CEIOPS-DOC-79/10
11 June 2010

# CATASTROPHE TASK FORCE REPORT ON STANDARDISED SCENARIOS FOR THE CATASTROPHE RISK MODULE IN THE STANDARD FORMULA

**June 2010**

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# 1. Introduction

1. Under CP48 and CP50, CEIOPS proposed the development of Standardised Scenarios as a method for the estimation of the Catastrophe Risk charge required under Article 111 1(c) of the Level 1 Directive.

2. The proposal included the creation of a joint industry and CEIOPS working group called the Catastrophe Task Force (CTF). The aim of the CTF would be to provide CEIOPS with input and guidance on the calibration and application of Non Life and Health Catastrophe standardised scenarios in line with the advice provided by CEIOPS in CP48 and CP50. The proposal was welcomed and supported by the European Commission.

3. In July 2009, CEIOPS sent a letter to a number of stakeholders inviting them to be part of the CTF. The CTF was established at the end of August 2009.

4. The members of the CTF are:
   - Swiss Re
   - Lloyd's of London
   - Munich Re
   - CCR
   - SCOR
   - The Actuarial Profession Health & Care Practice Executive Committee
   - Guy Carpenter
   - Willis
   - RMS
   - CEIOPS FinReq members

5. It was agreed with CEIOPS and the European Commission that the CTF would provide an interim paper in March 2010 and a final proposal by June 2010. The guidance presented in this paper is the Final June 2010 CTF proposal.

6. This paper aims to provide a calibration of catastrophe risk at the 99.5% VaR for undertakings that are exposed to extreme or exceptional events. The CTF has aimed to provide an appropriate and unbiased calibration based on the L1 Directive text and information that has been selected considering the views and expert opinions of the members of the task force. The analysis is subject to limitations and those have been covered in section 2.

7. The paper is divided into two main sections Non life catastrophe scenarios (man-made and natural) and Health and within each section there are two sub-sections:

   - Application: describes how undertakings ought to apply the scenario and,
   - Calibration: describes how the scenarios have been calibrated. The structure of the document follows that of other CEIOPS and QIS documents.

8. This information tries to serve as possible input for the QIS 5 technical specifications and CEIOPS advice.

9. This paper does not cover alternative methods nor life catastrophe risk.

## 2. General considerations on the use of catastrophe standardised scenarios

10. The CTF considered a variety of factors in order to ensure consistency with the L1 directive and CEIOPS requirements, for example:

- harmonisation across members states
- consistent treatment of undertakings irrespective of type and size
- balancing fairness with the need to design a simple, pragmatic process which is risk sensitive
- transparency in derivation

11. The CTF consulted widely within and outside their organisations and also made reference to useful documentation such as:

- QIS 4 regional scenarios set by supervisors as part of the QIS 4 Technical specifications
- Accumulation risks and large risks under Solvency II, December 2009, GDV[1],
- Current practice and methodologies

12. The CTF also consulted with other industry representatives to carry out backtesting exercises to assess the appropriateness of the results.

13. However the CTF would like to highlight that any standardised scenario is going to be a trade off between accuracy and ease of use. There may be many circumstances where the standardised scenarios will be inadequate because it is impossible to allow for all undertakings and risk profile particularities within the standard formula. The CTF recommends that undertakings should consider alternative measures, in particular partial internal model, before choosing to use the standardized scenarios.

14. This particularly applies to undertakings with significant exposure to cat perils such as flood or earthquake where close proximity to the source of the event requires a more sophisticated approach to resolve the geographic distribution of the risk, or those with a need to distinquish between vulnerability of different lines of business, rather than the aggregate approach provided by the scenarios.

15. Undertakings need to assess whether the standardised scenarios appropriately capture the risks to which they are exposed. Circumstances in which the standardised scenarios presented in this paper will not be appropriate, include among others:

- Where undertakings have non-life exposures outside the EEA, except French Dom Tom.
- Where undertakings write non proportional reinsurance business.
- Where undertakings write miscellaneous business

[1] Gesamtverband der Deutschen Versicherungswirtschaft e. V.
(German Insurance Association)

- Where undertakings have exposures which are not captured by the standardised scenario.

In these circumstances the "factor method" is a fall back option if a partial internal model (PIM) is not appropriate. Details of the factor method and PIM are outside the scope of this paper. Undertakings should refer to CEIOPS advice.

16. The above list is not exhaustive. Undertakings should assess whether the standardised scenarios appropriately capture the risks to which they are exposed. The CTF recommends a more accurate and appropriate estimation of the undertaking's catastrophe risk through the use of a partial internal model.

### 3. *Estimation of net catastrophe risk charge*

17. In line with CP48, CP51, CP52 and the L1 Directive the catastrophe risk charge has to be net of risk mitigation arrangements. Undertakings will be required to net down the estimation of their respective gross estimations.

18. The CTF has decided not to prescribe methodologies in a closed form because risk mitigation contracts can take a variety of forms and it is impossible to cover all possible cases.

19. The CTF would recommend that undertakings show supervisors their calculations and explain how they have arrived to the net estimation.

20. In the EEA there is a variety of national arrangements which provide protection in different ways. Without going into the specifics of each arrangement, undertakings should net down their gross estimation to reflect such protection, if applicable. Where Reinsurers provide or could potentially provide cover to the national arrangements, such reinsurance companies need to estimate a capital charge for this exposure.

21. Where there are separate reinsurance programmes for each country the aggregations (across countries) are done net of reinsurance. Where there are separate reinsurance programmes per peril, the aggregation (across perils) are done net of reinsurance.

22. In calculating net losses undertakings should include consideration of reinstatement premiums *directly* related to the scenario. Both *Outwards* reinstatement premiums associated with reinstating risk transfer protection and *Inwards* reinstatement premiums in respect of assumed reinsurance business should be calculated.

23. The CTF has provided some examples that show how firms ought to net down their gross estimations. These are included in Annex 7. A helper tab could be included for QIS 5 trying to illustrate such examples.

## *4. Non Life Catastrophe standardised scenarios*

24. Catastrophe risk is defined in the L1 Directive as:

Under Non life underwriting as:

*"the risk of loss, or of adverse change in the value of insurance liabilities, resulting from significant uncertainty of pricing and provisioning assumptions related to extreme or exceptional events. "*

25. Consistent with the above, the non life Catastrophe Standardised scenarios considered in this document are:

- Natural Catastrophes: extreme or exceptional events arising from the following perils:
  - Windstorm
  - Flood
  - Earthquake
  - Hail
  - Subsidence
- Man-made Catastrophes: extreme or exceptional events arising from:
  - Motor
  - Fire
  - Marine
  - Aviation
  - Liability
  - Credit & Suretyship
  - Terrorism

26. The CTF also considered Storm surge as an important peril. Where Storm surge is covered and is considered to be a material peril, the CTF has decided to combine this with the windstorm peril due to the inherently coupled nature. This was done for example for UK, where insurance covers both windstorm and surge in the same policies. For other countries, storm surge is excluded from standard private market insurance coverage, and was not incorporated into the windstorm scenario.

27. The above selection was based on the likelihood of such events resulting in extreme or exceptional events; therefore giving rise to losses or adverse changes in the value of insurance liabilities.

28. The list may not be exhaustive for all undertakings. Where this is the case, any additional risk should be captured through an alternative method.

29. Furthermore for the purpose of this work:

- Scenarios are EEA based. An exception to this is the French Dom/Tom[2] scenario.
- Geographical specifications are recognised where appropriate.
- Total Insured Value (TIV) is the same as Sum Insured (SI).
- Scenarios are provided gross of reinsurance and gross of all other mitigation instruments (for example national pool arrangements or cat bonds), unless otherwise stated. Undertakings shall take into account reinsurance and other mitigation instruments to estimate their net loss as specified in section 3. Care should be taken to ensure no double counting.
- Scenarios have been provided by peril or event and not by line of business. The CTF considers such approach the most appropriate for the purpose of Catastrophe risk due to tail correlation across lines of business and consistent with CEIOPS – DOC - CP48 and meets the needs of the scenarios for ease of use. However, there are limitations to such an approach in terms of differentiating the different damagability between industrial, commercial and residential risk, so undertakings with particular bias in their exposure to one of these lines of business need to assess if this is the most appropriate method to use.
- The catastrophe scenarios are not appropriate for non-proportional reinsurance writers because the relationship between total insured value and loss damage ratio (1 in 200 loss /total exposure) (and also premium and loss damage ratio) is more variable between reinsurance undertakings and from one year to the next, than for direct or proportional reinsurance writers. The relationship depends on the level of excess at which non proportional business is written and the pattern of participation by (re)insurance layer (e.g. whether a writer participates evenly across the layers of an excess programme, or whether it writes larger lines on the lower or higher layers of the programme). The complexity that would be introduced by attempting to allow for non proportional business would be disproportional to the benefits gained.

30. Finally, the CTF has worked on the basis that there is no double counting with other risks in the standard formula, in particular Premium risk and Reserve risk,

[2] The French Overseas Departments and Territories (French: départements d'outre-mer and territoires d'outre-mer or DOM-TOM) consist broadly of French-administered territories outside of the European continent. The French Overseas Departments and Territories include island territories in the Atlantic, Pacific and Indian oceans, a territory on the South American coast, and several periantarctic islands as well as an extensive claim in Antarctica.
According to the French constitution the French Overseas Departments are an integral part of France: French laws and regulations apply (civil code, penal code, administrative law, social laws, tax laws et cetera), in departments as in the mainland. As a result they have been considered within the scope of the task force.

## *4.1. Application of Non life Catastrophe Standardised Scenarios*

31. In this section, the CTF provides a comprehensive description of how the Catastrophe Standardised Scenarios need to be applied by undertakings. This could be the type of input that would be part of a QIS specification.

32. If undertakings require information regarding the parameterisation/ calibration or further information they should refer to the calibration section below.

### 4.1.1. Natural Catastrophes

33. The Catastrophe standardised scenarios are based on exposures at a sub-country level and use something akin to CRESTA zones which are an existing industry standard (or something similar if CRESTA zones are not available). The CTF have referred to these as "Zones".

34. Undertakings will find detailed information of CRESTA zone information at www.cresta.org. The information is publicly available. Depending on the country there are several levels of zoning, with higher or lower spatial resolution. Where CRESTA has multiples levels of zoning for a country, e.g. Greece, the CTF has been working with the lowest resolution scheme. Where CRESTA zones are not available for a particular country or are not available at the subzone level, the CTF has worked with two digit post code information.

35. Undertakings will be required to provide total insured values by zones. Unless otherwise stated, TIV should include buildings, contents and time elements e.g. business interruption, additional living expenses. In calculating the TIV undertakings should allow for their proportional shares where risks are written on a co-insured basis. Undertakings cannot allow for any deductibles, limits or sub-limits.

36. Where undertakings are not able to provide TIV at the level of detail required, the CTF strongly advises that undertakings should start to collect this information before the implementation of SII. In the meantime, until they have a robust set of information undertakings will need to use an approximation to estimate a TIV figure from proxy data, such as premiums. Where proxy data is used undertakings will be expected to explain how they have applied the proxy.

37. The CTF is aware that there are a variety of regional classifications used across the EU, and that some undertakings may prefer other segmentation other than CRESTA, but for the purpose of the standard formula it is necessary to aim for harmonization and simplicity. As a result the CTF would recommend keeping the CRESTA segmentation approach.

38. On that basis it was agreed that the estimation of a catastrophe charge for natural catastrophes should be based on the following formula:

$$WTIV_{ZONE} = F_{ZONE} * TIV_{ZONE}$$

$$CAT_{Peril\_ctry} = Q_{CTRY} \sqrt{\sum_{rxc} AGG_{r,c} * WTIV_{ZONE,r} * WTIV_{ZONE,c}}$$

Where

| | | |
|---|---|---|
| $CAT_{Peril\_ctry}$ | = | The estimation of cat capital charge for a specific country |
| $Q_{CTRY}$ | = | 1 in 200 year factor for each country and peril. The $Q_{CTRY}$ are provided in Annex 2. |
| $F_{ZONE}$ | = | relativity factors for each zone by country |
| $AGG_{r,c}$ | = | Rows and columns of the aggregation matrix AGG by country. [3] |
| $WTIV_{zone,r}$, $WTIV_{zonec}$ | = | Geographically weighted total insured value by zone. |
| $TIV_{ZONE}$ | = | This comprises, where applicable, of the weighted sum of:<br>$TIV_{ZONE\_Fire}$ = total insured value for Fire and other damage by zone<br>$TIV_{ZONE\_MPD}$ = total insured value for Motor property damage by zone<br>$TIV_{ZONE\_MAT}$ = total insured value for Marine by zone. Within the Marine Class, the material components are Cargo (=static warehouse risks) and Marine XL. The Static Cargo sums insured can be entered into the CRESTA table as per the direct property. The Marine XL (= Reinsurance of direct marine insurers) have exactly the same issues as Property Treaty reinsurers in that the standardised method would not be appropriate.<br><br>Weights are given to the TIVs depending on the line of business. This is because the calibration of the factors has been based on the damage caused by fire and other damage. Thus in order to use the same zone factors, the TIVs have to be scaled to reflect the true level of damage caused in other lines of business. |

39. Below we describe how undertakings should estimate their catastrophe charge for each peril.

40. The CTF has provided a table in Annex 1 which identifies the countries that are materially exposed to the respective perils. Where countries are not included, the CTF has considered the peril not to be material in those countries compared to others.

41. The CTF has allowed for multiple insured events occurring in any given year for natural catastrophes. This is addressed by calculating a Catastrophe Risk charge under both of the following circumstances:

[3] These values are provided in an excel spreadsheet « parameters for non life catastrophe »

- one large event, at 1 in 200 level occurrence basis, plus a second, smaller event
- two moderate events
- the larger of the results for the two sets of circumstances being used.

WINDSTORM

Input

42. Undertakings need to provide the following information:

| | | |
|---|---|---|
| $TIV_{ZONE}$ | = | This comprises the weighted sum of:<br>$TIV_{ZONE\_Fire}$ $+TIV_{ZONE\_MAT}$<br>$TIV_{ZONE\_Fire}$ = total insured value for Fire and other damage by zone<br>$TIV_{ZONE\_MAT}$ = total insured value for Marine by zone. Within the Marine Class, the material components are Cargo (=static warehouse risks) and Marine XL. The Static Cargo sums insured can be entered into the CRESTA table as per the direct property. The Marine XL (= Reinsurance of direct marine insurers) have exactly the same issues as Property Treaty reinsurers in that the standardised method would not be appropriate.<br>(Note that $TIV_{ZONE\_MPD}$ is not required for the Windstorm scenario.)<br>Inputs should be entered as gross figures unless otherwise stated. |

Calculation

43. The formula to be applied by undertakings for their respective gross exposures in each of the EEA countries is as follows:

$$WTIV_{ZONE} = F_{ZONE} * TIV_{ZONE}$$

$$CAT_{Windstorm\_ctry} = Q_{CTRY} \sqrt{\sum_{rxc} AGG_{r,c} * WTIV_{ZONE,r} * WTIV_{ZONE,c}}$$

where,

| | | |
|---|---|---|
| $CAT_{Windstorm\_ctry}$ | = | The estimation of the gross windstorm cat capital charge for a specific country |
| $Q_{CTRY}$ | = | 1 in 200 year factor for each country. The $Q_{CTRY}$ are provided in Annex 2 |

| | | |
|---|---|---|
| $F_{ZONE}$ | = | relativity factors for each zone by country[4] |
| $AGG_{r,c}$ | = | Rows and columns of the aggregation matrix AGG by country.[5] |
| $WTIV_{zone,r}$, $WTIV_{zonec}$ | = | Geographically weighted total insured value by zone. |

44. Undertakings are required to allow for multiple events. As a result undertakings should estimate two alternatives A and B on a gross basis and then net down for reinsurance as described below, including consideration of any reinstatement premiums and coverage limits.

$Cat_{Windstorm(A)\_ctry\_net}$ = loss from EventA1 + subsequent loss from EventA2,

Where

Loss from Event A1 = 0.8* $CAT_{Windstorm(A)\_ctry}$ then net down for reinsurance
Loss from Event A2 = 0.4*$CAT_{Windstorm(A)\_ctry}$ then net down for reinsurance

$CAT_{windstorm(B)\_ctry\_net}$ = Loss from EventB1 + subsequent loss from EventB2

Where

Loss from Event B1 = 1* $CAT_{Windstorm(B)\_ctry}$ then net down for reinsurance
Loss from Event B2 = 0.2* $CAT_{Windstorm(B)\_ctry}$ then net down for reinsurance

$Cat_{Windstorm\_ctry\_net}$= Max ($Cat_{Windstorm(A)\_ctry\_net}$, $Cat_{Windstorm(B)\_ctry\_net}$)

<u>Output</u>

| | | |
|---|---|---|
| $CAT_{Windstorm\_ctry\_net}$ | = | Catastrophe capital charge for windstorm net of risk mitigation. |

45. Undertakings should note that the output may be gross or net depending on whether the undertaking has reinsurance protection and whether this should be applied at a country level or peril level. For example you may have a European windstorm programme in which case this would still be gross and not adjusted for risk mitigation until aggregating at country level, or individual country cover in which case this would be net. When netting down, undertakings should take care to adjust and interpret formulae accordingly.

**EARTHQUAKE**

<u>Input</u>

46. Undertakings need to provide the following information:

[4] These values are provided in an excel spreadsheet « parameters for non life catastrophe »
[5] These values are provided in an excel spreadsheet « parameters for non life catastrophe »

| | | |
|---|---|---|
| $TIV_{ZONE}$ | = | This comprises the weighted sum of:<br>$TIV_{ZONE\_Fire}$ + $TIV_{ZONE\_MAT}$<br>$TIV_{ZONE\_Fire}$ = total insured value for Fire and other damage by zone<br>$TIV_{ZONE\_MAT}$ = total insured value for Marine by zone. Within the Marine Class, the material components are Cargo (=static warehouse risks) and Marine XL. The Static Cargo sums insured can be entered into the CRESTA table as per the direct property. The Marine XL (= Reinsurance of direct marine insurers) have exactly the same issues as Property Treaty reinsurers in that the standardised method would not be appropriate.<br>(Note that $TIV_{ZONE\_MPD}$ is not required for the earthquake scenario.)<br>Inputs should be entered as gross figures unless otherwise stated. |

Calculation

47. The formula to be applied by undertakings for their respective gross exposures in each of the EEA countries is as follows:

$$WTIV_{ZONE} = F_{ZONE} * TIV_{ZONE}$$

$$CAT_{Earthquake\_ctry} = Q_{CTRY} \sqrt{\sum_{rxc} AGG_{r,c} * WTIV_{ZONE,r} * WTIV_{ZONE,c}}$$

where,

| | | |
|---|---|---|
| $CAT_{Earthquake\_ctry}$ | = | The estimation of the gross earthquake cat capital charge for a specific country |
| $Q_{CTRY}$ | = | 1 in 200 year factor for each country. The $Q_{CTRY}$ are provided in Annex 2 |
| $F_{ZONE}$ | = | Relativity factors for each zone by country[6] |
| $AGG_{r,c}$ | = | Rows and columns of the aggregation matrix AGG by country.[7] |
| $WTIV_{zone,r}$, $WTIV_{zonec}$ | = | Geographically weighted total insured value by zone. |

48. Undertakings should net down accordingly for risk mitigation as explained in section 3 and for examples see Annex 7.

[6] These values are provided in an excel spreadsheet « parameters for non life catastrophe »
[7] These values are provided in an excel spreadsheet « parameters for non life catastrophe »

Output

| | | |
|---|---|---|
| $CAT_{Earthquake\_ctry\_net}$ | = | Catastrophe capital charge for earthquake net of risk mitigation |

49. Undertakings should note that the output may be gross or net depending on whether the undertaking has reinsurance protection and whether this should be applied at a country level or peril level. For example you may have a European windstorm programme in which case this would still be gross and not adjusted for risk mitigation until aggregating at country level, or individual country cover in which case this would be net. When netting down, undertakings should take care to adjust and interpret formulae accordingly.

