MA fund)</th> <th style="text-align: left;">Credit Spread increase</th> </tr> </thead> <tbody> <tr> <td>AAA</td> <td>0</td> <td>150bps</td> </tr> <tr> <td>AA</td> <td>1</td> <td>170bps</td> </tr> <tr> <td>A</td> <td>2</td> <td>200bps</td> </tr> </tbody> </table>	Credit Rating (non-MA fund)	Credit Quality Step (MA fund)	Credit Spread increase	AAA	0	150bps	AA	1	170bps	A	2	200bps
Credit Rating (non-MA fund)	Credit Quality Step (MA fund)	Credit Spread increase											
AAA	0	150bps											
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A	2	200bps											



	<table border="1"> <tr> <td><b>BBB</b></td> <td>3</td> <td>300bps</td> </tr> <tr> <td><b>BB and lower and unrated</b></td> <td>4+</td> <td>400bps</td> </tr> </table>	<b>BBB</b>	3	300bps	<b>BB and lower and unrated</b>	4+	400bps
<b>BBB</b>	3	300bps					
<b>BB and lower and unrated</b>	4+	400bps					
	The credit spread increase will apply to all types of bonds that do not qualify as 'sovereign' and does not vary by duration or sector.						
<u>Equities</u>	All equities experience a <b>30% decrease in value</b> . This applies to public and private equity, hedge funds and CIS investments.						
<u>Property</u>	Firms should assume a <b>40% fall in commercial property</b> and <b>30% fall in residential property</b> .						
<u>Cash and Money Market Instruments</u>	<p>Firms should assume <b>no stress</b> to the value of cash or money market instruments with duration less than one year. For instruments with duration more than one year these should be treated as described under '<i>All other assets</i>' below.</p> <p>Firms should not assume any management actions post-stress including entering into new money market transactions.</p>						
<u>Derivatives</u>	<p>Option values should move in line with an increase in implied volatility at all tenors of <b>700bps</b>. This includes, but is not limited to, equity and swaption implied volatility.</p> <p>Swap values should move in line with a decrease in the floating yield curve of 100bps at all tenors (ie the interest rate stress). Where relevant, firms should assume that reference swap assets also fall in value in line with the relevant stress outlined in the asset shock scenario.</p> <p><i>Longevity-linked instrument values should move as if floating longevity expectations matched the extent to which longevity is stressed (this is applicable only in scenarios 3 and 4).</i></p>						
<u>Inflation</u>	Firms should assume that there is <b>no stress</b> to inflation rates.						
<u>Foreign exchange</u>	Firms should assume that there is <b>no stress</b> to foreign exchange rates.						
<u>All other assets</u>	<p>Any investment asset not specifically referenced should be stressed as if it were a corporate bond (ie apply the <b>credit spread</b> and <b>interest rate</b> stresses above) where it is sensible to do so (ie the assets have a contractual cash flow profile and are either mapped to a CQS or have a credit rating).</p> <p>Where this is not possible, all other assets should experience a <b>30% value fall</b> as for equities. This is to ensure that all assets held by firms (other than cash) experience some form of stress. This should include investments in subsidiaries where the firm does not intend to 'look through'.</p>						
<u>Fundamental Spread</u>	<p>Firms should use the relevant EIOPA Fundamental Spread (FS) based on the Financial/Non-Financial sector and revised Credit Quality Step of the asset post-stress.</p> <p>Firms should assume there is no change to the EIOPA FS tables at the stress date.</p> <p>Firms should assume the Long Term Average Spread (LTAS) floor component of FS is unchanged following the stress event.</p>						

## SECTION B

### SCENARIO 2: INSURANCE ASSET SHOCK (IAS) WITH FUNDAMENTAL SPREAD INCREASE

This scenario assumes that the economic downturn specified in Scenario 1 occurs with a simultaneous increase in assumed Fundamental Spreads. This is intended to represent that in stressed conditions as outlined in Scenario 1, the way Fundamental Spreads are derived are reassessed and a more pessimistic view is taken.

#### Event Definition

This section sets out the movements in key macroeconomic variables or market indices.

Firms should assume the changes to macroeconomic variables or market indices as set out in Scenario 1 above, plus:

<u><i>Fundamental Spread</i></u>	<p>Apart from Central Government and Central Bank bonds (where firms should apply <b>no stress</b> to the EIOPA Fundamental Spread), firms should apply the following stresses to the EIOPA base FS tables:</p> <p>For avoidance of doubt, the Credit Quality Step (CQS) referred to in the table below is the <b>post-stress</b> CQS.</p> <table border="1"><thead><tr><th>Credit Quality Step (MA fund)</th><th>Fundamental Spread increase</th></tr></thead><tbody><tr><td>0</td><td>10bps</td></tr><tr><td>1</td><td>20bps</td></tr><tr><td>2</td><td>30bps</td></tr><tr><td>3</td><td>30bps</td></tr><tr><td>4+</td><td>30bps</td></tr></tbody></table> <p>The same specified bps increase in FS should apply to all asset classes in the MA calculation post-stress. These increases in FS should be applied to all durations, with the same increase in FS applying to Financial and Non-Financial assets.</p> <p>The assumed increase in FS should be split evenly between Probability of Default and Cost of Downgrade at all tenors.</p> <p>Firms should assume that The Long Term Average Spread (LTAS) floor component of FS is unchanged following the stress event.</p>	Credit Quality Step (MA fund)	Fundamental Spread increase	0	10bps	1	20bps	2	30bps	3	30bps	4+	30bps
Credit Quality Step (MA fund)	Fundamental Spread increase												
0	10bps												
1	20bps												
2	30bps												
3	30bps												
4+	30bps												

## SCENARIO 3: INSURANCE ASSET SHOCK (IAS) AND LONGEVITY EVENT

This scenario assumes that the economic downturn specified in Scenario 1 occurs with a simultaneous increase in longevity expectations.