**FLOOD**

Input

50. Undertakings need to provide the following information:

| | | |
|---|---|---|
| $TIV_{ZONE}$ | = | This comprises the weighted sum of:<br>$TIV_{ZONE\_Fire} + TIV_{ZONE\_MAT} + 2*TIV_{ZONE\_MPD}$<br>$TIV_{ZONE\_Fire}$ = total insured value for Fire and other damage by zone<br>$TIV_{ZONE\_MAT}$ = total insured value for Marine by zone. Within the Marine Class, the material components are Cargo (=static warehouse risks) and Marine XL. The Static Cargo sums insured can be entered into the CRESTA table as per the direct property. The Marine XL (= Reinsurance of direct marine insurers) have exactly the same issues as Property Treaty reinsurers in that the standardised method would not be appropriate.<br>$TIV_{ZONE\_MPD}$ = total insured value for Motor property damage by zone<br><br>Inputs should be entered as gross figures unless otherwise stated. |

Calculation

51. The formula to be applied by undertakings for their respective gross exposures in each of the EEA countries is as follows:

$$WTIV_{ZONE} = F_{ZONE} * TIV_{ZONE}$$

$$CAT_{Flood\_ctry} = Q_{CTRY} \sqrt{\sum_{rxc} AGG_{r,c} * WTIV_{ZONE,r} * WTIV_{ZONE,c}}$$

where,

| | | |
|---|---|---|
| $CAT_{Flood\_ctry}$ | = | The estimation of the gross flood cat capital charge for a specific country |
| $Q_{CTRY}$ | = | 1 in 200 year factor for each country |
| $F_{ZONE}$ | = | relativity factors for each zone by country[12] |
| $AGG_{r,c}$ | = | Rows and columns of the aggregation matrix AGG by country. [8] |
| $WTIV_{zone,r}$, $WTIV_{zonec}$ | = | Geographically weighted total insured value by zone. |

52. Undertakings are required to allow for multiple events. As a result undertakings should estimate two events A and B on a gross basis and then net down for reinsurance as described below, including consideration of any reinstatement premiums and coverage limits.

$CAT_{Flood(A)\_ctry\_net}$ = Loss from EventA1 + subsequent Loss from EventA2,

Where
Loss from EventA1 = 0.65* $CAT_{Flood\ (A)\_ctry}$ then net down for reinsurance
Loss from EventA2 = 0.45* $CAT_{Flood\ (A)\_ctry}$ then net down for reinsurance

$CAT_{Flood(B)\_ctry\_net}$ = Loss from EventB1 + subsequent Loss from EventB2

Where

Loss from EventB1 = 1* $CAT_{Flood\ (B)\_ctry}$ then net down for reinsurance
Loss from EventB2 = 0.1* $CAT_{Flood\ (B)\_ctry}$ then net down for reinsurance

And then,

$CAT_{Flood\_ctry\_net}$= Max ($CAT_{Flood(A)\_ctry\_net}$, $CAT_{Flood(B)\_ctry\_net}$)

<u>Output</u>

| | | |
|---|---|---|
| $CAT_{Flood\_ctry\_net}$ | = | Catastrophe capital charge for flood net of risk mitigation |

53. Undertakings should note that the output may be gross or net depending on whether the undertaking has reinsurance protection and whether this should be applied at a country level or peril level. For example you may have a European windstorm programme in which case this would still be gross and not adjusted for risk mitigation until aggregating at country level, or individual country cover in which case this would be net. When netting down, undertakings should take care to adjust and interpret formulae accordingly.

**HAIL**

[8] These values are provided in an excel spreadsheet « parameters for non life catastrophe »

Input

54. Undertakings need to provide the following information:

| | | |
|---|---|---|
| $TIV_{ZONE}$ | = | This comprises the weighted sum of:<br>$TIV_{ZONE\_Fire} + TIV_{ZONE\_MAT} + 5*TIV_{ZONE\_MPD}$<br>$TIV_{ZONE\_Fire}$ = total insured value for Fire and other damage by zone<br>$TIV_{ZONE\_MAT}$ = total insured value for Marine by zone. Within the Marine Class, the material components are Cargo (=static warehouse risks) and Marine XL. The Static Cargo sums insured can be entered into the CRESTA table as per the direct property. The Marine XL (= Reinsurance of direct marine insurers) have exactly the same issues as Property Treaty reinsurers in that the standardised method would not be appropriate.<br>$TIV_{ZONE\_MPD}$ = total insured value for Motor property damage by zone<br>Inputs should be entered as gross figures unless otherwise stated. |

Calculation

55. The formula to be applied by undertakings for their respective gross exposures in each of the EEA countries is as follows:

$$WTIV_{ZONE} = F_{ZONE} * TIV_{ZONE}$$

$$CAT_{Hail\_ctry} = Q_{CTRY} \sqrt{\sum_{rxc} AGG_{r,c} * WTIV_{ZONE,r} * WTIV_{ZONE,c}}$$

where,

| | | |
|---|---|---|
| $CAT_{Hail\_ctry}$ | = | The estimation of the gross hail CAT capital charge for a specific country |
| $Q_{CTRY}$ | = | 1 in 200 year factor for each country. The $Q_{CTRY}$ are provided in Annex 2 |
| $F_{ZONE}$ | = | relativity factors for each zone by country |
| $AGG_{r,c}$ | = | Rows and columns of the aggregation matrix AGG by country. [9] |
| $WTIV_{zone,r}$, $WTIV_{zonec}$ | = | Geographically weighted total insured value by zone. |

[9] These values are provided in an excel spreadsheet « parameters for non life catastrophe »

56. Undertakings are required to allow for multiple events. As a result undertakings should estimate two events A and B on a gross basis and then net down for reinsurance as described below, including consideration of any reinstatement premiums and coverage limits.

$CAT_{Hail(A)\_ctry\_net}$ = Loss from EventA1 + subsequent Loss from EventA2,

Where
Loss from EventA1 = 0.7* $CAT_{Hail(A)\_ctry}$ then net down for reinsurance
Loss from EventA2 = 0.5* $CAT_{Hail\ (A)\_ctry}$ then net down for reinsurance

$CAT_{Hail(B)\_ctry\_net}$ = Loss from EventB1 + subsequent Loss from EventB2

Where

Loss from Event B1 = 1* $CAT_{Hail(B)\_ctry}$ then net down for reinsurance
Loss from Event B2 = 0.2* $CAT_{Hail(B)\_ctry}$ then net down for reinsurance

And then,

$Cat_{Hail\_ctry\_net}$= Max ($Cat_{Hail(A)\_ctry\_net}$, $Cat_{Hail(B)\_ctry\_net}$)

Output

| | | |
|---|---|---|
| $CAT_{Hail\_net\_ctry}$ | = | Catastrophe capital charge for hail net of risk mitigation |

57. Undertakings should note that the output may be gross or net depending on whether the undertaking has reinsurance protection and whether this should be applied at a country level or peril level. For example you may have a European windstorm programme in which case this would still be gross and not adjusted for risk mitigation until aggregating at country level, or individual country cover in which case this would be net. When netting down, undertakings should take care to adjust and interpret formulae accordingly.

**SUBSIDENCE**

Input

58. Undertakings need to provide the following information:

| | | |
|---|---|---|
| $TIV_{ZONE}$ | = | This comprises of:<br>$TIV_{ZONE\_Fire}$<br>$TIV_{ZONE\_Fire}$ = total insured value for Fire and other damage by zone only in respect of residential buildings. |

Calculation

59. The formula to be applied by undertakings for their respective exposures in each of the EEA countries is as follows:

$$WTIV_{ZONE} = F_{ZONE} * TIV_{ZONE}$$

$$CAT_{Subsidence\_ctry} = Q_{CTRY} \sqrt{\sum_{rxc} AGG_{r,c} * WTIV_{ZONE,r} * WTIV_{ZONE,c}}$$

Where

| | | |
|---|---|---|
| $CAT_{Subsidence\_ctry}$ | = | The estimation of the gross subsidence cat capital charge for a specific country |
| $Q_{CTRY}$ | = | 1 in 200 year factor for each country. The $Q_{CTRY}$ are provided in Annex 2 |
| $F_{ZONE}$ | = | relativity factors for each zone by country |
| $AGG_{r,c}$ | = | Rows and columns of the aggregation matrix AGG by country. [10] |
| $WTIV_{zone,r}$, $WTIV_{zonec}$ | = | Geographically weighted total insured value by zone. |

60. Undertakings should net down accordingly for risk mitigation as explained in section 3 and for examples see Annex 7.

Output

61. The outputs are:

| | | |
|---|---|---|
| $CAT_{Subsidence\_ctry\_net}$ | = | Catastrophe capital charge for subsidence net of risk mitigation |

62. Undertakings should note that the output may be gross or net depending on whether the undertaking has reinsurance protection and whether this should be applied at a country level or peril level. For example you may have a European windstorm programme in which case this would still be gross and not adjusted for risk mitigation until aggregating at country level, or individual country cover in which case this would be net. When netting down, undertakings should take care to adjust and interpret formulae accordingly.

[10] These values are provided in an excel spreadsheet « parameters for non life catastrophe »

### 4.1.2. Man-made Catastrophes

63. All undertakings which have exposures to the events below will need carry out the relevant man-made scenarios:

- Fire
- Motor
- Marine
- Credit and Suretyship
- Terrorism
- Aviation
- Liability

FIRE

64. Undertakings with exposures under the Fire and other damage line of business are exposed to this scenario.

65. There are two options for the calculation of the risk charge, as outlined below; option 1 requires detailed exposure information whilst option 2 is a simplified scenario. Undertakings should attempt option 1 where possible.

Option 1

Input

66. Undertakings will need to provide details of:

| | | |
|---|---|---|
| P | = | Sum insured of largest known concentration of exposures under the Fire and Other Damage line of business in a 150 metre radius.<br><br>The concentration is intended to cover, for example, damage in the vicinity of industrial facilities (this could impact residential or industrial). |

Calculation

67. The formula to be applied by undertakings is as follows:

$$CAT_{Fire} = P * x$$

Where,

| | | |
|---|---|---|
| $CAT_{Fire}$ | = | the estimation of the gross Fire Cat capital charge (under Option 1) |
| P | = | Sum insured of largest known concentration of exposures under the fire and other damage line of business in a |

| | | |
|---|---|---|
| | | 150metre radius as described above. |
| x | = | proportion of damage caused by scenario (= 100%) |

68. While the relative weighting of coverage will vary from policy to policy, the CTF decided that an average damage ratio factor of 100% should be applied to the total exposure in a 150 metre radius.

69. Undertakings should net down accordingly for risk mitigation as explained in section 3 and for examples see Annex 7.

Output

70. The outputs are:

| | | |
|---|---|---|
| $CAT_{Fire\_net}$ | = | Catastrophe capital charge for Fire net of risk mitigation |

Option 2

Input

71. Undertakings, will be required to provide the following inputs for each of the sub lines that they are exposed to:

| | | |
|---|---|---|
| $SI_{FR}$ | = | Sum Insured for Fire for residential business |
| $SI_{FC}$ | = | Sum Insured for Fire for commercial business |
| $SI_{FI}$ | = | Sum Insured for Fire for industrial business |
| LSR | = | Maximum loss of the Largest Single Risk across all sub lines. This refers to one single location, e.g. a building; however, it could be covered by one or more policies. |

Calculation

72. The scenario incorporates both an extreme single event as well as a market loss event. The gross capital charge is estimated as follows:

$$CAT_{Fire} = Max\left( LSR, \sum_{sub-lines} SI_x * F_x \right)$$

Where,

| | | |
|---|---|---|
| $CAT_{Fire}$ | = | the estimation of the gross Fire Cat capital charge (under Option 2) |
| $SI_x$ | = | is the sum insured by sub-line of business x, where x is residential, commercial and industrial respectively. |

| | | |
|---|---|---|
| $F_x$ | = | are the Fire/Business Interruption market wide factors by sub-line of business x, where x is residential, commercial and industrial respectively |
| LSR | = | is the single largest risk across all sub lines. By largest single risk refers to one single location for example a building. It could be covered by one or many policies. |

73. Undertakings should net down accordingly for risk mitigation as explained in section 3 and for examples see Annex 7

<u>Output</u>

74. The outputs are:

| | | |
|---|---|---|
| $CAT_{Fire\_net}$ | = | Catastrophe capital charge for Fire net of risk mitigation |

<u>MOTOR</u>

75. Undertakings with exposures under the Motor Third Party Liability line of business are exposed to this scenario.

<u>Input</u>

76. Undertakings will need to provide details of:

| | | |
|---|---|---|
| $LIM_{COUNTRY}$ | = | Highest sum insured offered. For example if unlimited, undertakings should type in "unlimited" or a monetary amount |
| $VY_{COUNTRY}$ | = | Number of vehicles insured per country |

<u>Calculation</u>

77. The gross motor catastrophe risk charge is then given by:

$$F_{UNLIM}(CAT_{Motor}) + F_{LIM}(CAT_{Motor})$$

Where,

$$F_{UNLIM}(x) = F_{MTPL} * \left[ \sum_{Country} (LIM_{FAIL\_COUNTRY} * VY_{COUNTRY}) \right] * \left( \frac{GL_{MTPL}}{x} \right)^{ALPHA}$$

$$F_{LIM}(x) = F_{MTPL} * \left[ \sum_{Country, where x < LIM_{COUNTRY}} (1 - LIM_{FAIL\_COUNTRY}) * VY_{COUNTRY} \right] * \left( \frac{GL_{MTPL}}{x} \right)^{ALPHA}$$

$$x = CAT_{Motor}$$

| | | |
|---|---|---|
| $LIM_{COUNTRY}$ | = | Highest sum insured offered. For example if unlimited, undertakings should type in "unlimited" or a monetary amount. |
| $VY_{COUNTRY}$ | = | Number of vehicles insured per country |
| $CAT_{Motor}$ | = | Gross 1 in 200 year occurrence for an undertaking, ignoring policy limits $$CAT_{Motor} = \frac{GL_{MPTL}}{\left(\frac{-\log_e(0.995)}{F_{TOTAL}}\right)^{\frac{1}{ALPHA}}}$$ |
| $F_{MTPL}$ | = | Frequency of the Europe-wide Scenario per vehicle per annum $$F_{MTPL} = \frac{-\log_e(1-\frac{1}{RP_{MTPL}})}{VY_{MTPL}}$$ |
| $VY_{MTPL}$ | = | Total vehicle years (millions) assumed in Europe-wide scenario = 300 |
| $RP_{MTPL}$ | = | Return Period of Europe-wide Scenario = 20 years |
| $GL_{MTPL}$ | = | Gross Loss of Europe-wide Scenario = €275m |
| $F_{TOTAL}$ | = | Total expected frequency of scenario loss for undertaking $$F_{TOTAL} = F_{MTPL} * \sum_{Country} VY_{COUNTRY}$$ |
| ALPHA | = | Pareto shape parameter = 2 |
| $LIM_{FAIL}$ | = | Proportion of 'limit failure losses' amongst the extreme losses for each country = 6% (except for Iceland, Cyprus and Malta = 0%) |
| $LIM_{FAIL\_COUNTRY}$ | = | Proportion of 'limit failure losses' amongst the extreme losses for each country = $LIM_{FAIL}$ for all countries except Iceland, Cyprus and Malta =0. |

78. The net risk charge should be calculated by the undertaking allowing for any additional contingent premiums payable and in line with section 3 and the examples in the Annex 7.

<u>Output</u>

79. <u>The outputs are:</u>

| | | |
|---|---|---|
| $CAT_{Motor\_net}$ | = | Catastrophe capital charge for Motor net of risk mitigation |

MARINE

80. Undertakings with exposures under MAT, in particular Marine property and liability are exposed to this scenario.

81. Two distinct Marine scenarios are considered in calculating the $CAT_{Marine}$ charge:

$CAT_{Marine1}$ = Major marine collision event, and

$CAT_{Marine2}$ = Loss of major offshore platform/complex

Undertakings should calculate both.

MARINE COLLISION (Scenario 1)

82. Undertakings should consider the scenario specification below:

Scenario specification:

**Description:** Collision between a gas / oil tanker and a cruise ship causing 100 deaths and 950 seriously injured persons.
The cruise ship is operated out of Miami and claims are litigated in the US.
The tanker is to blame, is unable to limit liability, and has cover with a P&I club for four fourths collision liability.

**Costing Info:**

| $m | Unit cost | Number | Gross Loss |
|---|---|---|---|
| **Death** | 2 | 100 | 200 |
| **Injury** | 3 | 950 | 2,850 |
| **Oil Pollution** | 550 | 1 | 550 |
| **Total** | | | 3,600 |

**Notes for undertakings:** P&I clubs and their reinsurers should note that this scenario exhausts the Collective Overspill P&I Protection and First Excess layer of the Oil Pollution protection under the Intl Grp reinsurance programme

Hull insurers should consider their largest gross lines in respect of both Tankers and Cruise ships

Marine Reinsurers will need to consider carefully their potential for accumulation under this scenario and document any methodology or assumptions when calculating their gross loss position.

Input

83. Undertakings will need to provide details of:

| | | |
|---|---|---|
| $SI_{Ht}$ | = | Undertakings maximum gross marine hull exposures to tankers (t). |
| $SI_{Lt}$ | = | Undertakings maximum gross exposure to marine liability, subject to liability falling as per the scenario specification. |
| $SI_{Lo}$ | = | Undertakings maximum gross exposure to liability in respect of Oil pollution |
| $SI_{Hc}$ | = | Undertakings maximum gross marine hull exposures to cruise ships (c) |

Calculation

84. The formula to be applied by undertakings in calculating their respective gross exposures is as follows:

$$CAT_{Marine1} = SI_{Ht} + SI_{Lt} + SI_{Lo} + SI_{Hc}$$

Where $SI_{Ht}$, $SI_{Hc}$, $SI_{Lt}$ and $SI_{Lo}$ are as defined above.

85. Undertakings should carry out the same calculation as above with netted down figures for $SI_{Ht}$, $SI_{Hc}$, $SI_{Lt}$ and $SI_{Lo}$ to take account of risk mitigations. Undertakings should net down accordingly for risk mitigation as explained in section 3 and for examples see Annex 7.

Output

86. The outputs are:

| | | |
|---|---|---|
| $CAT_{Marine1\_net}$ | = | Catastrophe capital charge for Marine scenario 1 net of risk mitigation |

LOSS OF MAJOR PLATFORM/COMPLEX (Scenario 2)

87. Undertakings should consider the scenario specification below:

Scenario specification:

**Description:** This scenario contemplates a Piper Alpha type total loss to all platforms and bridge links of a major complex

All coverage in respect of property damage, removal of wreckage, liabilities, loss of production income and capping of well/making well safe

**Notes for undertakings:** Only consider Marine lines of business in calculating gross and net losses; A&H, Personal Accident & Life catastrophe risk charges are handled separately.
Marine Reinsurers will need to consider carefully their potential for accumulation under this scenario and document any methodology or assumptions when calculating their gross loss position.

Input

88. Undertakings will need to provide details of:

| | | |
|---|---|---|
| $SI_i$ | = | Undertakings gross exposure by subclass i for the largest offshore complex accumulation, where i = property damage, removal of wreck, loss of production income, making wells etc. |

Calculation

89. The formula to be applied by undertakings in calculating their respective gross exposures is as follows:

$$CAT_{Marine2} = \sum_i SI_i$$

Where $SI_i$ is as defined above.

90. Undertakings should carry out the same calculation as above with netted down figures for $SI_i$ to take account of risk mitigations. Undertakings should net down accordingly for risk mitigation as explained in section 3 and for examples see Annex 7.

Output

91. The outputs are:

| | | |
|---|---|---|
| $CAT_{Marine2\_net}$ | = | Catastrophe capital charge for Marine scenario 2 net of risk mitigation |

92. The $CAT_{Marine\_net}$ total charge net of risk mitigation is then calculated as:

$$CAT_{Marine\_net} = \sqrt{(CAT_{Marine1\_net})^2 + (CAT_{Marine2\_net})^2}$$

CREDIT AND SURETYSHIP

93. It should be noted that the Credit and Suretyship scenarios have been developed independently of the CTF and incorporated into this document for completeness. This is because the appropriateness of a *fixed* 99.5% VaR measure, i.e. cycle insensitive, is subject to ongoing discussions at a higher EC level.

Inputs

$SCR_{CAT\_individual\_max\_loss\_net}$ , = the net capital charge of the maximum loss of the individual (group) exposures.