### Event Definition

This section sets out the movements in key macroeconomic variables, market indices and demographic assumptions.

Firms should assume the changes to macroeconomic variables or market indices as set out in Scenario 1 above, plus:

<u>Longevity</u>	Firms should assume a <b>15% fall</b> in the base mortality table. There should be no change to mortality improvement assumptions.
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For the avoidance of doubt, firms should not assume the increase in fundamental spreads set out in Scenario 2.

## SCENARIO 4: INSURANCE ASSET SHOCK (IAS) AND LONGEVITY EVENT (REVERSE STRESS)

This scenario is a form of a reverse stress test and an extension of Scenario 3. Firms with SCR coverage at or below 100% after applying the previous scenario are not required to complete this scenario.

Firms are requested to provide details of what level of percentage fall in the base mortality table would result in a SCR coverage ratio of 100%. This should be done on a best endeavours basis.

### Event Definition

This section sets out the movements in key macroeconomic variables, market indices and demographic assumptions.

Firms should assume the changes to macroeconomic variables or market indices as set out in Scenario 1 above, plus:

<u>Longevity</u>	Firms should assume an <b>X% fall</b> in the base mortality table. There should be no change to mortality improvement assumptions. The fall in base mortality table should be estimated such that a fall of X% results in a SCR coverage ratio of 100%
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For the avoidance of doubt, firms should not assume the increase in fundamental spreads set out in Scenario 2.

## ASSUMPTIONS

This section details assumptions that firms should make in relation to Matching Adjustment (MA), Volatility Adjustment (VA), Transitional Measures on Technical Provisions (TMTPs), Equity Release Mortgages (ERMs), other assets in the Matching Adjustment Portfolio (MAP) and Defined Benefit (DB) Pension Schemes. The details outlined in this section apply to all scenarios in Sections A and B above.

### Matching Adjustment

Firms should calculate the Matching Adjustment (MA) assuming that asset values/spreads/CQS have experienced the stresses outlined above.

Firms should attempt to restore the asset and liability cash flow matching of their MA portfolio following the stress; so long as any assumed rebalancing actions are practical to be implemented in a post-stress environment within a 2-month time window. In particular, firms should consider the potential lack of availability of post-stress investment grade fixed income assets in such a scenario. Firms should not assume that they would be able to sell current holdings of illiquid assets, or purchase new illiquid assets, within the 2-month time window. We assume that for most firms the management actions described here are already anticipated within its existing SCR calculation methodology.

The BBB cap should continue to apply for the purposes of calculating technical provisions following the stress, consistent with Article 77c(1)(c) of the Directive (ie firms should limit the MA benefit obtained on lower credit quality assets to that obtained on similar BBB assets). Firms should estimate the impact of applying the BBB cap to their downgraded portfolio in determining technical provisions and set this out clearly in their response.

Where firms need to rely on further management actions over and above those anticipated in their current SCR calculations following the stress event to comply with MA requirements, and these management actions are in line with the expectations set out in SS8/18<sup>1</sup>, firms may outline these management actions in their response and if possible, provide the balance sheet impact of assuming these management actions as additional information.

Separately, firms should provide as a sensitivity the estimated impact on their (stressed) balance sheet if the only assets they could purchase externally for the purpose of restoring their asset liability matching of the MA portfolio were gilts.

### Volatility Adjustment

Firms should assume that the Volatility Adjustment increases by **20bps** after the stress.

### TMTP

Firms should assume that they will successfully apply for a TMTP recalculation following the stress event and include the impact of that recalculation in the results (unless they can demonstrate that the impact is not significant).

### ERMs

#### Restructured ERMs:

For simplicity, firms should treat any MA eligible note(s) as if it were a corporate bond (ie apply the **credit spread, credit downgrade** and **interest rate** stresses above).

Firms should stress the junior note(s)/equity tranche and other SPV assets as though they were an **equity** holding (ie apply a 30% fall in value).

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1 <https://www.bankofengland.co.uk/prudential-regulation/publication/2018/solvency-2-internal-models-modelling-of-the-matching-adjustment-ss>

Firms should not assume any management actions in respect of the restructured ERMs (including resizing of notes).

Separately, we ask firms to investigate and disclose how the specified stress would compare to the alternative of applying a look-through approach based on the specified stress to residential property and interest rates, and the impact this would have on the senior and junior notes/equity tranche (and in particular whether the credit quality of the senior notes would be impacted). A 'best efforts basis' response will be satisfactory for this purpose.

We also ask firms to indicate what level of residential property stress would deliver the same level of impact on own funds as the specified stress, for ERMs only. Again, a 'best efforts basis' response will be satisfactory for this purpose.

#### Unrestructured ERMs:

Unrestructured ERMs should be subject to a stress of a **30% fall** in value. We do not require firms to stress underlying properties and carry out a full revaluation of each ERM asset individually.

#### **Other assets held in the Matching Adjustment Portfolio (MAP)**

For the avoidance of doubt, all assets in the MAP (other than assets that qualify as 'sovereign' or cash) should be stressed as if they were a fixed income asset (ie apply the **credit spread, credit downgrade** and **interest rate** stresses above).

Regardless of the nature of the underlying asset, firms should assume that restructured assets experience the same treatment as outlined above for ERM restructurings. Firms should assume that the restructured MA eligible asset is treated as a fixed income asset (ie apply the **credit spread, credit downgrade** and **interest rate** stresses of that scenario). Firms should assume that all other assets of the SPV are equity holdings (ie 30% fall in value). Similar to ERMs, we ask firms to separately investigate and disclose how the specified stress would compare to the alternative of applying a look-through approach to the underlying assets. A 'best efforts basis' response will be satisfactory for this purpose.

#### **Pension scheme discount rate**

For the valuation of pension scheme liabilities, firms should assume that the discount rate would change by the level of any change in the risk-free rate plus 50% of the change in spread on AA rated corporate bonds. Under the proposed stress the risk-free rate decreases by 100bps and 50% of the spread on AA rated corporate bonds is an increase of 85bps. Therefore, both elements combined result in a **15bps fall** at all tenors to the discount rate.

#### **Reinsurance assets**

Where firms have material reinsurance arrangements, the value of the reinsurance asset in stress (and in particular the level of the Counterparty Default Adjustment) should be justified with sufficient backing evidence.

For material external reinsurance assets, firms should consider how the each scenario would impact the counterparty.

For intra-group reinsurance, one approach could be to include the group reinsurer within the scope of the stress testing exercise (and fill out the templates for the reinsurer). Where the group reinsurer is not a UK entity and/or it would be difficult to complete the templates at the specified level of granularity, firms should discuss with PRA what information can be provided in order to provide adequate justification for the value of the reinsurance asset.

Where this is not possible, an alternative approach would be to assume that the reinsurance arrangement is unwound pre-stress (ie recaptured by the cedant), although this approach should be discussed and agreed with PRA in advance.

## REPORTING

This section outlines how firms should report the results of the stress testing exercise.

### Post-stress SCR

Firms are asked to re-calculate the SCR following the stress. As an initial baseline, firms may assume the SCR stresses/calibrations are unchanged following the stress. For example, if the biting equity stress is a X% fall in equities then firms should assume that, after the application of the scenario stress, their equity holdings experience a fall of X% (ie a total stress of  $(1-30%)*(1-X\%)$ ). However, firms may choose to provide supplementary information outlining whether/why the SCR calibration should change post-stress. For the avoidance of doubt, where firms do recalibrate, this would be additional information provided on top of the baseline assumption.

### Risk margin

As part of the stressed balance sheet, firms are required to recalculate their risk margin following the stress. Firms should assume no change to the methodology for calculating the risk margin in any of the stress scenarios. Note that firms should assume that TMTP will be recalculated post stress.

### With-profit funds

In previous stress testing exercises, where firms have been able to demonstrate a significant estate leading to no burn-through to shareholder assets post-stress, they have been exempt from stressing with-profit funds. The ring-fencing requirements of with-profit funds mean that self-supporting with-profit funds do not affect the remainder of the insurance entity. However, the economic stress outlined is severe and any firm who seeks to excuse a with-profit fund from the calculation should be able to demonstrate with a high degree of certainty that the estate is capable of absorbing the stress and that any impact on shareholder transfers out of the fund (where applicable) is immaterial. This includes demonstrating that the method used to derive the stress position of the with-profit fund is reliable (ie where a proxy model is used to support the exclusion, that there are no material errors in the proxy model for the fund at this point in the distribution).

### Management actions

Firms should disclose what management actions they anticipate taking for the various scenarios and how this would affect their Own Funds and estimated SCR. This includes those that are already anticipated within the SCR calculation.

Where firms assume management actions over and above those already anticipated within the SCR calculation, the impact of the stress pre-management action and post-management action on both the stressed balance sheet and stressed SCR should be provided.

## SECTION C: CLIMATE CHANGE SCENARIOS

The potential financial impacts of climate change are well-documented. Furthermore, the PRA's recent draft Supervisory Statement<sup>1</sup> set out the importance of firms using scenario analysis to assess the impact of the financial risks from climate change on their business strategy. However, last year's Task Force on Climate-related Financial Disclosures (TCFD) report (published in September 2018) showed that while firms were starting to consider impacts to their strategic resilience resulting from climate change, few were systematically using scenario analysis.

This investigatory exercise is designed to provide additional market impetus in this area. It will also provide additional data that informs the Bank's development of a consistent and effective approach to climate-focused scenario analysis, both domestically and through international groups like the Network for Greening the Financial System. Whilst this exercise will inform future Bank work, it should be viewed as investigatory in nature. **The assumptions and methodology have been designed on this basis and should therefore not be taken as a precedent for future domestic or international exercises.**

This section comprises of two parts:

**Part 1** consists of three data-driven sets of hypothetical narratives that are designed to help companies think through how different plausible futures could impact their business models in the medium to longer term. And while we have provided a set of assumptions that are designed to quantify the impacts using simple metrics for illustrative purposes, this is designed to promote discussion on how business models and balance sheets may need to adapt, not about assessing current financial resilience.

Wherever possible we have obtained the underlying assumptions for each narrative based on publically available research. However, given the limited availability of research on how climate scenarios translate into financial impacts, high-level assumptions have been made to simplify the exercise and make results across firms comparable. These assumptions are set out below.

**Part 2** asks firms to provide qualitative and quantitative information on any climate scenarios that the firms have already developed.

Firms are asked to complete this section on a best endeavours basis. Where firms are not able to answer a specific question they should provide a reason – for example, whether this is due to the firm's level of maturity in this area or whether their approach to managing climate-related risks means the question is not relevant.

### Structure of the scenario analysis

The scenario analysis is split in two parts: a quantitative data-driven scenario analysis and a qualitative information gathering section.