$SCR_{CAT\_recession\_net}$= the net capital charge of the recession based scenario described below.

94. Undertakings with exposures under the Credit and Suretyship line of business are exposed to this scenario.

Calculation:

$$SCR_{CAT\_credit\_net} = \sqrt{(SCR_{CAT\_individual\_\max\_loss\_net})^2 + (SCR_{CAT\_recesion\_net})^2}$$

95. The $SCR_{CAT\_credit\_net}$ scenario is designed to adequately consider the risk at a gross level and the mitigating effects of proportional and non-proportional reinsurance as well.

96. The $SCR_{CAT\_recession\_net}$ scenario addresses the pro-cyclical nature of the C&S line of business.

Where

97. $SCR_{CAT_individual_max_}$loss shall be calculated as the maximum loss derived from one of the two following cases:

a) The default of the largest three exposures using a PML% of 14% and a recourse rate of 28%. Normally the PML is the possible maximum loss taking into account working the preventing measures working properly. However, the PML of 14% refers to the worse case situation that some measurements are not working properly[11]. These assumptions are reflecting an average loss given default of approximately 10% for the large risks[12]. The largest exposure shall be identified according the sum of the following magnitudes:

I. + Ultimate gross loss amount after PML and recourse.
II. - Recovery expected from reinsurance

[11] An example of the calculation of the ultimate gross loss amount after PML and recourse has been included in the annex.
[12] A LGD of 10% is in line with the latest PML Study of 23th September 2008 initiated by the PML Working Group.

III. +/- any other variation based on existing legal or contractual commitments, which modify the impact of the failure of the exposure on the undertaking (an example might be the reinstatements in respect of existing reinsurance contracts)

This sum shall identify the amount to compare with the output of paragraph b) in order to derive $SCR_{CAT\_individual\_max\_loss\_net}$.

b) The default of the largest three group exposures using a PML% of 14% and a recourse rate of 28%. For the identification of the largest group exposure and the assessment of the losses the undertaking shall apply the methodology described in paragraph a).

98. $SCR_{CAT\_recession\_net}$ = $SCR_{CAT\_recession\_ratio\_net}$ * *Net earned premium* including a dampening mechanism based on the *net loss ratio* of the undertaking. The $SCR_{CAT\_recession\_net}$ shall be calculated according the following method and assumptions:

- Exposures shall be classified into homogeneous groups of risks based on the nature of the exposures.
- For each group of exposures the undertaking shall calculate the net loss ratio, $SCR_{CAT\_recession\_ratio\_net}$ and $SCR_{CAT\_recession\_net}$ based on the failure rates, recourse rate and loss given default as described below.
- The percentages refer to the original assured amounts (gross exposures). However the aggregated $SCR_{CAT\_recession\_ratio\_net}$ and $SCR_{CAT\_recession\_net}$ are based on the overall *net loss ratio*.
- With the failure rates the $SCR_{CAT\_recession\_net}$ can be calculated for the current scenario and the worst case scenario:
  a. *Fail_rate_max* = the maximum value observed in the index of failures rates, selected by the undertaking, in a long period of observation. The period of observation should be at least 10 years building up to 30 years. With the *Fail_rate_max* the worst case scenario can be calculated in case *Fail_rate_current = Fail_rate_max.*
  b. *Fail_rate_min* = the minimum amount of the continuing average of 3 consecutive years observed in the same data.
  c. *Fail_rate_current* = the current failure rate.
  d. *Failure rate max(min;current)* = maximum of the *fail_rate_min* and *fail_rate_current.*
  e. *Recourse rate = Recourse rate of the current scenario reflects to the actual recourse rate, the recourse rate of the worse scenario should reflect to the estimated worse case recourse rate.*
  f. *Loss given default* is the result of the ultimate gross loss amount compared to the gross exposure.
- The above-mentioned rates shall be derived from the failure rates observed and periodically updated (see below the specific item at this respect).
- The dampening mechanism is limited to a $SCR_{CAT\_recession\_ratio\_net}$ of 200% of the net earned premium with a *net loss ratio* lower than 25% and to a

$SCR_{CAT\_recession\_ratio\_net}$ of 100% of the net earned premium with a *net loss ratio* higher than 125%. Within the limits the $SCR_{CAT\_recession\_ratio\_net}$ = 225% minus *net loss ratio*. This mechanism aims to ensure that at the peak of the cycle (low *failure* rates), the $SCR_{CAT\_recession\_net}$ shall reach its highest value and C&S undertakings shall be required to have enough own funds to cover a higher SCR. On the other hand, at the trough of the cycle, SCR will be at its lowest value, so that own funds will be released. In other words, as undertakings face harder net claims ratio due to an increase of failure rates, the SCR decreases.

99. A summary of 10 possible scenario's is included within QIS 5 TS with the following assumptions:

- The *fail_rate_max* is 0,50%, the *fail_rate_min* is 0,05% and the current failure rate varies from 0,05% up to 0,50%.
- The retention after reinsurance recovery for $SCR_{CAT\_individual\_max\_loss\_net}$ will be € 10 million per risk (both single and group exposures) and for $SCR_{CAT\_recession\_net}$ 50% based on a 50% Quota Share.
- The 10 possible scenarios are realistic scenarios based on representative market figures (e.g. underwriting risk profiles en P&L figures) to show the impact of the dampening mechanism and to give an example how the calculation should be set up.

TERRORISM

100. The CTF intends to follow a similar approach as per the Concentration Scenario in the Health section.

101. The total Terrorism capital charge shall be estimated as one of two options:

Option 1

Input

102. Undertakings will need to provide details of:

| | | |
|---|---|---|
| P | = | Sum insured of largest known concentration of exposures under the Fire and Other Damage line of business in a 300 metre radius.<br><br>The concentration may cover densely populated office blocks as found in financial hubs. |

Calculation

103. The formula to be applied by undertakings is as follows:

$$CAT_{Terr} = P * x$$

Where,

| | | |
|---|---|---|
| x | = | proportion of damage caused by scenario (= 50%) |

104. While the relative weighting of coverage will vary from policy to policy, the CTF decided that an average damage ratio factor of 50% should be applied to the total exposure in a 300 metre radius.

105. Undertakings should net down accordingly for risk mitigation as explained in section 3 and for examples see Annex 7.

Output

106. The outputs are:

| | | |
|---|---|---|
| $CAT_{Terr\_net}$ | = | Catastrophe capital charge for Terrorism net of risk mitigation |

Option 2

107. This is a simplified option that undertakings should choose only if they are not able to provide P (as defined above).

108. .

Input

109. Undertakings will need to provide details of:

| | | |
|---|---|---|
| Q | = | Sum largest 5 sums insured under the Fire and Other Damage line of business, insured in a capital city. The 5 largest risks may be based in densely populated areas as found in financial hubs. |

Calculation

110. The formula to be applied by undertakings is as follows:

$$CAT_{Terr} = Q * x$$

Where,

| | | |
|---|---|---|
| x | = | proportion of damage caused by scenario (=50%) |

111. Undertakings should net down accordingly for risk mitigation as explained in section 3 and for examples see Annex 7.

Output

112. The outputs are:

| | | |
|---|---|---|
| $CAT_{Terr\_net}$ | = | Catastrophe capital charge for Terrorism net of risk mitigation |

AVIATION

113. Undertakings will need to provide the following information from their Schedules A, B and C. The CTF has based the Aviation scenario on the information captured by the ABC schedules used by reinsurers to collect information regarding the exposures of insurers. These schedules are standard and every aviation insurer should have such information.

Input

114. Undertakings will need to provide details of:

| | | |
|---|---|---|
| $SHARE_{Hull}$ | = | Undertakings share for hull |
| $MIT_{Hull}$ | = | Mitigation / Reinsurance cover for hull |
| $SHARE_{Liability}$ | = | Undertakings share for liability |
| $MIT_{Liability}$ | = | Mitigation / Reinsurance cover for liability |
| WAP | = | Whole account protection, if applicable |

Calculation

115. The formula to be applied by undertakings in calculating their respective gross exposures is as follows:

$$CAT_{Aviation} = \underset{SchedA}{Max}(SHARE_{Total}) + \underset{SchedB}{Max}(SHARE_{Total}) + \underset{SchedC}{Max}(SHARE_{Total})$$

where

| | | |
|---|---|---|
| $CAT_{Aviation}$ | = | the estimation of the gross Aviation Cat capital charge |
| $SHARE_{Total}$ | = | $SHARE_{hull}$ + $SHARE_{liability}$ (as defined above) |
| Sched A,B,C | = | Schedule A, B and C respectively |

116. The net capital charge for aviation will be estimated as:

$$CAT_{Aviation\_net} = \left\lfloor \underset{SchedA}{Max}(SHARE_{Total} - MIT_{Total}) + \underset{SchedB}{Max}(SHARE_{Total} - MIT_{Total}) + \underset{SchedC}{Max}(SHARE_{Total} - MIT_{Total}) \right\rfloor - WAP$$

Where

| | | |
|---|---|---|
| $SHARE_{Total}$ | = | $SHARE_{hull}$ + $SHARE_{liability}$ |
| Sched A,B,C | = | Schedule A, B and C respectively |
| $MIT_{Total}$ | = | $MIT_{hull}$ + $MIT_{liability}$ |
| WAP | = | Whole Account Protection reinsurance if applicable |

Output

117. The outputs are:

| | | |
|---|---|---|
| $CAT_{Aviation\_net}$ | = | Catastrophe capital charge for Aviation net of risk mitigation |

LIABILITY

118. The liability scenarios need to cover the following types of business:-

- General Third party liability (incl hospitals)
- Product liability (incl recall and MPT where written)
- Professional indemnity/E&O (incl medmal)
- D&O
- Employer's liability/workers comp
- Pollution/environmental impairment liability
- Cyber liability (eg network security etc)
- Employment practices liability (although not common outside the US)

119. The task force has decided to focus on a method more reflective of the more material systemic exposures, assuming that other exposures are captured by the premium and reserve risk module. Examples of systemic events would include issues such as:

- Widespread losses within one profession or a small number of related professions due to an historically common practice or procedure being ruled as erroneous or negligent.
- Widely used generic drug is found to have harmful long term side effects (multiple insureds affected).
- A common process used in a particular industry/occupation is proved or ruled to give rise to injury for which compensation should be available.

120. Undertakings will need to provide the following information:

Input

| | | |
|---|---|---|
| $GWP_{E\&O}$ | = | Gross written premium for Errors & Omissions business |
| $GWP_{GTPL}$ | = | Gross written premium for General Third Party Liability business |

| | | |
|---|---|---|
| $GWP_{EL}$ | = | Gross written premium for Employers Liability business |
| $GWP_{D\&O}$ | = | Gross written premium for Directors and Officers business |

Calculation

121. The formula to be applied by undertakings is as follows:

$$V_{GWP\_f,r,c} = GWP_i * f_i$$

$$CAT_{Liability} = \sqrt{AGG_{r,c} * V_{GWP\_f,r} * V_{GWP\_f,c} *}$$

Where,

| | | |
|---|---|---|
| $CAT_{Liability}$ | = | Estimation of gross liability Cat capital charge. |
| $GWP_i$ | = | Gross written premium for line of business i, where i = E&O, D&O, GTPL and EL. |
| $f_i$ | = | Risk factor for line of business, where i = E&O, D&O, GTPL and EL (= 125%, 200%, 225%, 200% respectively). |
| $V_{GWP\_f,r,c}$ | = | The vector of GWP*f for each line of business I, where i = E&O, D&O, GTPL and EL. |
| $AGG_{r,c}$ | = | Rows and columns of the aggregation matrix between lines of business. |

122. Undertakings should net down accordingly for risk mitigation as explained in section 3 and for examples see Annex 7.

Output

123. The outputs are:

| | | |
|---|---|---|
| $CAT_{Liability\_net}$ | = | Catastrophe capital charge for Liability net of risk mitigation |

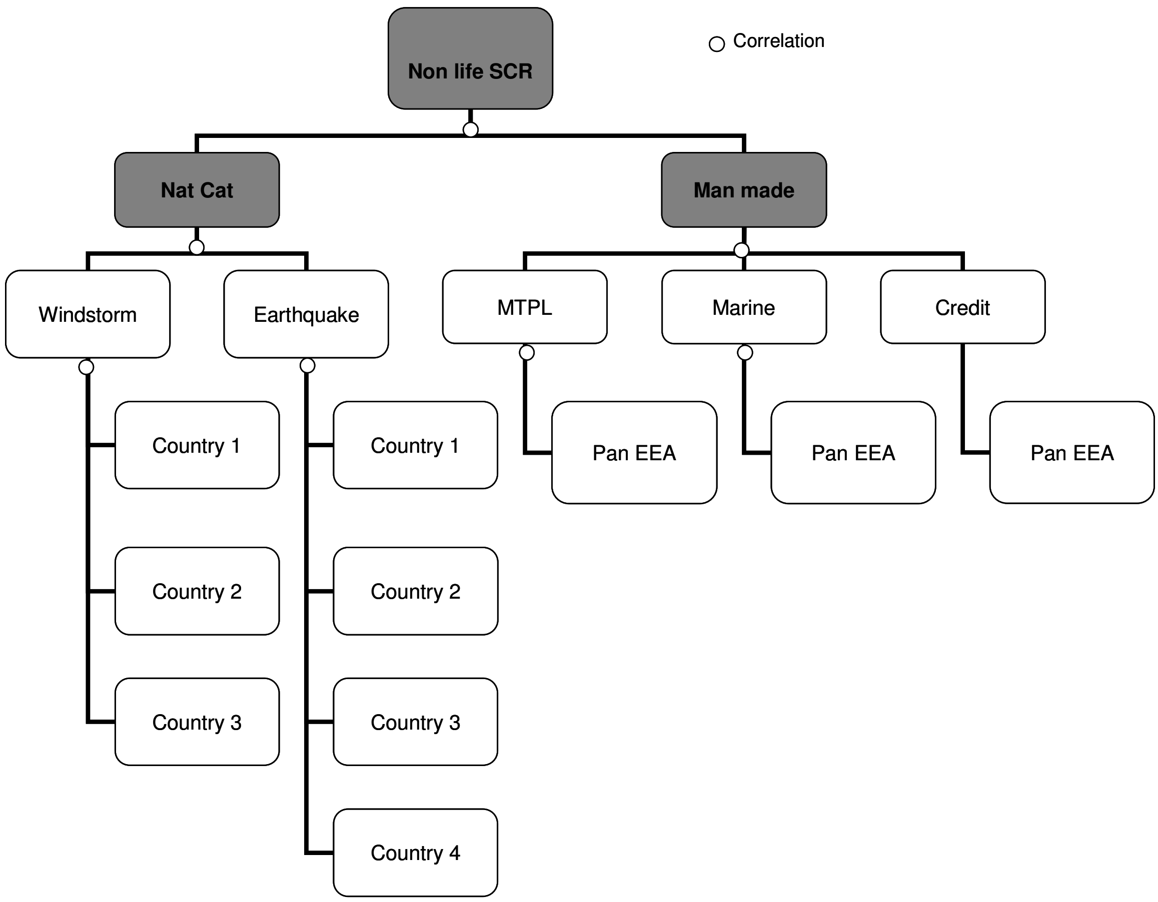
### *4.2. Aggregation of non life catastrophe scenarios*

124. The CTF has decided that the aggregation of risk charges should be carried out by country and perils. The rationale for such approach:

- Firstly, for each peril the charges in different countries are aggregated to give a pan-EEA view for that undertaking, enabling the application of pan-EEA reinsurance protection to the aggregated scenario. For some perils, e.g. Credit & Suretyship, full correlation is assumed. For others, such as flood, storm, earthquake where the correlation depends on the geographic distance between exposures, less correlation between countries is assumed.

- Between the perils, the diversification structure is complex. Some of the perils can be considered to be almost independent. Between other perils a positive dependence may exist, such as between meteorological perils. This dependence has been accounted for by aggregating some of the perils with a unique positive correlation factor, for example 25%. A positive correlation factor appears also to be appropriate to allow for the deficiencies of the linear correlation technique.

125. An illustration of this:



126. The correlation between perils was based on expert judgement as well as on historical/climatologically information. The wintertime meteorology of Europe is influenced strongly by the jet stream which can bring prevailing bad weather from the northern Atlantic, with multiple storms and floods often occurring in one year across Europe.

127. The aggregated catastrophe risk charge under standardised scenarios will be represented by $NL\_CAT$ .

Where

| | | |
|---|---|---|
| *NL_CAT* | = | Catastrophe capital charge for non life net of risk mitigation under standardised scenarios |

128. The $NL\_CAT$ will be the aggregation of the capital charges for Natural catastrophe and man-made disasters. The CTF has assumed both are independent. The CTF is aware that there be some correlation for some type events, for example a windstorm could lead to a marine disaster, however, attempting to allow for these effects would disproportionately add further complexity to the calculation without materially improving the risk sensitivity of the standardized scenarios. For that reason independence is assumed, as follows:

$$NL\_CAT = \sqrt{(NL\_CAT_{NatCat})^2 + (NL\_CAT_{Manmade})^2}$$

| | *Nat Cat* | *Man-made* |
|---|---|---|
| *Nat cat* | 1 | 0 |
| *Man-made* | 0 | 1 |

129. The $NL\_CAT_{NatCat}$ will be given as:

- Firstly catastrophe charges at country level should be aggregated to estimate the catastrophe charge at peril level:

$$CAT_{peril} = \sqrt{\sum_{ctry,i,i} Corr_{ctry,i,j} * CAT_{peril\_ctry,i} * CAT_{peril\_ctry,j}}$$

Where:

| | | |
|---|---|---|
| $CAT_{peril}$ | = | Catastrophe capital charge for each peril type = Windstorm, Earthquake, Flood, Hail and Subsidence. |
| $CAT_{peril\_ctry,i,j}$ | = | Catastrophe capital charge for each peril type by country = Windstorm, Earthquake, Flood, Hail and Subsidence. Where there are separate reinsurance programmes for each country the aggregations (across countries) are done net of reinsurance. |
| $Corr_{ctry,i,j}$ | = | Correlation between countries i,j |

- Secondly, catastrophe charges at peril level should be aggregated to estimate the catastrophe charge at total level:

$$NL\_CAT_{NatCat} = \sqrt{\sum_{peril,i,i} Corr_{peril,i,j} * CAT_{peril,i} * CAT_{peril,j}}$$

Where:

| | | |
|---|---|---|
| $NL\_CAT_{NatCat}$ | = | Catastrophe capital charge for non life net of risk mitigation under standardised scenarios |
| $Corr_{peril,i,j}$ | = | Correlation between perils i,j |
| $CAT_{peril,i,j}$ | = | Catastrophe capital charge for each peril= Windstorm, Earthquake, Flood, Hail and Subsidence. . Where there are separate reinsurance programmes per peril, the aggregation (across perils) are done net of reinsurance. |

130. Undertakings should refer to section 3 for details of netting down for risk mitigation.

131. The CTF has decided that geographical diversification needs to be allowed for when aggregating losses across countries. Geographical diversification is important facet of insurers and reinsurers writing international business. Furthermore Article 104 deals with the design of the basic Solvency Capital Requirement and sub-article 4 includes the following:

*“Where appropriate, diversification effects shall be taken into account in the design of each risk module.”*

132. As a result the CTF has integrated geographical diversification as part of the calculation of the capital charge for each undertaking.

133. The correlation between countries for each of the Nat Cat perils has been derived from multiple probabilistic event set based simulation tools as well as from expert judgement. The correlation coefficients reflect the relationship between countries in case of windstorms/floods/earthquakes with a return period of 1:200 years. The correlation coefficients strongly depend on the proximity of the countries, or, for flood, the shape of the river network.