**Part 1:** Asks firms to conduct a scenario analysis where we provide a set of hypothetical greenhouse gas emission scenarios expressed by their resulting climatic and financial impacts. ***These do not represent a PRA forecast neither do they represent scenarios that have been built bottom-up by the PRA based on a view of potential future climate policies (such as a carbon price).*** That is work for the future. Consequently, the scenarios presented as part of this exercise should not be interpreted as a prelude to a reference scenario for the Bank of England. Rather, they are a set of extreme yet plausible hypothetical assumptions, based on publically available information, that are put together using expert judgement to test a firm's ability to respond to a given assumed climatic state. We subsequently request firms to attempt and quantify the financial impacts against the assumed

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1 Draft PRA expectations set out in CP23/18 'Enhancing banks' and insurers' approaches to managing the financial risks from climate change' available at: <https://www.bankofengland.co.uk/prudential-regulation/publication/2018/enhancing-banks-and-insurers-approaches-to-managing-the-financial-risks-from-climate-change>

climatic and financial impacts stemming from three plausible future greenhouse gas emission scenarios.

**Part 1** of the scenario analysis has two objectives: (1) gather quantitative information regarding financial impacts under a given set of climate change-related assumptions; and (2) allow the PRA to assess the value of the systems, tools and data currently available to insurers for assessing financial impacts from physical climate change risk. Should the firms have already undertaken quantification of the financial impact from a climatic state under a different set of assumptions than those put forward by the PRA, they are requested to present those results in Part 2 below.

**Part 2:** For those firms that have already made sufficient progress in developing climate scenarios, we ask firms to outline qualitatively the set of assumptions they have contemplated under their assumed climate change scenarios. The aim of this qualitative information-gathering exercise is for the PRA to understand the range of assumptions and parameters currently considered by insurers when assessing financial impacts from climate change risks. This part of the scenario analysis focusses on understanding the main assumptions (and challenges) that firms use to translate broad climatic scenarios into tangible impacts to their firms. If firms consider multiple stress test scenarios they only need report a maximum of two in detail. If firms have not developed yet their own set of assumptions, they are requested to complete this section of the scenario analysis by expressing (1) any interim assumptions they may have contemplated; and (2) state any barriers that is prohibiting them from developing these scenarios.

### **Part 1: Potential quantitative impacts under specific socio-economic and climatic conditions**

We ask firms to consider the expected impact on their assets, liabilities and business models, assuming that their in-force insurance exposures and their current investment profile remain constant. In essence, we ask firms to undertake a sensitivity analysis under three different climatic states.

As a background to interpreting these three hypothetical scenarios: the Paris Agreement has set out climate targets for the year 2100. Meeting these targets will require significant structural changes in the economy over the coming years and decades. In order to consider how these risks could materialise as financial impacts to firms over short and long durations, we have set out three scenarios:

- The first scenario is designed to assess firm's resilience to a Minsky moment – a wholesale reassessment of prospects in financial markets which materialises over the medium-term business planning horizon.
- The second and third scenarios are designed at directing firms' focus on the long-term financial impact from climate-related risks in different future outcomes.

In order to be consistent with the Paris agreement, we have defined the projected temperature rise targets relevant to 2100, but we are asking firms to report these impacts at shorter time frames where the temperature rises achieved will be different from the long-term target specified. This exercise is not aiming to ask firms to develop the physical, macro- and micro-economic financial impacts stemming from the expected climatic state; instead, this scenario analysis provides explicit, hypothetical risk assumptions to ensure firms are analysing financial impacts on the same basis and hence minimise the burden of undertaking this exercise. As such, the three scenarios outlined below are provided for illustrative purposes to aid firms understand the basis upon which the PRA's hypothetical physical and transition risk assumptions have been provided.

*Scenario A:* A sudden transition scenario materialising over the medium-term business planning horizon that results in achieving a maximum temperature increase of 2°C (relative to pre-industrial levels) by 2100 but only following a **disorderly transition**. In this scenario, transition risk is maximised. Firms are invited to undertake scenario analysis assuming the Minsky moment has



occurred by 2022. The scenario is based on the type of disorderly transitions highlighted in Furman (2015)<sup>1</sup>.

*Scenario B:* A long-term **orderly** transition scenario that is broadly in line with the Paris Agreement. This involves a maximum temperature increase of 2°C by 2100 (relative to pre-industrial levels) with the economy transitioning to be greenhouse gas-neutral in the next three decades by 2050. The underlying assumptions for this Scenario are based on the range of 2° scenarios cited in the IPCC AR5 report (2014)<sup>1</sup>.

*Scenario C:* A 'hot house' scenario reaching a maximum temperature increase of 5°C (relative to pre-industrial levels) by 2100 assuming **no transition** where physical climate change is maximised following an emissions pattern similar to an IPCC RCP 8.5<sup>2</sup>. We have asked firms to consider their physical risks as at 2100.

Firms are requested to consider the impact of climate change on selected metrics of their business models and asset valuations, split between:

- Physical risk: for purpose of this investigatory exercise, physical risk is only applicable for **general insurers**. This is reflected as the risk arising from hydro-meteorological events, such as droughts, floods, storms and sea-level rises. To minimise the burden of the scenario analysis exercise, the components considered are only a subset of perils that could be impacted by physical climate change risk. For this exercise US hurricane and UK flood, freeze and subsidence perils have been selected to test firms' abilities to respond to such an exercise.
- Transition risk: financial risk that can result from the process of the financial system adjusting towards a lower-carbon economy, including policy, consumer behaviour or technological shifts.

The set of assumptions on climatic and financial impacts under the three scenarios are purposely non-exhaustive as the goal of the scenario analysis is investigatory in nature. The PRA recognises that for different portfolios, the materiality of natural catastrophe perils and asset classes affected will differ. We have provided reference values as part of the set of assumptions. Where firms are inclined to provide their own assessments of climate-related impacts under different scenarios; they are encouraged to do so together with their rationale. The resources listed in Annex I may be useful in interpreting the scenario analysis values below.

The PRA recognises that metric(s) chosen to measure the financial impact from climate change are dependent on the focus of any given climate change study. This scenario analysis exercise does not intend to capture the full range of relevant metrics that could reflect a meaningful financial impact as a result of climate change. From the consultation undertaken to date, the following metrics were selected for this exercise:

- Impact to assumed liabilities: Annual Average Loss (AAL) and 1-in-100 Aggregate Exceedance Probability (AEP).
- Impact to assets: change in portfolio market valuation. Expressed as a monetary value amount and as a 1-in-100 Value at Risk (VAR), separately for equities and bonds.

### **PHYSICAL RISKS – impact to liabilities (general insurers only)**

The set of assumptions detailed below are put together for exploratory purposes to ensure that firms complete the return on the same basis. **This set of assumptions are developed for illustrative purposes only.**

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1 Furman, J, Shadbegian, R., Stock, J. (2015): 'The cost of delaying action to stem climate change: a meta-analysis', available at <https://voxeu.org/article/cost-delaying-action-stem-climate-change-meta-analysis>.  
2 IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

The physical risk assumptions provided below have been developed to permit firms to assess the financial impacts of climate change contained on their existing assumed liabilities. The PRA acknowledges that life insurer’s liabilities and both life and non-life assets are equally exposed to physical climate change risk, however, for this exercise, we have limited the complexity of the analysis to reflect the current level of maturity of available tools, data and systems.

Peril	Assumptions	Scenario A: 2022	Scenario B: 2050	Scenario C: 2100
US Property - Hurricanes <sup>1,2,3,4</sup>	% increase in frequency of major hurricanes		10%	20%
	Uniform increase in wind speed of major hurricanes			5%
	% increase in surface runoff resulting from increased tropical cyclone-induced precipitation		5%	10%
	Increase in cm in average sea-levels for US mainland coastline between Texas and North Carolina		5cm	10cm
UK Property - Flood <sup>5</sup> , freeze and subsidence	% increase in surface runoff resulting from increased precipitation		6%	10%
	Uniform increase in cm in average sea-level		4cm	10cm
	Increase in subsidence-related property claims using as a benchmark the worst year on record since 1990		10%	25%
	Increase in freeze-related property claims using as a benchmark the worst year on record since 1990		10%	25%

**Notes:**

- For impact to General Insurers’ assumed liabilities, firms are advised to consider using available tools<sup>6</sup>.
- For impact to assets, firms are not expected to complete a return. However, if a firm has developed the tools that permit them to do so, we ask to provide this return with the underlying assumptions in Part 2.
- Refer to Annex I for further background on the material used to develop the assumptions above, which should be interpreted as exploratory only.

**TRANSITION RISKS – impact to assets**

The set of assumptions detailed below are put together for exploratory purposes to ensure that firms complete the return on the same basis. **This set of assumptions are developed for illustrative purposes only.**

<sup>1</sup> [Risky Business](#) (2014), National Report: The economic risks of climate change in the United States ;

<sup>2</sup> Emanuel K, Sobel A 2013. Response of tropical sea surface temperature, precipitation, and tropical cyclone-related variables to changes in global and local forcing. *J Adv Model Earth Syst*, 5:447–458.

<sup>3</sup> Emanuel, K. E., 2017: Assessing the present and future probability of Hurricane Harvey’s rainfall. *Proc. Natl. Acad. Sci. USA*, 114, 12 681–12 684, doi:10.1073/pnas.1716222114.

<sup>4</sup> Klotzbach, P.J.; Bowen, S.G.; Pielke, R., Jr.; Bell, M. 2018 Continental United States hurricane landfall frequency and associated damage: Observations and future risks. *Bull. Am. Meteorol. Soc.*

<sup>5</sup> Source: [UK Climate Change Risk Assessment](#) 2017.

<sup>6</sup> PRA (in press); A Framework for Assessing Financial Impacts of Physical Climate Change Risk for the General Insurance Sector: A Practitioner’s Aide

The transition risk assumptions provided below have been developed to permit firms to assess the financial impacts on their assets. The PRA recognises that feedback loops between climatic impact and the wider economy need to be fully incorporated when assessing the financial impacts from climate change on a firm, however, for this exercise, we have limited the complexity of the analysis to reflect the current level of maturity of tools, data and systems available.

The table below provides assumptions affecting equities. For impacts on corporate bonds apply a flat multiplier of 15% to these changes in equities values (i.e. impact on corporate bonds = 0.15 x impact on equities).

Sector	% of investment portfolio in following sectors <sup>1</sup>	Assumptions	Scenario A: 2022	Scenario B: 2050	Scenario C: 2100
Energy <sup>2</sup>	Electricity producers/Gas/Coal/Other/renewables	Change in equity value for sections of the investment portfolio comprising material exposure to the energy sector as per below:			
		Coal Oil Gas Renewables	- 40% - 28% +13% +20%	-15% -10% +7% +10%	
Transport <sup>3</sup>	Automotive (Electric Vehicles and non-Electric Vehicles), Aviation (freight and passenger), Marine (freight and passenger), manufacture of other transport equipment	Change in equity value for sections of the investment portfolio comprising material exposure to the transport sector as per below:	-30%	-10%	
		Automotive non EV Automotive EV Non-Automotive (eg marine, aviation)	- 30% + 5% - 20%	- 10% - -5%	
Materials/ Metals/ Mining <sup>4</sup>	Manufacture and first-order processing of coke and refined petroleum products, chemicals, cement, iron and related alloys processing	Change in equity value for sections of the investment portfolio comprising material exposure to materials/metals/mining sector as per below:			
		Proportion of the portfolio relying on transporting/extracting/processing fossil fuels or heavily reliant on fossil-fuel energy	-25%	-10%	

<sup>1</sup> Refer to Annex I for indicative suggested NACE and GICS sector codes to help guide your portfolio segmentation

<sup>2</sup> Source: [World Energy Outlook](#) (IEA, 2018). Scenario A based on SDS, Scenario B based on NPS and Scenario C on CPS.