134. Please note GU, SM, MA and RE stand for Guadaloupe, St. Martin, Martinique and Reunion.

135. The country correlation matrixes $Corr_{ctry,i,j}$ for each peril are:

For Windstorm:

| | AT | BE | CH | CZ | DE | DK | ES | FR | UK | IE | IS | LU | NL | NO | PL | SE | GU | SM | MA | RE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT | 1.00 | | | | | | | | | | | | | | | | | | | |
| BE | 0.25 | 1.00 | | | | | | | | | | | | | | | | | | |
| CH | 0.50 | 0.25 | 1.00 | | | | | | | | | | | | | | | | | |
| CZ | 0.25 | 0.25 | 0.25 | 1.00 | | | | | | | | | | | | | | | | |
| DE | 0.25 | 0.50 | 0.25 | 0.25 | 1.00 | | | | | | | | | | | | | | | |
| DK | 0.00 | 0.25 | 0.00 | 0.00 | 0.50 | 1.00 | | | | | | | | | | | | | | |
| ES | 0.00 | 0.00 | 0.25 | 0.00 | 0.00 | 0.00 | 1.00 | | | | | | | | | | | | | |
| FR | 0.25 | 0.50 | 0.50 | 0.25 | 0.50 | 0.25 | 0.25 | 1.00 | | | | | | | | | | | | |
| UK | 0.00 | 0.50 | 0.00 | 0.00 | 0.25 | 0.25 | 0.00 | 0.25 | 1.00 | | | | | | | | | | | |
| IE | 0.00 | 0.25 | 0.00 | 0.00 | 0.25 | 0.00 | 0.00 | 0.00 | 0.50 | 1.00 | | | | | | | | | | |
| IS | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | | | | | | | | | |
| LU | 0.25 | 0.75 | 0.25 | 0.25 | 0.50 | 0.25 | 0.00 | 0.75 | 0.25 | 0.25 | 0.00 | 1.00 | | | | | | | | |
| NL | 0.25 | 0.75 | 0.25 | 0.25 | 0.50 | 0.50 | 0.00 | 0.50 | 0.50 | 0.25 | 0.00 | 0.50 | 1.00 | | | | | | | |
| NO | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.50 | 0.00 | 0.00 | 0.25 | 0.00 | 0.00 | 0.25 | 0.25 | 1.00 | | | | | | |
| PL | 0.00 | 0.25 | 0.00 | 0.25 | 0.50 | 0.25 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.25 | 0.00 | 1.00 | | | | | |
| SE | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.50 | 0.00 | 1.00 | | | | |
| GU | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | | | |
| SM | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 1.00 | | |
| MA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 1.00 | 1.00 | |
| RE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 |

For Flood:

| | AT | BE | CH | CZ | FR | DE | HU | IT | BG | PL | RO | SI | SK | UK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT | 1.00 | | | | | | | | | | | | | |
| BE | 0.00 | 1.00 | | | | | | | | | | | | |
| CH | 0.25 | 0.00 | 1.00 | | | | | | | | | | | |
| CZ | 0.75 | 0.00 | 0.00 | 1.00 | | | | | | | | | | |
| FR | 0.00 | 0.25 | 0.25 | 0.00 | 1.00 | | | | | | | | | |
| DE | 0.75 | 0.25 | 0.25 | 0.75 | 0.25 | 1.00 | | | | | | | | |
| HU | 0.75 | 0.00 | 0.00 | 0.25 | 0.00 | 0.75 | 1.00 | | | | | | | |
| IT | 0.00 | 0.00 | 0.25 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | | | | | | |
| BG | 0.25 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.25 | 0.00 | 1.00 | | | | | |
| PL | 0.75 | 0.00 | 0.00 | 0.75 | 0.00 | 0.75 | 0.25 | 0.00 | 0.00 | 1.00 | | | | |
| RO | 0.75 | 0.00 | 0.00 | 0.25 | 0.00 | 0.75 | 0.75 | 0.00 | 0.50 | 0.25 | 1.00 | | | |
| SI | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.00 | 0.00 | 0.00 | 1.00 | | |
| SK | 0.75 | 0.00 | 0.00 | 0.75 | 0.00 | 0.75 | 0.25 | 0.00 | 0.00 | 0.50 | 0.25 | 0.25 | 1.00 | |
| UK | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 |

136. For earthquake: the CTF considers that there is correlation between Italy, Switzerland and neighbouring countries, which reflects the smaller geographical scope of an earthquake in Europe as compared to large windstorms or floods which easily cross several countries.

For Earthquake:

| | AT | BE | BG | CR | CY | FR | DE | HE | HU | IT | PT | RO | SI | CZ | CH | SK | GU | SM | MA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT | 1.00 | | | | | | | | | | | | | | | | | | |
| BE | 0.00 | 1.00 | | | | | | | | | | | | | | | | | |
| BG | 0.00 | 0.00 | 1.00 | | | | | | | | | | | | | | | | |
| CR | 0.00 | 0.00 | 0.00 | 1.00 | | | | | | | | | | | | | | | |
| CY | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | | | | | | | | | | | | | | |
| FR | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | | | | | | | | | | | | | |
| DE | 0.00 | 0.25 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | | | | | | | | | | | | |
| HE | 0.00 | 0.00 | 0.25 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | | | | | | | | | | | |
| HU | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | | | | | | | | | | |
| IT | 0.25 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | | | | | | | | | |
| PT | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | | | | | | | | |
| RO | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | | | | | | | |
| SI | 0.00 | 0.00 | 0.00 | 0.25 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.00 | 0.00 | 1.00 | | | | | | |
| CZ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | | | | | |
| CH | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.25 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | | | | |
| SK | 0.25 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.25 | 0.00 | 1.00 | | | |
| GU | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | | |
| SM | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 1.00 | |
| MA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 1.00 | 1.00 |

For Hail:

| | AT | BE | FR | DE | IT | LU | NL | CH | ES |
|---|---|---|---|---|---|---|---|---|---|
| AT | 1.00 | | | | | | | | |
| BE | 0.00 | 1.00 | | | | | | | |
| FR | 0.00 | 0.25 | 1.00 | | | | | | |
| DE | 0.00 | 0.00 | 0.00 | 1.00 | | | | | |
| IT | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | | | | |
| LU | 0.00 | 0.50 | 0.25 | 0.25 | 0.00 | 1.00 | | | |
| NL | 0.00 | 0.50 | 0.00 | 0.25 | 0.00 | 0.00 | 1.00 | | |
| CH | 0.00 | 0.00 | 0.25 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | |
| ES | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 |

137. The peril correlation matrix $Corr_{peril,i,j}$ is:

| | Windstorm | Earthquake | Flood | Hail | Subsidence |
|---|---|---|---|---|---|
| Windstorm | 1.00 | | | | |
| Earthquake | 0.00 | 1.00 | | | |
| Flood | 0.25 | 0.00 | 1.00 | | |
| Hail | 0.25 | 0.00 | 0.00 | 1.00 | |

| | | | | | |
|---|---|---|---|---|---|
| Subsidence | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 |

138. The $NL\_CAT_{ManMade}$ will be given as:

$$NL\_CAT_{ManMade} = \sqrt{\sum_x ((CAT_{x\_net})^2)}$$

Where,

| | | |
|---|---|---|
| $CAT_{x\_net}$ | = | Net Cat charges for man-made event x |
| x | = | Fire, motor, marine, credit & suretyship, terrorism, aviation and liability. |

139. Independence is assumed between the types of man-made event.

### 4.3. Calibration of Non life Catastrophe standardised scenarios

140. This section provides the detailed information in respect of how the CTF has calibrated Natural and Man-made catastrophe scenarios. This section does not necessarily detail how to apply the scenarios, but details how the parameters are calibrated.

#### 4.3.1. Calibration of Natural Catastrophes

141. The CTF considered a number of options and assessed the pros and cons of each. After careful thought and consideration the CTF reached the following unanimous conclusions

i. the Catastrophe standardised scenarios should be driven by undertakings' exposure, (rather than using premiums, which does not measure a company's exposure at risk satisfactorily)

ii. that aggregate country level exposure data is inadequate to properly reflect the variability in natural catastrophe risk – especially for large countries with strong gradients of risk, hence

iii. the Catastrophe standardised scenarios should be based on exposure at a sub-country level and use something akin to CRESTA zones which are an existing industry standard (or something similar if CRESTA zones are not available. The CTF has refer to them as "zones") for ease of use. We recognise that this resolution is still inadequate to resolve some risks e.g. those very close to rivers, or earthquake faults, or prone to hail risk, and does not resolve the difference in risk eg. between different construction materials or standards, or age. This is due to the pragmatic needs of the scenarios, and undertakings are advised to determine if the scenarios are appropriate for their business. These

142. On that basis the CTF agreed on the following proposal for the estimation of a catastrophe charge for natural catastrophes:

$$WTIV_{ZONE} = F_{ZONE} * TIV_{ZONE}$$

$$CAT_{Peril\_ctry} = Q_{CTRY} \sqrt{\sum_{rxc} AGG_{r,c} * WTIV_{ZONE,r} * WTIV_{ZONE,c}}$$

Where

| | | |
|---|---|---|
| $CAT_{Peril\_ctry}$ | = | The estimation of cat capital charge for a specific country |
| $Q_{CTRY}$ | = | 1 in 200 year factor for each country and peril. The $Q_{CTRY}$ are provided in Annex 2 |
| $F_{ZONE}$ | = | relativity factors for each zone by country |
| $AGG_{r,c}$ | = | Rows and columns of the aggregation matrix AGG by country. [13] |
| $WTIV_{zone,r}$, $WTIV_{zonec}$ | = | Geographically weighted total insured value by zone.[14] |

[13] These values are provided in an excel spreadsheet « parameters for non life catastrophe »

[14] These values are provided in an excel spreadsheet « parameters for non life catastrophe »

| | | |
|---|---|---|
| $TIV_{ZONE}$ | = | This comprises, where applicable, of the weighted sum of:<br>$TIV_{ZONE\_Fire}$ = total insured value for Fire and other damage by zone<br>$TIV_{ZONE\_MPD}$ = total insured value for Motor property damage by zone<br>$TIV_{ZONE\_MAT}$ = total insured value for Marine by zone. Within the Marine Class, the material components are Cargo (=static warehouse risks) and Marine XL. The Static Cargo sums insured can be entered into the CRESTA table as per the direct property. The Marine XL (= Reinsurance of direct marine insurers) have exactly the same issues as Property Treaty reinsurers in that the standardised method would not be appropriate.<br><br>Weights are given to the TIVs depending on the line of business. This is because the calibration of the factors has been based on the damage caused by fire and other damage. Thus in order to use the same zone factors, the TIVs have to be scaled to reflect the true level of damage caused in other lines of business. |

143. Below we describe the process followed to calibrate each of the above inputs and where possible provide information regarding the underlying thought process.

### *A) Calibrate the 1 in 200 year factor for each country and peril ($Q_{CTRY}$)*

144. The country factor represents the cost of a 1 in 200 loss to the industry as a whole, expressed as a percentage of sum insured. This is a measure that will be readily understood by the industry. It is also readily comparable between countries, which helps with transparency.

145. Each participant of the CTF provided their own industry view of what a 1 in 200 year loss could be as a percentage of Total insured value for a particular country. Where views diverged, the CTF discussed further before making a final collective decision. The final selection is provided in Annex 2.

146. It is important when looking at the factors that readers interpret these correctly. The factors are not only a measure of the intensity of the hazard in a region, but also a measure of the vulnerability of the building stock and concentrations of exposure at risk. For countries with high earthquake risk and a history of damaging earthquakes, they typically have strong building-codes that would moderate the impact compared to countries with weaker buildings.

147. Where information was not available for a particular country, the task force requested CEIOPS input or used an extrapolation technique between neighbouring countries.

### *B) Construct CRESTA relativities: relativity factors for each zone by country ($F_{ZONE}$)*

148. The CTF does not believe it is appropriate to allocate the 1 in 200 industry loss estimated above between undertakings. This is because Solvency II specifies that the required capital be calibrated to a 1 in 200 level for each undertaking. As natural catastrophe risk can vary considerably depending on where you are in a country, taking a single, averaged country level factor is not risk sensitive enough and will not treat undertakings fairly, particularly for larger countries.

149. As a result the CTF designed a simple way to allow for the differing risk in the different zones in each country given the spatially varying nature of natural perils. This is done through the use of cresta relativities, which represent the level of damage relative to the 1 in 200 on a national basis. The fact that in some areas within a country you will be more exposed and the level of damage may be greater than others.

150. In doing so the CTF considered two approaches:

1. **Applying an event footprint approach**: Using a single event footprint that generates a national 1-in-200 year loss, and calculating the damage ratio in each zone that is impacted by that event.

2. **Applying a »Hazard Map«[15] approach:** The loss damage ratio in each zone corresponding to equivalent to the 1-in-200 year loss in that zone on a national basis.

151. The approaches reflect opposite extremes of the trade off between different levels of hazard in different local areas and allowance for geographic diversification across wider areas.

152. The main disadvantage of a single-event footprint approach is that it is often only one of a range of many possible events that could cause a 1-in-200 loss, and will not represent the 1-in-200 loss for many undertakings: especially for those whose exposure lies partly or predominantly outside the single scenario event footprint.

153. In principle the hazard map approach better reflects the physical reality of the pattern and gradients of natural perils across Europe, and would better reflect a company's exposure to that pattern of risk. Thus for a particular undertaking, we can assess the suitability of each approach for different undertakings as follows:

| Undertaking | Footprint | Hazard Map |
|---|---|---|
| Geographically well diversified | Will work well | Will over-estimate |
| Locally concentrated | Will under or overestimate | Will work well |

[15] Other definitions of hazard map exist –e.g. annual average loss, which is more appropriate for pricing. The definition here seems to be best suited to our purpose.

154. In order to decide the best way forward, the CTF proceeded to test and analyse the bias introduced by applying each approach and exploring any adjustments that could be made to each approach to make it more appropriate for all undertakings. The analysis was performed on Windstorm and was assessed on the market exposures of a few countries.

155. For illustration, we present the steps followed for one particular case, the Netherlands, though the preferred method was then tested on additional countries:

- The CTF used an anonymised data set of 86 companies at province level (12 provinces based on the risk based reporting data of the current Dutch framework). The data included buildings sum insured information.

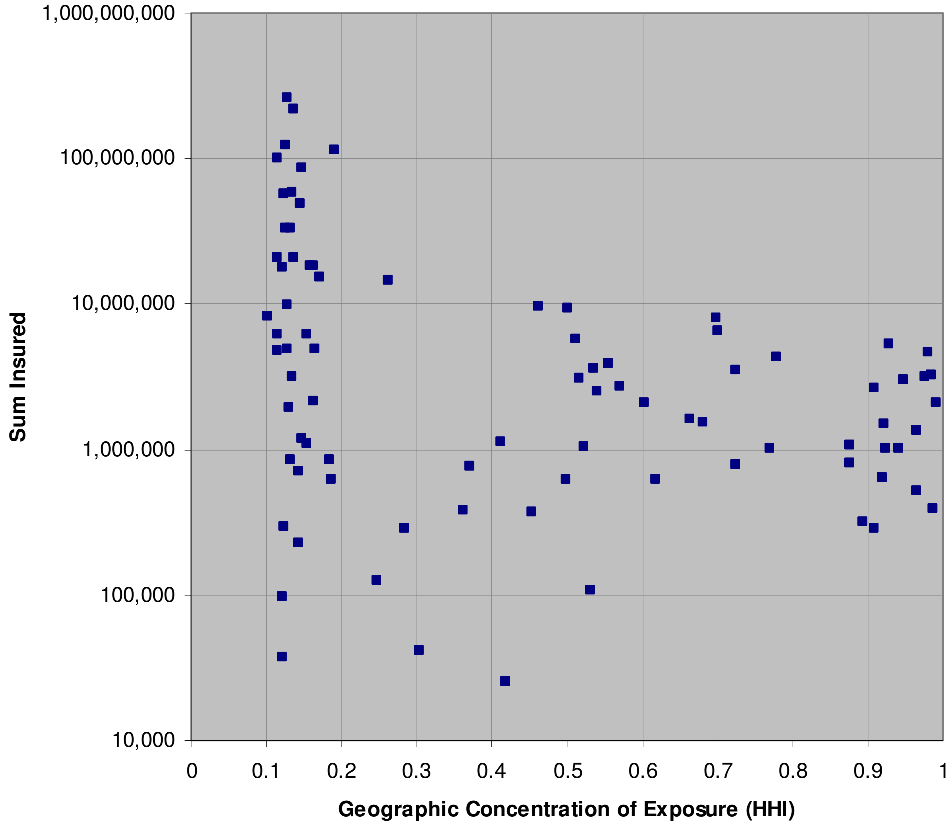
- The CTF used a Windstorm Cat model to carry out the necessary calculations. It is important to note that this model was selected for the purpose of testing for bias, rather than to calibrate the actual scenarios. The CTF does not believe that the conclusions of this assessment would differ materially if a different Cat model had been used. The final catastrophe standardised scenarios themselves are not based on this Cat model but reflect the views of task force as whole.

- A »ground-up« perspective of the loss was used to test the relative methodologies: that is without the application of insurance policy conditions or reinsurance treaties, again simply to compare the validity of each approach.

- The steps followed were:

  I. Selected a hypothetical 1 in 200 year market loss.

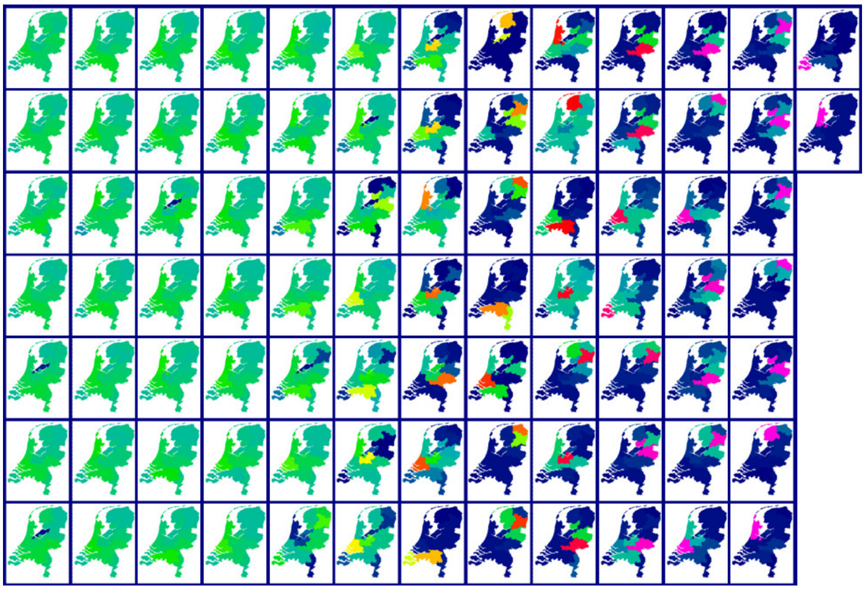
  II. The CTF run a range of models for each of the 86 companies' actual exposure data. Below is a graph which illustrates the structure of the market for this anonymised market as well as highlights some of the problems the CTF was faced when selecting a methodology which provided results that where adequate for all the market participants.




Each dot represents a single company. A concentration equal to 1 means that all of a company's exposure is in a single province. The market portfolio has a concentration roughly equal to 0.12, indicating that as a whole it is quite a concentrated market. This chart shows that the largest 20 companies (representing around 87% of the exposure) are well geographically diversified. However, 43 companies have more than 80% of their exposure concentrated in just two provinces.

Below we see the same issue from a spatial perspective. Each chart represents a single company (in order of concentration). It shows where (geographically) their exposure is proportionally more or less than their market share:

- green= share of exposure in province roughly equals national market share
- blue= share of exposure in province less national than market share
- yel/ora/red/pur= share of exposure in province greater than national market share

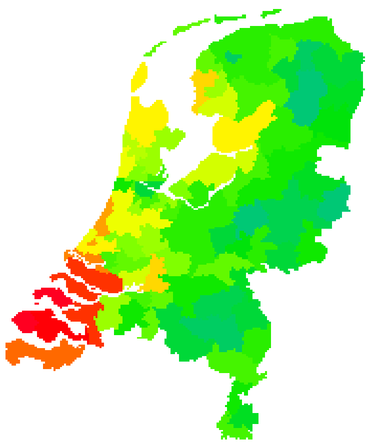


The chart shows that many companies have strong geographical skews to where they are writing business, which would intuitively indicate that the use of a single scenario footprint would not effectively represent their exposure to natural hazard risk.