<sup>3</sup> Source: [World Energy Outlook](#) (IEA, 2018), and De Nederlandsche Bank (2018); An energy transition risk stress test for the financial system of the Netherlands

<sup>4</sup> Source: De Nederlandsche Bank (2018); An energy transition risk stress test for the financial system of the Netherlands

Water, Agriculture & Food Security <sup>1</sup>	Agriculture, forestry, fishing, dairy cattle, water utilities, food logistics and retail	Change in equity value for sections of the investment portfolio comprising material exposure to water (inc. utilities), agriculture & food security sector as per below:			
		Proportion of the portfolio with income heavily reliant on transporting/trading/supplying products based on water/food/agriculture (eg super-market chains, utilities, etc.)	-15%	-10%	
Real Estate Assets (inc. CRE & infrastructure) <sup>2</sup>	Real estate activities	Change in property value for assets materially affected by physical climate change risk. Apply the price drop impact on mortgage valuations where relevant.	-30%	-10%	
		Change in property value for assets <u>not</u> affected by physical climate change risk. Apply the price drop impact on mortgage valuations where relevant.	+10%	+7%	
Investment / Interest Rates <sup>3</sup>		Sovereign bond credit ratings downgraded as countries stress their balance sheets in their need to fund adaptation strategies (downgrade as a function of a country vulnerability to climate change – refer to Annex I)	-30 to -5 basis points	- 50 to -10 basis points	

#### Notes:

- The asset categories outlined below have been purposely limited to first-order impacts as the purpose of the scenario analysis is primarily investigatory in nature. To help firms classify the asset portfolio across the categories outlined in the table below we have provided in the Annex I suggested indicative NACE and GICS codes that could be used alongside tools such as Thomson Reuters and Bloomberg Terminal.
- Other resources: A non-exhaustive list of tools and data providers that may assist firms in undertaking this scenario analysis is provided below. This set of resources should not be considered as an endorsement of the following products or services, or the data underlying them, but rather a list of resources that may be useful to consult as a starting point of this investigatory exercise.
  - [TCFD Knowledge Hub](#): for resources on how to get started on climate-related scenario analysis.
  - [PACTA tool](#): for help in assigning listed debt and equity to specific sector categories such as energy, transport and materials.

<sup>1</sup> Source: [OECD](#) (2015), The Economic Consequences of Climate Change

<sup>2</sup> De Nederlandsche Bank (2018); An energy transition risk stress test for the financial system of the Netherlands. UNEP FI - Acclimatise (2018); Navigating a New Climate  
Dubbelboer, J., Nikolic, I., Jenkins, K., and Hall, J. (2017) An Agent-Based Model of Flood Risk and Insurance, Journal of Artificial Societies and Social Simulation 20(1) 6, Doi: 10.18564/jasss.3135;  
[Risky Business](#) (2014) National Report: The economic risks of climate change in the United States.

<sup>3</sup> GEF (2014) The price of doing too little too late: the impact of the carbon bubble on the EU financial system

- [Transition Pathway Initiative](#): Assessing companies' strategic resilience to transition-related risks for a subset of large global firms.
- [Climate Impact Lab](#): Maps of physical impacts on a granular level, up to end of century.
- Notre Dame Global Adaptation Initiative [country vulnerability ranking](#) or Moody's Investors Service' [Climate Change & Sovereign Credit Risk](#): provides relative country ranking on sovereign susceptibility to climate risks.

## Part 2: Scenario assumptions

Part 2 supports the development of future climate change scenarios for PRA stress tests. For those firms that have already made sufficient progress in developing climate change scenarios, the scenario analysis requests assumptions and parameters. The focus of this part of the scenario analysis is on understanding how firms are translating broad climate change scenarios into more detailed assumptions to assess financial tangible impacts on their businesses.

Firms are asked to provide details of all the material assumptions for up to two of their main climate change-related scenarios (where available).

The climate change scenarios should indicate how physical and transition risks related to climate change are addressed in the context of their key business decisions.

We expect the material assumptions to include the following:

### Climatic scenario assumptions

1. Greenhouse gas levels and extent of the global temperature rise assumed to occur
2. Time frame and pathway over which this rise is assumed to occur
3. Material additional aspects such as the impacts of international initiatives / policy actions, assumptions around technology (for example carbon-capture), consumer sentiment, etc. It would be particularly helpful if firms could explain what assumptions they have made about a future carbon price, and how that was calculated.

### Assumptions required translating climatic scenarios to business impacts

1. Impacts on asset valuations (by class – equities, corporate bonds, sovereigns, property, infrastructure, utilities, oil and gas, automotive, etc. - if material), and split between
  - a. Physical Risk (general insurers only): Physical risks from climate change are those which arise from climate and weather-related events, such as droughts, floods and storms, and sea-level rise; and
  - b. Transition Risk: Transition risk is the financial risk which can result from the process of adjustment towards a lower-carbon economy and associated impact/cost of reducing emissions.
2. Impact on the valuation of liabilities
  - a. Physical risk (general insurers only): Physical risks from climate change are those which arise from climate and weather-related events, such as droughts, floods and storms, and sea-level rise. In particular, changes in the frequency and severity of hydro-meteorological natural catastrophes (to the extent that the firm has exposure to specific perils). Physical risk can impact both general and life insurance (eg impact on mortality rates of more extreme summers or winters).