III. Apply footprint and hazard map approach and compare results from the model, as follows:

Footprint approach

156. The scenario was based on a footprint with mean loss closest to selected 1-in-200 market loss.

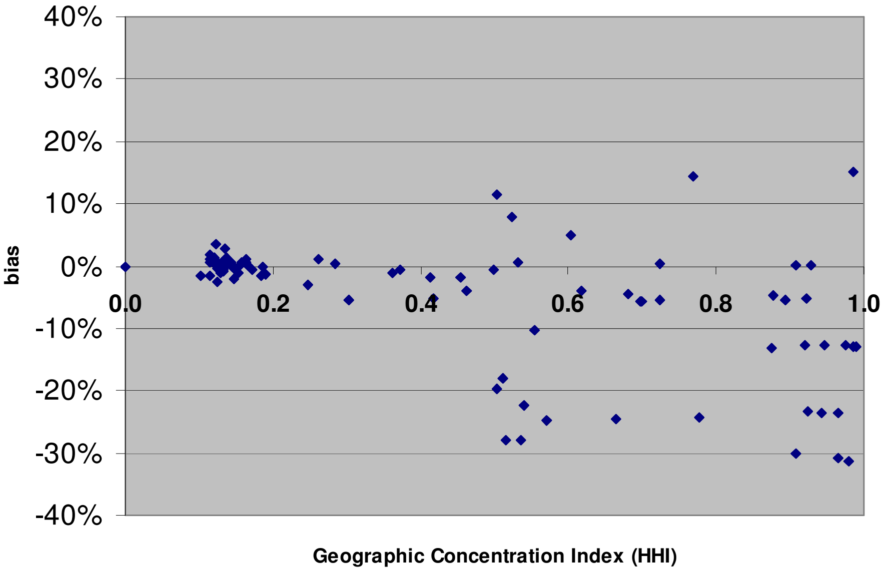


157. The relativity between the highest and lowest zonal factors was around 4.

158. The modelling results provided the following results:

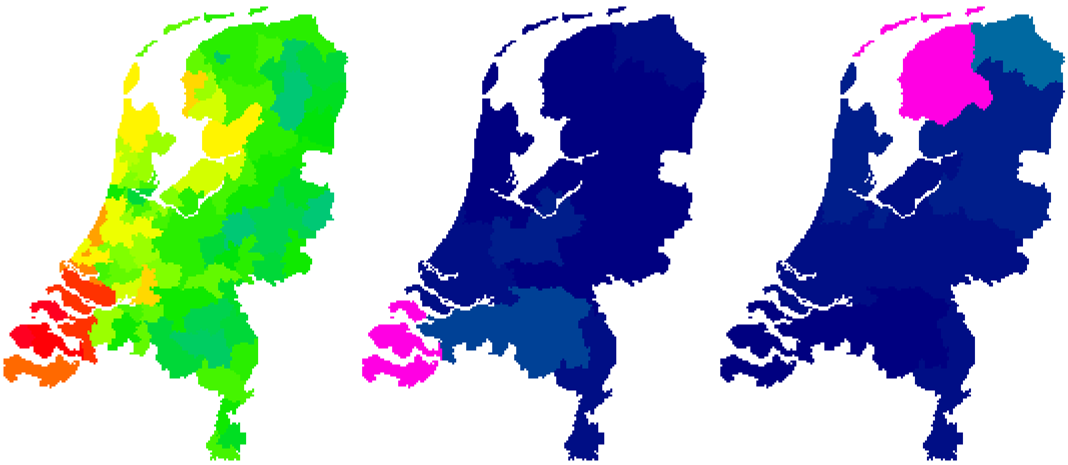
- The aggregate Cat Risk Charge = 100% of selected
- Aggregate Bias = 0%
- Company Bias = 31% under to 15% over

159. Below is a graph which shows the level of bias across the firms under this approach:




160. So why the range of results? The three pictures below show why:

15% under 31% over



161. As expected, companies with geographically diversified portfolios are handled well whilst companies with concentrated portfolios can be materially under-or over-estimated, as their exposure falls in or outside the selected scenario footprint.

162. The CTF identified the following solutions to these problems, and analysed the pros and cons for each one:

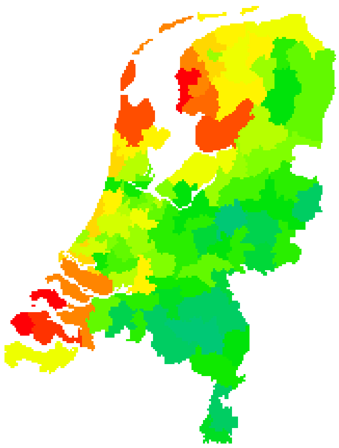
| Possible Fixes | CTF conclusions |
|---|---|
| Option a) | - not easy to specify how |

| | |
|---|---|
| More careful selection of footprint | - almost all will have some bias (one particular selection gives a bias range *81% under* to *130% over*!)<br>- even harder for larger countries<br><br>Conclusion: not possible in practice |
| Option b) Select footprint to give narrowest range of bias | - The event was scaled to chosen €4.08bn<br>- The results where good, with company bias 7.8% down to 5.7% up.<br>- However this resembles a hazard map.<br>- Possible that no footprint will give good enough range.<br>- Need per company zonal data to derive and this is not available.<br><br>Conclusion: not possible in practice |
| Option c) Combine multiple footprints | - How to select which ones?<br>- Need to define method for combining different footprint losses.<br>- If too many then effectively moving towards hazard map approach.<br><br>Conclusion: possible but very subjective |

163. Overall the CTF concluded that a footprint-based method would not meet the stated objectives of providing a fair method that is harmonized across countries.

Hazard Map Approach

164. A probabilistic event set was utilized to calculate the 1-in-200 damage ratio for each individual zone:

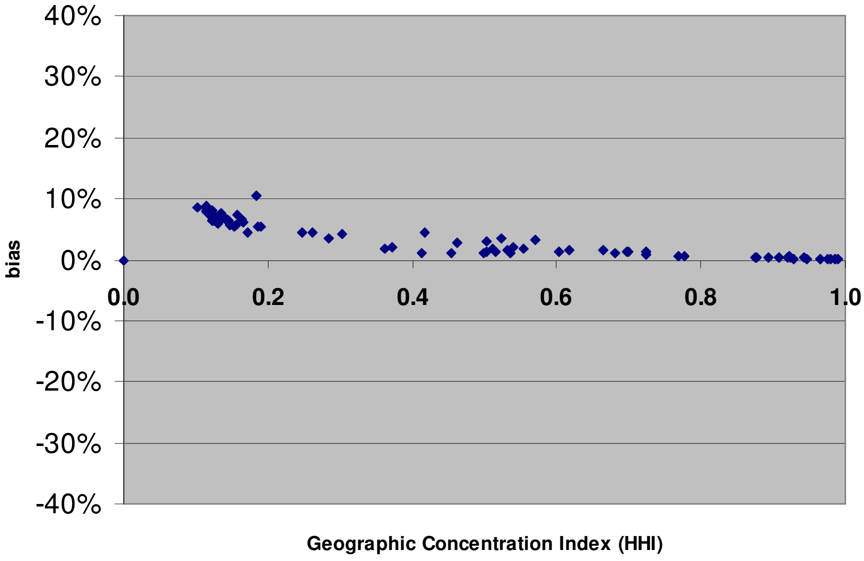


- The relativity between the highest and lowest zone damage factors was around 3.
- Highest factors in coastal regions including Friesland and Flevoland, which are the most high-risk parts of the country. Thus this method seems to reflect the actual risk across the country well, compared to the footprint method.

165. The modelling results provided the following results:

- Aggregate Cat Risk Charge = 107% of selected
- Aggregate Bias = 7% overestimate
- Company Bias = level to 10% over

166. Below is a graph which show the level of bias across firms:




167. As expected, companies with concentrated portfolios are handled well whilst geographically diversified portfolios are overestimated. While on balance, this method is clearly favourable to the footprint method, a solution was needed to address the overestimation of geographically diverse portfolios. This was done as follows:

| **Possible Fixes** | **CTF conclusions** |
|---|---|
| Option a) Do nothing (i.e. no within-country geographic diversification allowed) | Although an aggregate 7% overestimation might be considered acceptable (given the uncertainty in the starting factors), a preliminary exercise based on other larger countries would give aggregate overestimates in the range 25% to 50%. These are unlikely to be considered reasonable by the industry.<br>Also the 7% overestimation is based on province level data. This is likely to be higher with more detailed zone exposure information.<br><br>Conclusion: probably not an option |
| Option b) Scale down to fix aggregate bias | Although this will eliminate any aggregate bias and reduce the overestimate for diversified companies, it will produce an underestimation for less well diversified companies.<br><br>As with option a, in other countries the aggregate bias may be much larger. This could cause underestimates for individual companies by as much as 33%. This is probably not desirable from a regulatory point of view.<br><br>Conclusion: better than option A, but still not desirable |
| Option c) Explicitly build in geographic | The simplest approach would be to adopt the same type of correlation structure as used elsewhere in the QIS exercises. i.e. include a matrix to allow for aggregation/diversification between zones. |

| | |
|---|---|
| diversification | Although seemingly complex it is not insurmountable.<br><br>Conclusion: Possible but need to see in practice |

<u>Option c - Explicitly build in geographic diversification</u>

168. The CTF decided to test this alternative and create a matrix to allow for aggregation/diversification between Zones.

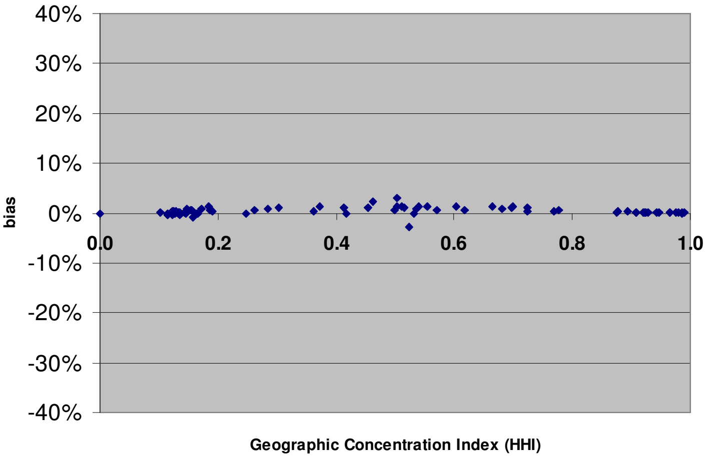
169. As before, the ratios are based on 1-in-200 loss ratio for each zone in isolation.

- Factors in range 0.18% to 0.55%
- CRESTA "correlation" matrix (entries either 0, 0.25, 0.5, 0.75 or 1 )

170. The integration of this additional step gives decent results for most companies:

- Aggregate Cat Risk Charge = 101% of selected
- Aggregate Bias = 1%
- Company Bias = 2.7% under to 3.1% over

171. Below is a graph which shows the level of bias across firms under this approach:




<u>Conclusions:</u>

172. To summarise, the CTF assessment of the two approaches is:

Footprint (multiple with combination method)

- quite subjective as to choice of the actual footprint scenario
- difficult to avoid obvious biases (credibility issue)
- harder to ensure consistency between countries
- need to detach from any actual model footprints

Hazard Map (with geographical diversification)

- less subjective

- diversification matrix hardest part, but proven achievable

173. The CTF chose unanimously, Hazard Map over Footprint and to explicitly incorporate geographical diversification as the method for calibrating the zone factors

### C) Aggregation matrix by country ($AGG_{r,c}$)

174. To build in explicitly geographical diversification, the CTF had to estimate aggregation matrices for each country. These matrices are designed to reflect the geographic extent and nature of the damage caused by events giving risk to 1-in-200 year losses and also the geographic relationship between the zones and the distribution of building values by CRESTA within the country. For example, the tracks of windstorms in Europe tend to track in an easterly direction. This means that there should be more diversification between 2 zones located 200 km apart in a north-south directions than then 2 zone located 200 km apart in an east-west direction.

175. A constant scaling factor was applied to the zonal relativities to ensure that when the formulae are applied to an estimated market portfolio the resulting gross loss is equal to the total market sum insured multiplied by the country factor.

176. Catastrophe models developed by members of the task force were used in part of this estimation process. However, in most cases adjustments were made to reflect the collective expert judgement and experience so that the Catastrophe standardised scenarios being proposed reflected the consensus view of the CTF not any of the particular cat models. The correlation matrices have all been approved by the collective expert judgement of the CTF to make sense, and could be reviewed in future if required, for example if a new type of storm or earthquake occurred that altered the previous-held scientific viewpoint of the pattern of natural perils across Europe.

177. The approach described above was also deemed appropriate for the other perils. However there were particularities that had to be addressed differently due to the nature of the peril. Below we expand on this:

178. For earthquake and flood, the procedure was repeated to derive a hazard map and to explicitly incorporate geographical diversification as the method for calibrating the zone factors. The geographical distribution of flood and earthquake perils across Europe is quite different to Windstorm, however. Windstorm risk across Europe shows a strong, and yet quite smooth gradient from northwest to southeast, as large damaging windstorms are driven in from the Atlantic, with Ireland and the UK having the highest risk from both frequency and severity. Further east, fewer storms penetrate and thus the risk decreases. Thus correlation between risks is quite closely related to their physical proximity, on a roughly west to east axis, and with less correlation in the north-south dimension, as previously mentioned.

179. For Earthquake, risk is mostly connected with the collision of the Eurasian and African tectonic plates, with lower amounts of risk associated with smaller fault systems spreading through Germany. The highest earthquake risk areas are

associated with fault systems that pass through Switzerland, Italy and through the south-east European countries towards Greece and Turkey, and towards the western margin of the Eurasian plate, through Portugal. Thus the correlation between risks is less straightforward. Earthquakes in particular generate occasional but very damaging events, compared with windstorms, and the shape of the frequency-severity distribution is quite different. Thus for earthquake in particular, and to a certain extent flood, a problem can occur when assessing the risk in two widely distant cities, each exposed to rare severe events, but little risk otherwise. Thus, using an earthquake example, if the return period for large damaging events is high for both cities, e.g. about 500 years, the 1in 200 year loss for each city would be low, because the more common seismic events would be just tremors. However the 1 in 200 year loss for the joint portfolio would be substantial, because this would correspond to either of the two cities suffering damage from one of the rare major local earthquakes. A different approach to properly assess diversification benefits is required, to overcome this combination problem, as this effect could otherwise promote concentration of risk in one location where the loss distribution has a long tail may perversely seem preferable to splitting it between distant independent locations. A standard choice in catastrophe risk management is to use a weighted-average of tail losses to overcome this problem, particularly for perils dominated by rare but highly damaging events. For this reason, the CTF used a TVar approach, using tail losses above 1 in 200 level, in order to derive the most appropriate CRESTA relativity factors zone level aggregation matrices.

180. For flood, catastrophe risk is more associated with the course of the major river systems throughout Europe, which drives most types of 1 in 200 river flood losses, along with some flash-flooding risk. Where possible the relativities and aggregation matrices have been determined using the methodology described above.

181. However for some countries the information required to adopt this approach was not available and an alternative had to be used.

182. This alternative approach was as follows:

1) Assess the level of peril (flood/quake) hazard in each zone. As examples, for quake this might be based on peak ground acceleration at a particular return period of event. For flood this might be based on proximity to a major river/river system.
2) Assess the exposure to the peril in each cresta. Where possible estimates of building values in the area were used. Where this is not readily available, population has been used as a proxy.
3) Calculate the exposure weighted hazard in each cresta, and exposure weighted average hazard for the country.
4) Divide the cresta exposure weighted hazard by the country average.
5) Assess the degree of correlation between pairs of crestas. For quake this will be based on proximity and the extent to which it seems likely that a severe event could spread using the pattern of hazard levels. For flood this would be based on proximity and being connected by the same river system. For flood it is possible that the resulting aggregation matrix could be asymmetric (the correlation between zone x and zone y could be stronger than between zone y

and zone x if x is downstream of y). In the interests of simplicity we have constrained our aggregation matrices to be symmetrical.

6) We rebase the factors calculated in step 4 so that the product of the aggregation calculation gives the overall required 1 in 200 damage ratio if the exposure values for the whole country are entered. These rebased factors are the relativities to be used (after being rounded to the nearer 0.1).

183. In rare instances where the hazard appears fairly evenly spread between crestas, the method has to be adapted one stage further in order for the rebasing to be possible, as follows:

a) We select the areas or river systems that we believe are most likely to be involved in a 1 in 200 national level event.
b) For each area/system we identify the crestas that would be affected. We perform steps 1 to 4 above for those crestas only – essentially estimating values for relativities for each area/river system.
c) We then weight each area/river system to reflect a view on the relative probability of that area/system being involved in a 1 in 200 event. The relativities are multiplied by this probability
d) We sum the probability weighted relativities for each zone (some zones may not appear, some may appear in more than one area/river system)
e) We then proceed as per step 6 above, but using the results of (d) as the pre-rebasing relativities.

184. As this approach involves additional expert judgement based assumptions (steps (a) and (c)), we have only used this approach if steps 1 to 6 would not allow for correct rebasing.

<u>French Dom Tom</u>

185. French mainland and offshore territories have been considered separately as they are quite different on many aspects detailed hereinafter.

186. First of all, it should be mentioned that the local insurance industry is shared between few insurers.

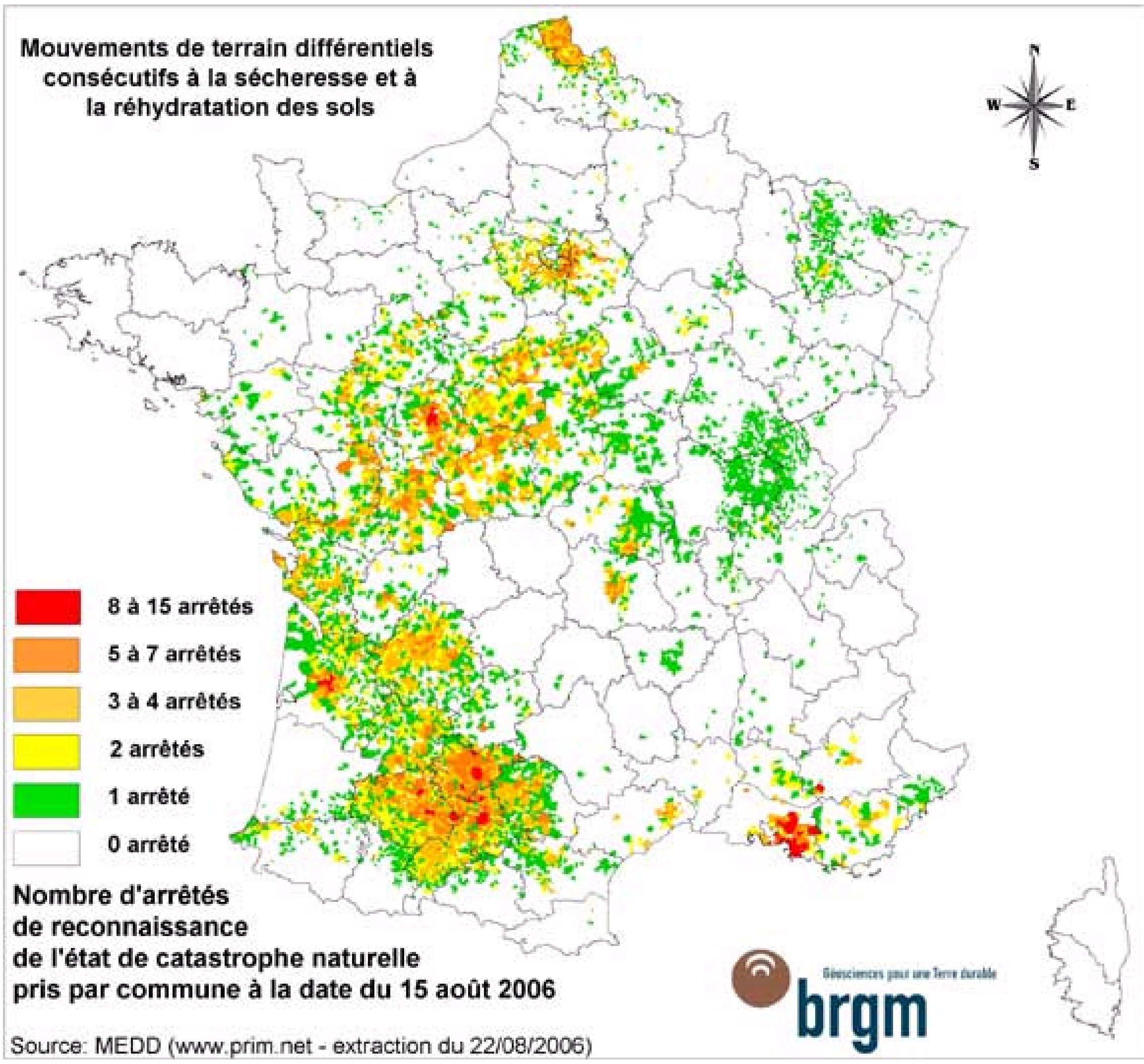
187. The offshore territories insurance industry is evolving differently in respect to the mainland:
- the population grows at an annual average rate reaching ~ 1.7% within the last 20 years, whereas the French mainland population grew only ~ 0.5% a year;
- the professional industry grew up to ~ 15% during auspicious year like in 2006;
- the annual premium income increases of ~ 6.5% during the 2005 – 2008 period.