- b. Transition risk: Transition risk is the financial risk that can result from the process of adjustment towards a lower-carbon economy and associated impact/cost of reducing emissions. For example, the transition to a lower carbon economy and wider adoption of electric vehicles could affect levels of air pollutants.

Where firms have other material assumptions, these will also need to be set out in the feedback. Firms should set out where they make assumptions about potential opportunities (eg green revenues) as well as risks in their analysis.

## ANNEX I: CLIMATE CHANGE SCENARIOS – ADDITIONAL INFORMATION

The background information provided in this Annex is to aid the firms understand the basis upon which expert judgement assumptions were developed in creating the climate change scenario analysis parameters. The information provided below is neither an example of a thorough nor exhaustive research effort to develop climate change scenarios. Instead this information is shared in aim of full transparency of underlying assumptions. Since the aim of the scenario analysis as part of the Insurance Stress Test 2019 exercise is principally exploratory, the information upon which the scenarios were based upon are not representing the latest research and understanding that would permit an insurance firm to build their own climate change scenarios. Future Bank of England initiatives such as the NGFS will provide with further information to support firms build their own climate change scenarios.

### PHYSICAL RISK

- The development of hypothetical values affecting US Hurricane are based on the PRA-led working group discussions leading to the publication of the Framework for Assessing Financial Impacts of Physical Climate Change Risk for the General Insurance Sector<sup>1</sup> and particularly literature review analysed and discuss with catastrophe model development firms including AIR, KatRisk and RMS, supplemented by discussions with experts in the market and academics<sup>2</sup>. The hypothetical values put forward in this exploratory exercise do not represent the opinions of the above-mentioned sources.

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<sup>1</sup> PRA (2019), in press.

<sup>2</sup> Sources: Bhatia, K., G. Vecchi, H. Murakami, S. Underwood, and J. Kossin, 2018: Projected response of tropical cyclone intensity and intensification in a global climate model. *J. Climate*, in review; and Crompton, R. P., R. A. Pielke Jr., and J. K. McAneney, 2011: Emergence time scales for detection of anthropogenic climate change in US tropical cyclone loss data. *Environ. Res. Lett.*, 6, 014003, doi:10.1088/1748-9326/6/1/014003; and Donnelly JP, Hawkes AD, Lane P, MacDonald D, Shuman BILLION, Toomey MR, van Hengstum P, Woodruff JD. Climate forcing of unprecedented intense-hurricane activity in the last 2,000 years. *Earth Future* 2015, 3:49–65. doi:10.1002/2014EF000274; and Emanuel K, Sobel A. Response of tropical sea surface temperature, precipitation, and tropical cyclone-related variables to changes in global and local forcing. *J Adv Model Earth Syst* 2013, 5:447–458; and Emanuel, K. E., 2017: Assessing the present and future probability of Hurricane Harvey's rainfall. *Proc. Natl. Acad. Sci. USA*, 114, 12 681–12 684, doi:10.1073/pnas.1716222114; and Klotzbach, P.J.; Bowen, S.G.; Pielke, R., Jr.; Bell, M. Continental United States hurricane landfall frequency and associated damage: Observations and future risks. *Bull. Am. Meteorol. Soc.* 2018; and Knutson TR, McBride JL, Chan J, Emanuel K, Holland G, Landsea C, Held I, Kossin JP, Srivastava AK, Sugi M. Tropical cyclones and climate change. *Nat Geosci* 2010, 3:157–163. doi:10.1038/ngeo0779; and Knutson TR, Sirutis JJ, Zhao M, Tuleya RE, Bender M, Vecchi GA, Villarini G, Chavas D. Global projections of intense tropical cyclone activity for the late 21st century from dynamical downscaling of CMIP5/RCP4.5 scenarios. *J Clim* 2015, 28:7203–7224; and Kossin, J. P., 2018: A global slowdown of tropical cyclone translation speed. *Nature*, 558, 104-108; and Levin E., and Murakami, H. Examining the Sensitivity and Impact of Anthropogenic Climate Change on North Atlantic Major Hurricane Landfall Drought and Activity. Presented at AMS 2018 <https://ams.confex.com/ams/33HURRICANE/webprogram/Paper339882.html>; and Murakami H, Vecchi GA, Underwood S, Delworth T, Wittenberg AT, Anderson W, Chen J-H, Gudgel R, Harris L, Lin S-J, et al. Simulation and prediction of category 4 and 5 hurricanes in the high-resolution GFDL HiFLOR coupled climate model. *J Clim*. 2015 and Peduzzi P, Chatenoux B, Dao H, De Bono A, Herold C, et al. Global trends in tropical cyclone risk. *Nat Clim Change* 2012, 2:289–294; and Stott, P. A., Christidis, N., Otto, F. E., Sun, Y., Vanderlinden, J., van Oldenborgh, G. J., Vautard, R., von Storch, H., Walton, P., Yiou, P. and Zwiers, F. W. (2016), Attribution of extreme weather and climate-related events. *WIREs Clim Change*, 7: 23-41. doi:10.1002/wcc.380; and Walsh, K. J. E., and Coauthors, 2015: Tropical cyclones and climate change. *Wiley Interdiscip. Rev.: Climate Change*, 7, 65–89, doi.org/10.1002/wcc.371.