188. Finally, the offshore territories have to deal with specific natural hazards:
- very important seismic hazard in the West Indies;
- major tropical cyclones affecting both the West Indies and La Reunion island in the Indian ocean,
- active explosive volcanism in the West Indies;
- tsunami concerns almost all the French islands around the world.

Subsidence

189. Subsidence is the sudden sinking or gradual downward settling of the Earth's surface with little or no horizontal motion. Subsidence can be caused by a multitude of human activities as well as natural processes. In the scenario proposed in here, the underlying cause of subsidence is a combination of soil type and weather. After a longer period of drought, depending on the clay content of the soils, substantial shrinking of the soil can take place. This, in turn, can cause severe building damage.

190. Unlike earthquake, windstorm or flood, the proposed scenario is not based on an hazard model, but on observed single declarations of state of natural disaster from the past. The single declarations of state of natural disaster data consist of over 18'000 single claims gathered since 1989. The map below shows the spatial distribution of these claims.




*Source: [http://www.argiles.fr/presentation.asp#regions](http://www.argiles.fr/presentation.asp#regions)*

191. The number of claims by zone put in relation to the population is used as an approximation of the subsidence hazard. This hazard factor is then transformed into the cresta relativities by applying a constant scaling factor. The purpose of this scaling factor is to ensure that the resulting gross loss calculated by applying the cresta relativities and the cresta aggregation matrix to the exposed market portfolio (in the scenario formula) equals the market loss country factor (.05%).

192. As subsidence catastrophic losses are not sudden, but develop over a longer period of time, the proposed scenario displays an annual view (instead of an event view for the other perils). As such, it is not necessary to develop a loading for multiple events.

### *D) Loading for multiple events*

193. The calibrations only considered the possibility of one event occurring during the year (i.e. it is based on an occurrence not annual aggregate loss view),

except for subsidence. In reality extreme scenarios such as Windstorms and Floods can happen more than once in a year. As a result the net cat risk charge needs to take into account two different drivers of risk – the risk associated with a single very large occurrence and also the risk posed by multiple more moderately sized occurrences. The former tests the resilience of vertical reinsurance protections and the latter the resilience of reinsurances to multiple large occurrences (sideways protection). As a result, a calibration based on one event could result in an underestimation compared to a calibration based on more than one event occurring in a year.

194. For the perils of windstorm, flood and hail the calculation of Catastrophe Risk charge therefore takes into account the possibility of multiple insured events in any given year. This is addressed in the template by calculating a Catastrophe Risk charge under both of the following circumstances:
- one large event, at 1 in 200 level occurrence basis, plus a second, smaller event
- two moderate events
- the larger of the results for the two sets of circumstance being used.

195. Both calculations result in equivalent total gross losses for each undertaking, while testing the efficacy of undertaking risk transfer instruments to determine the appropriate net Catastrophe Risk charge as follows:

- For Windstorm:
    - 0.8 for the first event and 0.4 for the second or,
    - 1 for the first and 0.2 for the second.
- For Flood:
    - 0.65 for the first event and 0.45 or,
    - 1 for the first and 0.10 for the second.
- For Hail:
    - 0.7 for the first event and 0.5 or,
    - 1 for the first and 0.2 for the second.

196. The sum of the two factors, for example 1.2 for Windstorm, is the consensus view of the CTF for the ratio of the AEP/OEP at the 1 in 200 level. There are two sets of factors because the total loss could be split differently. The factors chosen test the response of reinsurance programmes to different combinations of annual loss events.

### 4.3.2. Calibration of Man-made Catastrophes

197. Unlike natural catastrophes, where the gross insured loss will be shared by market participants, man-made events are more likely to hit a single policy, or at most a very small number of policies, and so undertakings.

198. Furthermore, while a company market share approach would reflect the frequency of the scenario, it would not adequately reflect the potential severity.

199. Whilst harmonisation is assumed, a single formula for all scenarios was not deemed appropriate due to the very different nature of the underlying risks. Such scenarios were looked into in detail, and appropriate calibration was considered based on the characteristics of the event and the risks involved.

200. Below is a description of the how the CTF has calibrated each of the provided scenarios.

**FIRE**

201. The CTF has provided below an illustration of what they have considered to be possible Fire man-made scenarios: Actual historic examples would include for example Buncefield and Toulouse.

*Scenario Rotterdam*

*Consider an explosion or fire in the oil refineries at the port of Rotterdam – one of the largest ports in the world. Large volumes of crude oil are stored around the port, and these catch fire as a result of the explosion. The fire causes a large number of fatalities, closure of the whole port (business interruption), almost complete destruction of port buildings and machinery as well as generating a highly toxic cloud of fumes.*

*Scenario Armament company*

*Due to a short circuit in an army aircraft a fire occurs in the premises of an armament company. In the building are 10 highly developed fighter jets, which are destroyed along with the hall and machinery.*

202. When considering the calibration of the Fire scenario the CTF considered the impact of a fire scenario on two types of exposure: Fire and Business Interruption as well as a split between residential, industrial and commercial business sub-lines would provide a more risk sensitive result, as the risk of fire/exposion differs materially between them.

203. A split according to residential, industrial and commercial provides a more risk sensitive result. For residential risks, the underlying catastrophic scenario is a clash of many individual risks, whereas for industrial risks, the catastrophic scenario can be one single industrial plant suffering a large loss.

204. A split according to Fire (property damage) and Business Interruption would provide a more risk sensitive result. Still, since the CTF expects that most undertakings can not differentiate between total sum insured for Fire and BI, the decision was taken to consider both sub-lines together.

205. There are two options to undertakings dependant on the information available.

Option 1

206. The formula to be applied by undertakings is as follows:

$$CAT_{Fire} = P * x$$

Where,

| | | |
|---|---|---|
| $CAT_{Fire}$ | = | the estimation of the gross Fire Cat capital charge (under Option 1) |
| P | = | Sum insured of largest known concentration of exposures under the fire and other damage line of business in a 150m radius as described above. |
| x | = | proportion of damage caused by scenario (= 100%) |

207. The scenario has been calibrated consistently with the terrorism scenario. Undertakings should refer to this for further detail. However there are some minor changes.

208. While the relative weighting of coverage will vary from policy to policy, the CTF decided that an average damage ratio factor of 100% should be applied to the total exposure in a 150 metre radius. (Compared to 50% in the terrorism scenario because the radius is much smaller).

Option 2

209. The scenario incorporates both an extreme single as well as a market loss event. The gross capital charge is estimated as follows:

$$CAT_{Fire} = Max\left(LSR, \sum_{sub-lines} SI_x * F_x\right)$$

Where,

| | | |
|---|---|---|
| $CAT_{Fire}$ | = | the estimation of the gross Fire Cat capital charge (under Option 2) |

| | | |
|---|---|---|
| $SI_x$ | = | is the sum insured by sub-line of business x, where x is residential, commercial and industrial respectively. |
| $F_x$ | = | are the Fire/Business Interruption market wide factors by sub-line of business x, where x is residential, commercial and industrial respectively |
| LSR | = | is the single largest risk across all sub lines. By largest single risk refers to one single location for example a building. It could be covered by one or many policies. |

210. The factors $F_x$ were calibrated as follows:

- In a first step, the CTF used internal risk models of re-insurers and modelling companies to identify a ratio between capital needs for Fire and BI vs. European-wide windstorm risk.
- This ratio was applied to the market-wide 1:200 LDR ratio for windstorm, derived by applying the standard scenario's for windstorm to a market portfolio. The result of this approach is a factor, independent of residential/commercial/industrial business.
- To have separate factors for R/C/I, assumptions were made on average risk sizes (average sums insured for single risks as follows: R=EUR 500'000, C=EUR 5mn, I=EUR 100mn) and typical exposure clusters that would represent a catastrophic scenario. These clusters were assumed as 100 for residential, 10 for commercial and 1 for industrial (i.e. complete destruction of a large industrial complex can be a 1:200y loss).
- Resulting from these considerations are the following factors:

| | 1:200 Loss Damage Ratio |
|---|---|
| Residential | 0.004% |
| Commercial | 0.010% |
| Industrial | 0.073% |

- The factors are EU representative, ie. it is assumed that the impact would not differ materially by location.

211. Limitations of the approach
- As the factors are to be applied to the total sums insured, the method will fail in cases where the total sum insured is an imperfect measure for the exposure (e.g. reinsurance, excess primary insurance).

**MOTOR**

212. The CTF has provided below an illustration of a possible Motor man-made scenario:

<u>Motor Scenario 1 – Selby like</u>

*Consider a car, which falls off a bridge onto a railway and causes a collision of two trains. Assume 10 fatalities and 80 injured persons as well as a high degree of material damage to the car, the trains and the bridge.*

*<u>Motor Scenario 2 – Mont Blanc tunnel like</u>*

*Consider a collision of two trucks in a tunnel of 500 metre length. Both trucks catch fire and cause the quick development of heat and smoke. Assume 40 fatalities, 40 injured persons as well as a high degree of damage to the tunnel and the vehicles. There are also associated Business Interruption losses.*

*<u>Motor Scenario 3 –Extreme crash</u>*

*Consider a major collision of a car with a coach killing all passengers on board the coach. Assume coach passengers are Premier League / Bundesliga / Serie A football players travelling to international football match.*

213. The CTF does not believe that catastrophic Motor man-made scenarios are limited to the events described above. Therefore the calibration is not intended to represent any particular one of these.

214. The motor insurance market in Europe is complex with some very specific national differences between countries with some EEA wide common features.

215. Some factors which should be borne in mind are:

- Cross-border nature of motor vehicle transportation.
    - Although registered and insured in one country, vehicles may readily travel into other countries. This applies particularly to commercial vehicles.

- local legal / compensatory / health systems
    - there are large differences between bodily injury awards in different countries
    - different healthcare practices can affect the impact on the insurers.

- local policy limits
    - as MTPL is a compulsory insurance, most countries specify a minimum level of cover that policies must provide.
    - These limits can change over time.
    - In particular the 5$^{th}$ Motor Directive (2005/14/EC) introduces a minimum level across Europe and obliged member to states to transition by 2012 to national minima that are compatible with the directive.
    - This will result in significant increases in limits in some countries.

- In addition, some countries require that insurance cover must be unlimited for some or all types of loss.

- Local market practice
  - Insurance companies often offer cover in excess of the legal minima for marketing or other reasons.

- "Green card" exposures.
  - The first motor directive requires that every motor insurance policy issued in the EEA must provide the minimum insurance cover required by law in any other EEA country.
  - This means that in the event of an accident the policy will provide cover up to the higher of (a) the policy limit and (b) the legal minimum. e.g. an Italian insured vehicle with a €2m policy limit will have unlimited cover in the UK for third party bodily injury

- Reinsurance purchase
  - Usually purchased on an unlimited basis where this is offered on original policy
  - Where original policies do have a limit, "green card" reinsurance will often be bought to cover these potential unlimited overseas exposures.
  - In practice, reinsurance means that the overall net cat charge for MTPL will consist of the retention of the reinsurance programme plus, elsewhere in the standard formula, an allowance for reinsurance credit default risk on the recoveries. This makes that the overall cat risk charge for MTPL is relatively insensitive to values of individual parameters in the calibration.

- Per country scenarios are particularly troublesome here as the mode of loss the types of scenario we are considering is different from most 'normal' MTPL claims and this means that extrapolation/curve fitting is unlikely to produce a harmonized cat risk charge.

216. Unlike natural catastrophes, an extreme motor vehicle accident is likely to hit a single (or at most a very small number of) policies. Hence the *severity* of a given scenario will not depend on how many policies an undertaking issues. Instead, it is the *frequency* of the scenario that will vary by undertaking according to the volume of business written.

217. With all these factors in mind, the CTF decided to design a simple formula whilst reflecting the key features of the market. Although it would probably be possible to construct a substantially more complex approach, this would have been at the likely expense of transparency.

218. The calibration is based on a Pan European loss scenario as follows:

| | | |
|---|---|---|
| $GL_{MTPL}$ | = | Gross Loss of Europe-wide Scenario = €275m |

| | | |
|---|---|---|
| $RP_{MTPL}$ | = | Return Period of Europe-wide Scenario = 20 years |

219. The CTF believed that this return period of 20 years should be amenable to some form of subjective real-world judgment when considered against the historic events. In addition, a 1-in-20 year pan European loss should exceed the 1-in-200 year loss for any individual undertaking.

220. The underlying model for a loss that stems from Motor catastrophe is being modelled as a Poisson / Pareto with:

- Vehicle Years driving the Poisson frequency
- The Pan European scenario driving severity.
- Pareto shape parameter, alpha given by 2.

| | | |
|---|---|---|
| ALPHA | = | Pareto shape parameter = 2 |

221. It was agreed that there is little data on these types of extreme losses to determine with any great accuracy a particular value for Alpha. The value chosen was based on expert judgement combining the views of the CTF members. It should be noted that, in the absence of policy limits, a selection of the value 2 means that the pan-EEA calculation will give the same results as if the calculation was made at a country level with the country results being aggregated assuming independence between countries.

222. The underlying assumption is made that every insured vehicle in Europe is equally likely to be involved in the types of incident envisaged in this scenario. Other sources of information such as frequency road accidents were also considered by the CTF, but number of vehicles was considered a more straightforward measure, more consistently collected and available for more countries. Although not strictly correct, it is believed to be a suitable assumption for a standard formula.

223. The underlying vehicle base is assumed to be:

| | | |
|---|---|---|
| $VY_{MTPL}$ | = | Total Vehicle Years (in millions) assumed in Europe-wide Scenario = 300 |

This enables us to calculate the frequency of the scenario per million vehicles.

| | | |
|---|---|---|
| $F_{MTPL}$ | = | Annual Frequency of Scenario loss per annum per million vehicles. |

$F_{MPTL} = - \log_e( 1 – 1 / RP_{MTPL} ) / VY_{MTPL}$

224. In the absence of policy limits this can then be used with the undertaking exposure to calculate the gross risk charge for an undertaking.

| | | |
|---|---|---|
| $VY_{COUNTRY}$ | = | Number of vehicles insured per country (provided by undertaking) |

| | | |
|---|---|---|
| | | |

$F_{TOTAL} = F_{MTPL} * \Sigma_{COUNTRY} (VY_{COUNTRY})$

$GRC_{MTPL} = GL_{MPTL} / ((- \log_e(0.995) / F_{TOTAL}) \wedge (1/ALPHA))$

| | | |
|---|---|---|
| $F_{TOTAL}$ | = | Total Expected Frequency of Scenario loss for undertaking |
| $GRC_{MTPL}$ | = | Gross 1-in-200 year occurrence for an undertaking ignoring policy limits |

225. However, the scenario must also consider limits of coverage provided by undertakings in different countries. In addition, allowance must also be made for losses caused outside the 'home' country of the insurance.

226. The scenario therefore includes a 'limit failure factor' for each country which represents a proportion of the extreme losses that are considered to occur in such a way that the cover under the original policy is unlimited.

| | | |
|---|---|---|
| $LIM_{FAIL}$ | = | Proportion of 'limit failure losses' amongst the extreme losses for each country. |

The suggested value of this parameter is 6% for all countries except Iceland, Cyprus and Malta where 0% was chosen. (Note that this parameter has no effect for countries with unlimited exposures.)

| | | |
|---|---|---|
| $LIM_{FAIL\_CTRY}$ | = | Proportion of 'limit failure losses' amongst the extreme losses for each country = LIMFAIL for all countries, except Iceland, Cyprus and Malta where = 0 |

This value of the parameter was estimated by comparing the results of an earlier version of this approach against a study performed by the GDV[16].

227. Allowing for the limits requires an additional input from the undertakings.

| | | |
|---|---|---|
| $LIM_{COUNTRY}$ | = | Highest sum insured offered. For example if unlimited, undertakings should type in "unlimited" or a monetary amount |

228. The calculation of the gross risk charge allowing for limits is more complicated than for the no limits case. For ease of exposition it can be considered in two parts:

| | | |
|---|---|---|
| $F_{UNLIM}(x)$ | = | Frequency of a loss of size x, ignoring limits |

16 Accumulation risks and large risks under Solvency II, December 2009, GDV

| $F_{LIM}(x)$ | = | Frequency of a loss of size x, allowing for limits |
|---|---|---|

$F_{UNLIM}(x) = F_{MTPL} * [\Sigma_{COUNTRY} (LIM_{FAIL\_COUNTRY} * VY_{COUNTRY})] * ( GL_{MTPL} / x )^{ALPHA}$

$F_{LIM}(x) = F_{MTPL} * \Sigma_{COUNTRY\ (where\ x<LIMCOUNTRY)} [(1-LIM_{FAIL\_COUNTRY}) * VY_{COUNTRY}] * ( GL_{MTPL} / x )^{ALPHA}$

229. The gross risk charge can then be calculated as the solution of the following equation.

$-\log_e(0.005) = F_{UNLIM}(CAT_{Motor}) + F_{LIM}(CAT_{Motor})$

where

| $CAT_{Motor}$ | = | Gross 1-in-200 year occurrence for an undertaking ignoring policy limits |
|---|---|---|

230. Note that, due to the discontinuity in the distribution caused by the policy limits biting most of the time, it is possible that there is no solution to the above equation. In such case the correct gross risk charge is the value of ‘x’ at the lower limit of the discontinuity.

## MARINE

231. The CTF has provided below a illustration of a possible Marine man-made scenarios:

***Marine Scenario 1 – Collision***

*A Collision between a gas/oil tanker and a cruise ship causing 100 deaths and 950 seriously injured people. The cruise ship is operated out of Miami and claims are litigated in the US. The tanker is deemed at fault, is unable to limit liability and has cover with a P&I club for four/fourths liability*

***Marine Scenario 2 – Loss of major platform/complex***

*A total loss to all platforms and bridge links of a major complex*

232. The calibrations of the Marine scenarios where based on discussions with marine experts, P&I clubs and other industry experts. Specific features of the marine market place made descriptive scenarios more appropriate than a factor based approach. The scenarios described below are consistent with marine market practices.

233. Two distinct Marine scenarios are considered in calculating $CAT_{Marine}$ charge:

$CAT_{Marine1}$ = Major marine collision event, and

$CAT_{Marine2}$ = Loss of major offshore platform/complex

MARINE COLLISION (Scenario 1)

234. Two distinct Marine scenarios are considered in calculating $CAT_{Marine}$ charge:

**Description:** Collision between a gas / oil tanker and a cruise ship causing 100 deaths and 950 seriously injured persons.

The cruise ship is operated out of Miami and claims are litigated in the US.

The tanker is to blame, is unable to limit liability, and has cover with a P&I club for four fourths collision liability.

**Costing Info:**

| **$m** | **Unit cost** | **Number** | **Gross Loss** |
|---|---|---|---|
| **Death** | 2 | 100 | 200 |
| **Injury** | 3 | 950 | 2,850 |
| **Oil Pollution** | 550 | 1 | 550 |
| **Total** | | | 3,600 |

**Notes for undertakings:** P&I clubs and their reinsurers should note that this scenario exhausts the Collective Overspill P&I Protection and First Excess layer of the Oil Pollution protection under the Intl Grp reinsurance programme

Hull insurers should consider their largest gross lines in respect of both Tankers and Cruise ships

Marine Reinsurers will need to consider carefully their potential for accumulation under this scenario and document any methodology or assumptions when calculating their gross loss position.

LOSS OF MAJOR PLATFORM/COMPLEX (Scenario 2)

**Description:** This scenario contemplates a Piper Alpha type total loss to all platforms and bridge links of a major complex

All coverage in respect of property damage, removal of wreckage, liabilities, loss of production income and capping of well/making well safe

**Notes for undertakings:** Only consider Marine lines of business in calculating gross and net losses; A&H, Personal Accident & Life catastrophe risk charges are handled separately.

Marine Reinsurers will need to consider carefully their potential for accumulation under this scenario and document any methodology or assumptions when calculating their gross loss position.

## AVIATION

235. The CTF has based the Aviation scenario on the information captured by the ABC schedules used by reinsurers to collect information regarding the aviation exposures. These schedules are standard and every aviation insurer should have such information.

236. It was the view of the CTF that such information was valuable in making a catastrophe assessment. For details of the application see the "application section".

## LIABILITY

237. The liability scenarios need to cover the following types of business:-

- General Third party liability (incl hospitals)
- Product liability (incl recall and MPT where written)
- Professional indemnity/E&O (incl medmal)
- D&O
- Employer's liability/workers comp
- Pollution/environmental impairment liability
- Cyber liability (eg network security etc)
- Employment practices liability (although not common outside the US)

238. The CTF has decided to focus on a method more reflective of the more material systemic exposures, assuming that other exposures are captured by the premium and reserve risk module. Examples of systemic events would include issues such as:

  - Widespread losses within one profession or a small number of related professions due to an historically common practice or procedure being ruled as erroneous or negligent.
  - Widely used generic drug is found to have harmful long term side effects (multiple insureds affected).
  - A common process used in a particular industry/occupation is proved or ruled to give rise to injury for which compensation should be available.

239. They contemplate both systemic and non systemic events.

Examples of systemic events would include issues such as:

- Widespread losses within one profession or a small number of related professions due to an historically common practice or procedure being ruled as erroneous or negligent.
- Widely used generic drug is found to have harmful long term side effects (multiple insureds affected).
- A common process used in a particular industry/occupation is proved or ruled to give rise to injury for which compensation should be available.

Examples of non-systemic events would include issues such as:

- The collapse of or serious structural flaw/construction delays relating to a major building (eg Charles de Gaulle Terminal, Cologne Archive, Wembley stadium). Potentially could involve architects, engineers, construction company, suppliers of construction materials.
- An explosion in a major industrial complex causing extensive damage to property in the surrounding area and loss of life/injury amongst employees, contractors, visitors and workers/residents in the surrounding area. This could potentially involve the complex owner, operator, maintenance company, contractors, suppliers and installers of equipment and machinery and parts, engineers/construction company.
- Financial collapse of a major company. This could potentially involve the E&O cover for its various advisors (auditors, lawyers, management consultants, investment bankers etc), its D&O cover, the E&O cover for the trustees of its pension scheme, E&O for the pension scheme advisors. eg Enron, Parmalat
- Recently developed drug found to have very harmful side effects (only one or two insureds likely to be involved) eg Thalidomide,
- Major product recall (eg Toyota, Sudan Red).

240. However future events are unlikely to exactly mirror those that have happened in the past and could be significantly different. Hence the CTF has decided not to specify any specific scenarios, but instead take a generic approach. This also has the merit of relative simplicity and avoids the problems that can be associated with being too specific in definition.

241. The CTF considered including both:

- A calculation designed to pick out the impact of a large non-systemic loss (i.e. one that can be aggregated for reinsurance recoveries)
- A calculation designed to test the impact of multiple losses with the same underlying cause (i.e. systemic) but which is too broad for the losses to be aggregated for reinsurance recoveries.

242. However it seems likely that non-systemic losses will never really be large enough to be 1 in 200 level catastrophe events – certainly not for direct writers, where the net loss is likely to be their reinsurance retention (unless they have chosen to write risks that are excluded by their reinsurance protections). Hence this is more of a concern for reinsurers, but even for them it seems likely to be small in the context of the potential natural catastrophe losses. The task force has therefore decided to focus on a method more

reflective of the more material systemic exposures, assuming that other exposures are thus captured by the premium and reserve risk module.

243. It would be entirely possible that a catastrophe could affect a number of accident (underwriting) years at the same time, as did asbestosis and as could a change in law with retrospective effect. However, we assume that we are concerned only with the current year impact and that the effects on prior accident or underwriting years are captured within the reserve risk charge.

244. Hence the suggested approach should be to apply a set of factors to the corresponding gross written premiums for the undertaking. The factors are intended to represent additional loss ratio due to a 1 in 200 level liability catastrophe in that line of business. It should be assumed that these losses cannot be aggregated for reinsurance purposes and all fall below the retention of the undertakings reinsurance programme.

245. The factors, shown in the table below, were estimated by looking at historic liability cat events and expressing them as a percentage of the corresponding gross premiums.

| LOB (Line of Business) | E&O/Professional Liability (Errors & Omission/ Professional liability) | D&O (Direct & office) | GTPL (General third party liability) | EL (Employers liability) |
|---|---|---|---|---|
| | Including physicians medical malpractice | | Including product liability, recall, EPL, hospital and nursing home medmal | |
| Direct and proportional reinsurance business | 125% | 200% | 225% | 200% |

246. The CTF also considered that employer's liability may need to be subdivided between business written in no fault and fault regimes, as they believed that the potential for catastrophic loss could be lower where fault needs to be established. However for the purpose of the standard formula this distinction was not made.

247. There are potential scenarios that could affect more than one of the lines of business simultaneously and hence an aggregation matrix will then be applied to aggregate the line of business level cat charges.

248. The proposed aggregation matrix is (for a single direct charge):

| | E&O | D&O | GTPL | EL |
|---|---|---|---|---|
| E&O | 1 | | | |
| D&O | 0.5 | 1 | | |

| | | | | |
|---|---|---|---|---|
| GTPL | 0.25 | 0.25 | 1 | |
| EL/WC | 0 | 0 | 0.25 | 1 |

## CREDIT & SURETYSHIP[17]

249. In light of the credit crisis, due attention was given to concerns regarding pro-cyclicality of financial systems and their regulatory regimes. One particular insurance field on which this concern has focused is credit insurance and surety ship (C&S).[18] For instance, the EFC report to the Council of the European Union states that "credit insurance is, in terms of its risks, substantially similar to the banking business and faces the same pro-cyclical challenges. Credit insurance could therefore also benefit from a dampening mechanism, such as dynamic reserving or provisioning."[19]

250. Credit insurers' operations are cyclical in nature: demand for payments increase as economic growth slows down. From the point of view of the credit insurer, dynamic limit management ensures that risks can be reduced rapidly and efficiently. From a micro-prudential stance, this is an important mechanism, because the risks run by credit insurers can rapidly be reduced. From a macro-prudential viewpoint, this has the consequence that the risks return to the policyholders at the moment that this insurance is needed most. This may mean that parties incur major losses or that some transactions cannot be effected. This is undesirable from a macro-economic viewpoint if the losses lead to bankruptcies or trade grinds to a halt.

251. Therefore, next to micro-prudential risk (insolvency risk vis-à-vis its individual policyholders), as faced by any other insurance business, C&S is also exposed to significant macro-prudential risk: a contraction of credit coverage has domino effects which weaken business activity and the economic system as a whole. This macro consideration necessitates actions to take on board counter-cyclicality.

252. The EFC report noted above refers to a "dampening mechanism" and mentions dynamic provisioning or reserving in this context. However, the Directive text does not foresee in the possibility to create dynamic provisions for solvency purposes. Two other options are then a dynamic reserving requirement or a dampening mechanism in the SCR.

253. CTF feels that the treatment of credit insurance in the calculation of the SCR standard formula could create a more accurate risk assessment than that provided by the mechanisms applied in Solvency I. This could be achieved through a specific catastrophe scenario for C&S. CTF considers that the approach proposed in this document adequately addresses pro-cyclicality and that it provides an adequate incentive to implement effective forward looking monitoring controls.

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[17] It should be noted that the Credit and Suretyship scenarios have been developed independently of the CTF and incorporated into this document for completeness. This is because the appropriateness of a *fixed* 99.5% VaR measure, i.e. cycle insensitive, is subject to ongoing discussions at a higher EC level.

[18] For ease of reference, credit insurance and surety ship will be referred to as 'C&S'.

[19] Final Report of the EFC Working Group on Pro-Cyclicality, p18, Brussels, 29 June 2009.

254. An advantage of this approach is its natural alignment with the design of the standard calculation of the SCR in Solvency II. Nevertheless, the relevance of this approach depends to a great extent on its design. A simple design of the catastrophe scenario would not present any significant advantage compared to other simple mechanisms. A sufficiently risk sensitive design accompanied with a counter-cyclical calibration of the catastrophe scenario would meet the goals targeted above.

Calculation

255. $SCR_{CAT\_credit\_net}$ shall be calculated as:

$$SCR_{CAT\_credit\_net} = \sqrt{(SCR_{CAT\_individual\_\max\_loss\_net})^2 + (SCR_{CAT\_recesion\_net})^2}$$

256. The $SCR_{CAT\_credit\_net}$ scenario is designed to adequately consider the risk at a gross level and the mitigating effects of proportional and non-proportional reinsurance as well. The $SCR_{CAT\_recession\_net}$ scenario addresses the pro-cyclical nature of the C&S line of business.

257. $SCR_{CAT\_individual\_max\_loss\_net}$ shall be amounted as the maximum loss derived from one of the two following cases:

- The default of the largest three exposures using a PML% of 14% and a recourse rate of 28%. Normally the PML is the possible maximum loss taking into account working the preventing measures working properly. However, the PML of 14% refers to the worse case situation that some measurements are not working properly. These assumptions are reflecting an average loss given default of approximately 10% for the large risks. The largest exposure shall be identified according the sum of the following magnitudes:

  I. + Ultimate gross loss amount after PML and recourse.
  II. - Recovery expected from reinsurance
  III. +/- any other variation based on existing legal or contractual commitments, which modify the impact of the failure of the exposure on the undertaking (an example might be the reinstatements in respect of existing reinsurance contracts)

  This sum shall identify the amount to compare with the output of paragraph 8.2 in order to derive $SCR_{CAT\_individual\_max\_loss\_net}$.

- The default of the largest three group exposures using a PML% of 14% and a recourse rate of 28%. For the identification of the largest group exposure and the assessment of the losses the undertaking shall apply the methodology described in paragraph 8.1.

258. $SCR_{CAT\_recession\_net}$ = $SCR_{CAT\_recession\_ratio\_net}$ * *Net earned premium* including a dampening mechanism based on the *net loss ratio* of the undertaking.

259. $SCR_{CAT\_recession\_net}$ shall be calculated according the following method and assumptions:

- Exposures shall be classified into homogeneous groups of risks based on the nature of the exposures.
- For each group of exposures the undertaking shall calculate the net loss ratio, $SCR_{CAT\_recession\_ratio\_net}$ and $SCR_{CAT\_recession\_net}$ based on the failure rates, recourse rate and loss given default as described below. The percentages refer to the original assured amounts (gross exposures). However the aggregated $SCR_{CAT\_recession\_ratio\_net}$ and $SCR_{CAT\_recession\_net}$ are based on the overall *net loss ratio*.
- With the failure rates the $SCR_{CAT\_recession\_net}$ can be calculated for the current scenario and the worst case scenario:

  g. *Fail_rate_max* = the maximum value observed in the index of failures rates, selected by the undertaking, in a long period of observation. The period of observation should be at least 10 years building up to 30 years. With the *Fail_rate_max* the worst case scenario can be calculated in case *Fail_rate_current* = *Fail_rate_max.*
  h. *Fail_rate_min* = the minimum amount of the continuing average of 3 consecutive years observed in the same data.
  i. *Fail_rate_current* = the current failure rate.
  j. *Failure rate max(min;current)* = maximum of the *fail_rate_min* and *fail_rate_current.*
  k. *Recourse rate = Recourse rate of the current scenario reflects to the actual recourse rate, the recourse rate of the worse scenario should reflect to the estimated worse case recourse rate.*
  l. *Loss given default* is the result of the ultimate gross loss amount compared to the gross exposure.

  The above-mentioned rates shall be derived from the failure rates observed and periodically updated (see below the specific item at this respect).

- The dampening mechanism is limited to a $SCR_{CAT\_recession\_ratio\_net}$ of 200% of the net earned premium with a *net loss ratio* lower than 25% and to a $SCR_{CAT\_recession\_ratio\_net}$ of 100% of the net earned premium with a *net loss ratio* higher than 125%. Within the limits the $SCR_{CAT\_recession\_ratio\_net}$ = 225% minus *net loss ratio*. This mechanism aims to ensure that at the peak of the cycle (low *failure* rates), the $SCR_{CAT\_recession\_net}$ shall reach its highest value and C&S undertakings shall be required to have enough own funds to cover a higher SCR. On the other hand, at the trough of the cycle, SCR will be at its lowest value, so that own funds will be released. In other words, as undertakings face harder net claims ratio due to an increase of failure rates, the SCR decreases.

260. A summary of 10 possible scenario's is included within QIS 5 TS with the following additional assumptions:

- The *fail_rate_max* is 0,50%, the *fail_rate_min* is 0,05% and the current failure rate varies from 0,05% up to 0,50%.
- The retention after reinsurance recovery for $SCR_{CAT\_individual\_max\_loss\_net}$ will be € 10 million per risk (both single and group exposures) and for $SCR_{CAT\_recession\_net}$ 50% based on a 50% Quota Share.
- The 10 possible scenarios are realistic scenarios based on representative market figures (e.g. underwriting risk profiles en P&L figures) to show the impact of the dampening mechanism and to give an example how the calculation should be set up.

Failure rates

261. One of the main inputs of the model proposed in this paper is the 'failure rates'. CTF prefer the use of undertaking specific 'failure rates'. For the time being this is a point under analysis where industry's views are welcomed.

262. From a legal perspective, it is necessary to ascertain that this way is possible under the umbrella of the standard calculation of the SCR, and these undertaking specific 'failure rates' should meet and be based on methods and information satisfying the requirements developed in the other level 2 advice, such as verifiability, objectivity, consistency, etc. (i.e. see level 2 advice on data quality, statistical standards and methodologies).

263. The alternative is the use of publicly disclosed and updated 'failure rates' provided by official institutions. For example, ECB publishes in its monthly bulletin a set of indexes regarding written-offs and written-downs (example copied from page 122 2009-06 bulletin, link *http://www.ecb.int/pub/mb/html/index.en.html*).

## 2.7 Revaluation of selected MFI balance sheet items [1), 2)]
(EUR billions)

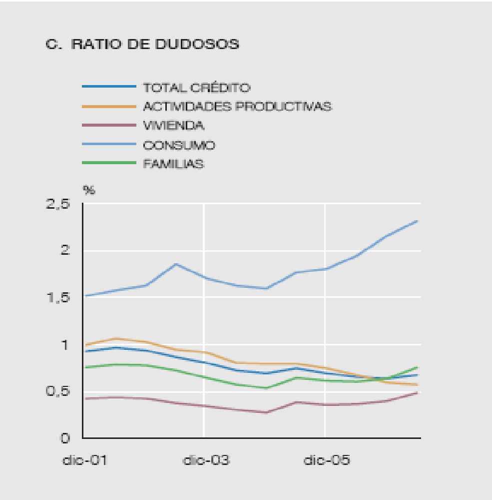
### 1. Write-offs/write-downs of loans to households [3)]

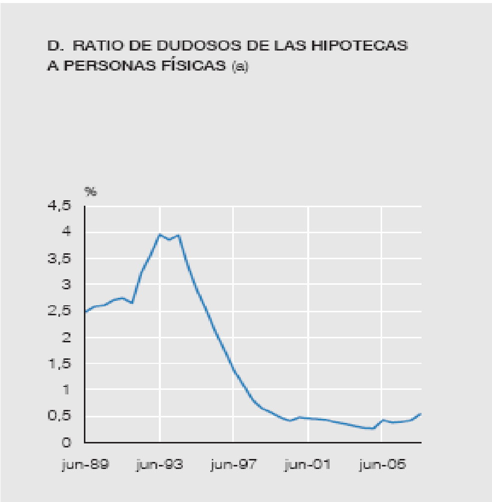
| | Consumer credit | | | | Lending for house purchase | | | | Other lending | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Up to 1 year | Over 1 year and up to 5 years | Over 5 years | Total | Up to 1 year | Over 1 year and up to 5 years | Over 5 years | Total | Up to 1 year | Over 1 year and up to 5 years | Over 5 years |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 2006 | -3.9 | -1.5 | -0.9 | -1.6 | -2.7 | -0.1 | -0.1 | -2.5 | -6.7 | -1.1 | -2.0 | -3.6 |
| 2007 | -4.2 | -1.2 | -1.4 | -1.6 | -2.7 | -0.2 | -0.2 | -2.3 | -6.9 | -0.8 | -2.3 | -3.7 |
| 2008 | -4.5 | -1.1 | -1.5 | -1.9 | -2.7 | 0.0 | -0.2 | -2.5 | -6.7 | -1.2 | -2.3 | -3.2 |
| 2008 Q4 | -1.5 | -0.3 | -0.5 | -0.7 | -0.6 | 0.0 | -0.1 | -0.5 | -2.1 | -0.4 | -0.8 | -1.0 |
| 2009 Q1 | -1.7 | -0.4 | -0.5 | -0.8 | -1.2 | 0.0 | -0.1 | -1.1 | -2.1 | -0.7 | -0.2 | -1.3 |
| 2009 Jan. | -0.6 | -0.2 | -0.2 | -0.3 | -0.6 | 0.0 | 0.0 | -0.6 | -0.9 | -0.5 | 0.0 | -0.4 |
| Feb. | -0.5 | 0.0 | -0.2 | -0.3 | -0.1 | 0.0 | 0.0 | -0.1 | -0.5 | -0.1 | -0.1 | -0.4 |
| Mar. | -0.6 | -0.1 | -0.2 | -0.3 | -0.5 | 0.0 | 0.0 | -0.4 | -0.7 | -0.1 | -0.1 | -0.5 |
| Apr. [(e)] | -0.6 | 0.0 | -0.2 | -0.3 | -0.2 | 0.0 | 0.0 | -0.2 | -0.2 | 0.0 | 0.0 | -0.2 |

### 2. Write-offs/write-downs of loans to non-financial corporations and non-euro area residents

| | Non-financial corporations | | | | Non-euro area residents | | |
|---|---|---|---|---|---|---|---|
| | Total | Up to 1 year | Over 1 year and up to 5 years | Over 5 years | Total | Up to 1 year | Over 1 year |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 2006 | -13.2 | -3.5 | -4.6 | -5.1 | -0.8 | -0.1 | -0.7 |
| 2007 | -12.5 | -2.1 | -5.4 | -4.9 | -5.2 | -3.4 | -1.8 |
| 2008 | -17.7 | -4.0 | -9.1 | -4.5 | -6.6 | -3.4 | -3.2 |
| 2008 Q4 | -5.5 | -1.2 | -2.7 | -1.6 | -2.9 | -0.8 | -2.1 |
| 2009 Q1 | -4.7 | -1.9 | -1.0 | -1.8 | -2.6 | -1.3 | -1.3 |
| 2009 Jan. | -1.8 | -0.8 | -0.4 | -0.6 | -1.3 | -0.9 | -0.5 |
| Feb. | -1.4 | -0.6 | -0.3 | -0.4 | -0.4 | -0.1 | -0.3 |
| Mar. | -1.6 | -0.5 | -0.3 | -0.7 | -0.9 | -0.3 | -0.6 |
| Apr. [(e)] | -1.8 | -0.7 | -0.6 | -0.6 | 0.1 | -0.6 | 0.2 |

264. Some national central banks also disclosure similar indexes. For example, see Banco de España, page 26, Financial Stability Report)




265. Eurostat also provides numerical information that might be used for this purpose in the following link and paths :

http://epp.eurostat.ec.europa.eu/portal/page/portal/living_conditions_and_social_protection/data/database

- Living conditions and welfare / Income and living conditions / Material deprivation/ Economic strain / Arrears (mortgage or rent, utility bills or hire purchase) from 2003 (Source: SILC) (ilc_mdes05)

- Economic strain linked to dwelling (ilc_mded)/ Financial burden of the repayment of debts from hire purchases or loans (Source: SILC) (ilc_mded05)

266. The appropriateness of these indexes to the features of the business of C&S undertakings should be based on supervisory approval.