- The development of hypothetical values affecting UK Flood are based on the PRA-led working group discussions leading to the publication of the Framework for Assessing Financial Impacts of Physical Climate Change Risk for the General Insurance Sector and literature review analysed and presented by JBA Risk Management and Ambiental supplemented by discussions with the Environment Agency and the MetOffice. The hypothetical values put forward in this exploratory exercise does not represent the opinions of the above-mentioned sources.

## TRANSITION RISK

- The values related to the set of assumptions behind the Energy section have been developed based on International Energy Agency's World Energy Outlook (2018) assuming projections given an interpretation of the New Policies/Current Policies and Sustainable Development scenario projections.
- To support the investment portfolio segmentation, indicative NACE and GICS codes are provided as examples of the sectors inferred.

Sector	% Exposure to NACE sector	GICS sector
Energy	D35 Production of electricity  D35.11 Production of electricity, to be supplemented with additional classification by source: oil, gas, coal, renewable energy (solar, wind, hydro, geothermal, nuclear)	55: Utilities, broken down to industry leve (electric, gas, multi-utilities, water, independent power and Renewable energy producers)
	5.1 Mining of hard coal 5.2 Mining of lignite 6.1 Extraction of crude petroleum 6.2 Extraction of natural gas 8.92 Extraction of peat 9.1 Support activities for petroleum and natural gas extraction	10 Energy:  101020 Oil, gas and consumable fuels
Transport	D34: Manufacture of motor vehicles, trailers and semi-trailers (supplemented by percentage of EV)  D35 manufacture of other transport equipment	2030: Transport  2510: Automobiles and components
	H 50.1 Sea and coastal passenger transport H 50.2 Sea and coastal freight water transport  H51.1 Passenger air transport H51.2 Freight air transport	
Materials/ Metals/ Mining	C19 Manufacture of coke and refined petroleum products C20 Manufacture of chemicals and chemical products C 23.51 Manufacture of cement C24.1 Manufacture of basic iron and steel and of ferro-alloys C24.52 Casting of steel	15 – Materials  151010 – Chemicals 151040 – Metals and mining
Water, Agricultu re & Food Security	A: agriculture, forestry, and fishing  A1.41: Raising of dairy cattle	301010 Food & Staples retailing



Real Assets (inc. CRE & infrastructure)	L – Real estate activities	60 – real estate
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- To aid the assessment of sovereign credit risk, firms are invited to estimate by linearly interpolating the country rank based on a published source. For instance, using the Notre Dame country vulnerability ranking: Switzerland under Scenario A will suffer 5 basis points downgrade whilst Albania 30.
- Transition Risk assumptions were developed based on discussions with experts in the field and material<sup>1</sup> reviewed for purposes of this exploratory exercise.

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<sup>1</sup> Sources: 2 degrees investing initiative (2016); Transition Risk Toolbox; and CISL (2015); Unhedgeable risk; and CRO Forum (2019); The heat is on – insurability and resilience in a changing climate; and De Nederlandsche Bank (2018); An energy transition risk stress test for the financial system of the Netherlands; ESRB (2018); Adverse macro-financial scenario for the 2018 EU-wide banking sector stress test; and FED Reserve (2018); Dodd-Frank Act Stress Test 2018: Supervisory Stress Test Methodology and Results; and GIZ; UNEP FI; NCFA (2017) Drought Stress Testing – Making Financial Institutions More Resilient to Environmental Risks; and IRENA ( 2019); Renewable Energy Prospects for the European Union; and OECD (2015) The Economic Consequences of Climate Change; and Ralite, S., and Thoma, J for the 20 investing initiative (2019); Storm Ahead: A proposal for a climate stress-test scenario. Discussion Paper; and Standard & Poors (2017); How Environmental and Climate Risks And Opportunities Factor into Global Corporate Ratings – an update; and UNEP FI - Acclimatise (2018); Navigating a New Climate.

## ANNEX II: ABBREVIATIONS USED

<b>AAL</b>	Annual Average Loss
<b>ACS</b>	Annual Cyclical Scenario
<b>AEP</b>	Aggregate Exceedance Probability
<b>AOF</b>	Ancillary Own Funds
<b>BOF</b>	Basic Own Funds
<b>CC</b>	Climate Change
<b>CQS</b>	Credit Quality Step
<b>PD</b>	Probability of Default
<b>E(.)</b>	Expected Value
<b>EEA</b>	European Economic Area
<b>EIOPA</b>	European Insurance and Occupational Pensions Authority
<b>ERM</b>	Equity Release Mortgages
<b>FS</b>	Fundamental Spread
<b>FRN</b>	Firm Reference Number
<b>GBP</b>	Great Britain Pound
<b>IAS</b>	Insurance Asset Shock
<b>IM</b>	Internal Model
<b>IMAP</b>	Internal Model Approval Process
<b>IST</b>	Insurance Stress Test
<b>LEI</b>	Legal Entity Identifier
<b>LGD</b>	Loss Given Default
<b>LTAS</b>	Long Term Adjustment Spread
<b>MA</b>	Matching Adjustment
<b>MAP</b>	Matching Adjustment Portfolio
<b>Nat Cat</b>	Natural Catastrophe
<b>OEP</b>	Occurrence Exceedance Probability
<b>OF</b>	Own Funds
<b>PRA</b>	Prudential Regulatory Authority
<b>SCR</b>	Solvency Capital Requirement
<b>SD</b>	Standard Deviation
<b>SII</b>	Solvency II
<b>TMTP</b>	Transitional Measures on Technical Provisions
<b>TP</b>	Technical Provisions
<b>VA</b>	Volatility Adjustment
<b>VAR</b>	Value At Risk
<b>UFR</b>	Ultimate Forward Rate
<b>USD</b>	United States Dollar