267. While these public indexes may provide a suitable solution for credit undertakings with a localized business, worldwide credit undertakings would need to ascertain that specific indexes for the most relevant areas of business are used.

**Summary results standard formula Credit & Surety - Concept**

| **Assumptions** | **Scenario 1** | **Scenario 2** | **Scenario 3** | **Scenario 4** | **Scenario 5** | **Scenario 6** | **Scenario 7** | **Scenario 8** |
|---|---|---|---|---|---|---|---|---|
| PML % 200 year | 14,00% | 14,00% | 14,00% | 14,00% | 14,00% | 14,00% | 14,00% | 14,00% |
| Recourse % | 28,00% | 27,00% | 26,00% | 25,00% | 24,00% | 23,00% | 22,00% | 21,00% |
| Failure rate max | 0,50% | 0,50% | 0,50% | 0,50% | 0,50% | 0,50% | 0,50% | 0,50% |
| Failure rate min | 0,05% | 0,05% | 0,05% | 0,05% | 0,05% | 0,05% | 0,05% | 0,05% |
| Failure rate current | 0,05% | 0,10% | 0,15% | 0,20% | 0,25% | 0,30% | 0,35% | 0,40% |
| Failure rate max(min;current) | 0,05% | 0,10% | 0,15% | 0,20% | 0,25% | 0,30% | 0,35% | 0,40% |
| | | | | | | | | |
| **SCR Cat Individual max loss single** | **Scenario 1** | **Scenario 2** | **Scenario 3** | **Scenario 4** | **Scenario 5** | **Scenario 6** | **Scenario 7** | **Scenario 8** |
| Insured loss amount | 1.000.000.000 | 1.000.000.000 | 1.000.000.000 | 1.000.000.000 | 1.000.000.000 | 1.000.000.000 | 1.000.000.000 | 1.000.000.000 |
| PML % 200 year | 14,00% | 14,00% | 14,00% | 14,00% | 14,00% | 14,00% | 14,00% | 14,00% |
| PML loss amount | 140.000.000 | 140.000.000 | 140.000.000 | 140.000.000 | 140.000.000 | 140.000.000 | 140.000.000 | 140.000.000 |
| Recourse % | 28,00% | 27,00% | 26,00% | 25,00% | 24,00% | 23,00% | 22,00% | 21,00% |
| Ultimate gross loss amount | 100.800.000 | 102.200.000 | 103.600.000 | 105.000.000 | 106.400.000 | 107.800.000 | 109.200.000 | 110.600.000 |
| LGD 200 year | 10,08% | 10,22% | 10,36% | 10,50% | 10,64% | 10,78% | 10,92% | 11,06% |
| SCR Cat Individual max loss single - Gross | 100.800.000 | 102.200.000 | 103.600.000 | 105.000.000 | 106.400.000 | 107.800.000 | 109.200.000 | 110.600.000 |
| SCR Cat Individual max loss single - Net | 30.000.000 | 30.000.000 | 30.000.000 | 30.000.000 | 30.000.000 | 30.000.000 | 30.000.000 | 30.000.000 |
| | | | | | | | | |
| **SCR Cat Individual max loss group** | **Scenario 1** | **Scenario 2** | **Scenario 3** | **Scenario 4** | **Scenario 5** | **Scenario 6** | **Scenario 7** | **Scenario 8** |
| Insured loss amount | 2.000.000.000 | 2.000.000.000 | 2.000.000.000 | 2.000.000.000 | 2.000.000.000 | 2.000.000.000 | 2.000.000.000 | 2.000.000.000 |
| PML % 200 year | 14,00% | 14,00% | 14,00% | 14,00% | 14,00% | 14,00% | 14,00% | 14,00% |
| PML loss amount | 280.000.000 | 280.000.000 | 280.000.000 | 280.000.000 | 280.000.000 | 280.000.000 | 280.000.000 | 280.000.000 |
| Recourse % | 28,00% | 27,00% | 26,00% | 25,00% | 24,00% | 23,00% | 22,00% | 21,00% |
| Ultimate gross loss amount | 201.600.000 | 204.400.000 | 207.200.000 | 210.000.000 | 212.800.000 | 215.600.000 | 218.400.000 | 221.200.000 |
| LGD 200 year | 10,08% | 10,22% | 10,36% | 10,50% | 10,64% | 10,78% | 10,92% | 11,06% |
| SCR Cat Individual max loss group - Gross | 201.600.000 | 204.400.000 | 207.200.000 | 210.000.000 | 212.800.000 | 215.600.000 | 218.400.000 | 221.200.000 |
| SCR Cat Individual max loss group - Net | 30.000.000 | 30.000.000 | 30.000.000 | 30.000.000 | 30.000.000 | 30.000.000 | 30.000.000 | 30.000.000 |
| | | | | | | | | |
| **SCR Cat Recession** | **Scenario 1** | **Scenario 2** | **Scenario 3** | **Scenario 4** | **Scenario 5** | **Scenario 6** | **Scenario 7** | **Scenario 8** |
| Exposure | 400.000.000.000 | 400.000.000.000 | 400.000.000.000 | 400.000.000.000 | 400.000.000.000 | 400.000.000.000 | 400.000.000.000 | 400.000.000.000 |
| Failure rate max(min;current) | 0,05% | 0,10% | 0,15% | 0,20% | 0,25% | 0,30% | 0,35% | 0,40% |
| Failure loss amount | 200.000.000 | 400.000.000 | 600.000.000 | 800.000.000 | 1.000.000.000 | 1.200.000.000 | 1.400.000.000 | 1.600.000.000 |
| Recourse % | 28,00% | 27,00% | 26,00% | 25,00% | 24,00% | 23,00% | 22,00% | 21,00% |
| Ultimate gross loss amount | 144.000.000 | 292.000.000 | 444.000.000 | 600.000.000 | 760.000.000 | 924.000.000 | 1.092.000.000 | 1.264.000.000 |
| LGD | 0,04% | 0,07% | 0,11% | 0,15% | 0,19% | 0,23% | 0,27% | 0,32% |
| | | | | | | | | |
| Gross earned premium | 1.000.000.000 | 1.000.000.000 | 1.000.000.000 | 1.000.000.000 | 1.000.000.000 | 1.000.000.000 | 1.000.000.000 | 1.000.000.000 |
| Ultimate gross loss amount | 144.000.000 | 292.000.000 | 444.000.000 | 600.000.000 | 760.000.000 | 924.000.000 | 1.092.000.000 | 1.264.000.000 |
| Fixed costs | 350.000.000 | 350.000.000 | 350.000.000 | 350.000.000 | 350.000.000 | 350.000.000 | 350.000.000 | 350.000.000 |
| Gross result | 506.000.000 | 358.000.000 | 206.000.000 | 50.000.000 | -110.000.000 | -274.000.000 | -442.000.000 | -614.000.000 |
| Gross loss ratio | 14,40% | 29,20% | 44,40% | 60,00% | 76,00% | 92,40% | 109,20% | 126,40% |
| SCR cat recession ratio gross | 200,00% | 195,80% | 180,60% | 165,00% | 149,00% | 132,60% | 115,80% | 100,00% |
| SCR Cat Recession - Gross | 2.000.000.000 | 1.958.000.000 | 1.806.000.000 | 1.650.000.000 | 1.490.000.000 | 1.341.500.000 | 1.194.500.000 | 1.062.100.000 |
| | | | | | | | | |
| Net earned premium | 500.000.000,00 | 500.000.000,00 | 500.000.000,00 | 500.000.000,00 | 500.000.000,00 | 500.000.000,00 | 500.000.000,00 | 500.000.000,00 |
| Net loss amount | 72.000.000,00 | 146.000.000,00 | 222.000.000,00 | 300.000.000,00 | 380.000.000,00 | 462.000.000,00 | 546.000.000,00 | 632.000.000,00 |
| Net result | 253.000.000,00 | 179.000.000,00 | 103.000.000,00 | 25.000.000,00 | -55.000.000,00 | -137.000.000,00 | -221.000.000,00 | -307.000.000,00 |
| Net loss ratio | 14,40% | 29,20% | 44,40% | 60,00% | 76,00% | 92,40% | 109,20% | 126,40% |
| SCR cat recession ratio net | 200,00% | 195,80% | 180,60% | 165,00% | 149,00% | 132,60% | 115,80% | 100,00% |
| SCR Cat Recession - Net | 1.000.000.000 | 979.000.000 | 903.000.000 | 825.000.000 | 745.000.000 | 663.000.000 | 579.000.000 | 500.000.000 |
| | | | | | | | | |
| **SCR Cat Credit & Surety - Gross** | **Scenario 1** | **Scenario 2** | **Scenario 3** | **Scenario 4** | **Scenario 5** | **Scenario 6** | **Scenario 7** | **Scenario 8** |
| SCR Cat Individual maximum loss - Gross | 201.600.000 | 204.400.000 | 207.200.000 | 210.000.000 | 212.800.000 | 215.600.000 | 218.400.000 | 221.200.000 |
| SCR Cat Recession - Gross | 2.000.000.000 | 1.958.000.000 | 1.806.000.000 | 1.650.000.000 | 1.490.000.000 | 1.341.500.000 | 1.194.500.000 | 1.062.100.000 |
| SCR Cat Credit & Surety - Gross | 2.010.134.961 | 1.968.639.977 | 1.817.847.034 | 1.663.309.953 | 1.505.119.211 | 1.358.714.690 | 1.214.301.779 | 1.084.889.787 |
| | | | | | | | | |
| **SCR Cat Credit & Surety - Net** | **Scenario 1** | **Scenario 2** | **Scenario 3** | **Scenario 4** | **Scenario 5** | **Scenario 6** | **Scenario 7** | **Scenario 8** |
| SCR Cat Individual maximum loss - Net | 30.000.000 | 30.000.000 | 30.000.000 | 30.000.000 | 30.000.000 | 30.000.000 | 30.000.000 | 30.000.000 |
| SCR Cat Recession - Net | 1.000.000.000 | 979.000.000 | 903.000.000 | 825.000.000 | 745.000.000 | 663.000.000 | 579.000.000 | 500.000.000 |
| SCR Cat Credit & Surety - Net | 1.000.449.899 | 979.459.545 | 903.498.201 | 825.545.274 | 745.603.782 | 663.678.386 | 579.776.681 | 500.899.191 |

TERRORISM

268. The CTF considered two options for the terrorist scenario, one where undertakings have readily available information regarding their exposures in a 300 metre radius and a simplified option where this is not the case.

269. According to the CTF a 1/200 event would be consistent with a large conventional weapon. The CTF looked at information from 3 modeled attack modes that would be consistent with an event of this scale in a central business district: 2-ton, 5-ton, and 10-ton bombs. Each of these attack modes is detailed below.

2-ton Bomb

This scenario represents a sizeable truck bomb. This quantity of explosive could fit in a large truck (e.g., a rental truck), and would be powerful enough to cause complete destruction of a low- to mid-rise building, or severe structural damage to a high-rise commercial building. A bomb of this size was used in the 1995 Oklahoma City bombing.

Assumptions: In probabilistic modeling, the blast distribution is calibrated according to the density of the urban area around the target location. Blast pressures from a 2-ton bomb can cause structural damage and some partial collapse of buildings close to the explosion.

Historical Examples:
• World Trade Center, New York City, 26 February 1993 (Al Qaeda) (1 ton bomb)
• Murrah Federal Building, Oklahoma City, Oklahoma, 19 April 1995 (U.S. right-wing extremists)

Loss Example: 2-ton truck bomb in central business district of New York
*Property Loss* ~$3.3 *Billion $US*

5-ton Bomb

This scenario represents a sizeable truck bomb. This quantity of explosive could fit in a large
truck and would be powerful enough to cause complete destruction of a low to mid-rise building, or severe structural damage to a high-rise commercial building.

Assumptions: In probabilistic modeling, the blast distribution is calibrated according to the density of the urban area around the target location. Blast pressures from a 5-on bomb can cause structural damage and partial collapse of many well-engineered buildings. Total collapse of weaker buildings is possible in the vicinity of the bomb.

Historical Examples:
• U.S. Marine barracks, Beirut, Lebanon, 23 October 1983 (Islamic Jihad)
• Thwarted attack on U.S. and Israeli embassies, Singapore, 1 Dec. 2001 (Al Qaeda)

Loss Example: 5-ton truck bomb in central business district of New York
*Property Loss* ~$6.1 *Billion $US*

<u>10-ton Bomb</u>
This attack mode is of lower probability due to the difficulties of amassing sufficient explosive material and finding a way to transport and detonate it at a structurally sensitive location. If detonated very close to or inside a multi-story building (as an apartment bomb, for example), it is capable of causing complete structural collapse. A bomb of this size could also be contained in a tractor-trailer or a large cargo container or railroad car.

Assumptions: In probabilistic modeling, the blast distribution is calibrated according to the density of the urban area around the target location. A 10-ton bomb can generate blast pressures severe enough to cause partial collapse to large engineered buildings and complete collapse to some of the less well engineered buildings in the vicinity.

Historical Examples:
• The bomb used by Hizballah to attack Khobar Towers U.S. military accommodation complex in
Dharan, Saudi Arabia on 25 June 1996 is estimated at 10 to 15 tons TNT equivalent yield. This one of the largest vehicle bombs known.

270. The conclusion was that using a 5 ton bomb as a guide, the recommended radius and mean damage for the concentration scenario and exposure concentrations would be as follows:

- Within 300 metres of the blast, mean damage ratios based on area are:

    - Building: 45%
    - Contents: 21%
    - Business interruption 90%

271. These figures are based on vulnerability curves for the UK and assume "unknown" height and construction type.

272. While the relative weighting of coverages will vary from policy to policy, and a differentiation would be ideal, the CTF decided that for simplicity, an overall average damage ratio factor of 50% should be applied to the total exposure in a 300 metre radius.

273. If undertakings are not able to provide hi-resolution data to enable them to quantify the sum insured of the largest known concentration of exposures in a 300 metre radius, they should apply a second option where they would apply the damage factor to a fixed number of largest risk for example: buildings.

274. The question is: how many buildings should they be required to apply the 5-Ton bomb factor to as a surrogate for 300 metres radius? For this the CTF looked at the comparison of greatest exposure accumulation in a 300 metre radius within a capital city to the number of "high value" buildings that it would take to equal the same amount, as follows:

- 12 sample portfolios in Capital cities with detailed address information where compared with the 300 metre accumulations. For the 12 portfolios, the number of top valued buildings to equal the top 300 metre accumulation ranged from 1 building to 5 buildings.

275. Therefore the CTF would recommend that undertakings that cannot provide 300 metre exposures be asked to apply the 300 metre factor to the top 5 buildings they insure in the capital city.

### *5. Health Catastrophe standardised scenarios*

276. During the decision making process the CTF considered a variety of factors in order to be consistent with the L1 directives and CEIOPS requirements:

- harmonisation across member states
- level playing field
- reduced complexity

277. The CTF consulted widely within their organisations and also made reference to a variety of publications.

278. The Health Catastrophe standardised scenarios considered in this document are:

- ➢ Arena disaster
- ➢ Concentration scenario
- ➢ Pandemic scenario

279. The above selection was based on the likelihood of such events occurring being extreme or exceptional and therefore giving rise to losses, or adverse changes in the value of insurance liabilities.

280. The CTF acknowledges that the list may not be exhaustive for all undertakings. Where this is the case, any additional risk should be captured through alternative scenarios.

281. The CTF decided:

- o Scenarios can be applied to worldwide exposures.
- o Geographical boundaries are recognised where necessary.
- o Scenarios are provided gross of reinsurance and gross of all other mitigation instruments (for example national pool arrangements). Undertakings shall take into account reinsurance and other mitigation instruments to estimate their net loss as specified in section 3.
- o Scenarios have not been provided by line of business nor segmented between NSLT and SLT. The CTF has provided scenarios for the health catastrophe risk module allowing for the respective risks affecting SLT and NSLT.

282. Proportional reinsurers should apply the scenarios as described herein.

283. Where an undertaking accepts non-proportional reinsurance of some or all of the products included in the health catastrophe scenarios, the undertaking should consider how, if at all, the scenarios would affect the business written. If the business would be affected, then the scenario(s) should be applied with

the relevant factors adjusted to reflect the undertaking's exposure to the scenario.

284. The CTF has worked on the basis that there is no double counting with other risks in the standard formula.

285. Finally, the CTF would like to highlight that in their view the Life catastrophe module does not capture the catastrophe risk arising from the loss of life as a result of an extreme or exceptional event such as an Arena or Concentration scenario as described below.

### 5.1. Application of Health Catastrophe standardised scenarios

286. The CTF provides a comprehensive description of how the Catastrophe Standardised scenarios need to be applied by undertakings.

ARENA DISASTER

287. The Arena disaster aims to capture the risk of having lots of people in one place at one time and a catastrophic event affecting such location and people.

Input

| | | |
|---|---|---|
| $E_p$ | = | exposure measure i.e. total sum insured by product type p |
| $MS_P$ | = | market share by product type p as listed below |

Calculation

288. The total capital charge as a result of an arena disaster is estimated as follows:

$$H_{CAT\_ARENA\_CTRY} = 0.5 * S * \sum^{products} I_P * x_P * E_P * MS_P$$

$$H_{CAT\_ARENA} = \sqrt{\sum_{CTRY}((H_{CAT\_ARENA\_CTRY})^2)}$$

Where

| | | |
|---|---|---|
| S | = | arena capacities as outlined in Annex 4. |
| $I_P$ | = | insurance penetration for product type and by country |
| $x_P$ | = | proportion of accidental deaths/disabilities (short and long term) and injuries |
| P | = | product types |

289. All policies which include one or more of the following product types should be included in the calculation. The product types defined are a representation of the type of benefits paid (so you can have many different products but overall the type of benefits paid under these products should fall into one of the 5 categories below).

***Product types***

- Accidental Deaths
- Permanent Total Disability
- Long Term Disability
- Short Term Disability
- Medical/Injuries

290. The CTF considers the product types above to be sufficiently granular that an undertaking should be able to allocate its business to one of them, provided it keeps appropriate records.

291. The value for S is the maximum capacity of the largest arena in each country as provided in Annex 4.

292. The values of $I_P$ are provided in Annex 5.

293. Where the health product types considered are features of a larger product package (such as workers' compensation) then a calculation of required capital should be made for each of the relevant product types. Disabilities are split in to short-term and long-term in assessing likely claim amounts under disability income policies taking into account the monthly benefit amount and the expected duration of the claim.

294. The factors $X_P$ , which represent the distribution of injuries by type. These apply in each country as follows:

***Proposed Injury Distributions***

| | % |
|---|---|
| Accidental Deaths | 10.0 |
| Permanent Total Disability | 1.5 |
| Long Term Disability | 5.0 |
| Short Term Disability | 13.5 |
| Medical/Injuries | 30.0 |
| | |
| Total percentage | 60.0 |

295. Each undertaking will be required to provide its total sum insured by product type, $E_P$. For the estimation of $E_P$, undertakings need to consider:

- In the case of disability where payments are not lump sums, the exposure measure should be the present value of expected future payments for disability claims.
- In calculating the present value of future payments, firms should assume that a short term disability would last for 12 months and a long term disability would last for 10 years (or a shorter period for which the average policy would make payments) from the date of the catastrophe event; firms should also make allowance for any deferred period before claim payments commence. Where partial disability payments are possible, firms should assume that claimants are entitled to a full benefit for the full duration of the claim.

- For medical expense insurance, the total sum insured may be taken as zero. Medical expense insurance, be it on a SLT or non-SLT basis, may cover all of an insured's medical treatment (such as in the Netherlands or Germany) or may function to top up or provide an alternative to the state health system. In the latter type of market, medical treatment of the consequences of a catastrophe would fall to the state health system rather than to health insurers. As healthcare resources are transferred to deal with the catastrophe within the state health system, it is possible that the claims on the medical expenses insurers would reduce rather than increase. For example, UK products provide access to care from private care providers. These providers attend to acute conditions such as cancer, cardiovascular disease, etc and not emergencies. In emergencies arising from an accident or a pandemic, policyholders would rely on the National Health Service for treatment/care rather than private providers. For markets such as these, no capital requirements are considered necessary for the catastrophe scenarios specified. For the former type of market, insurers would have to pay the medical expenses of those affected by the catastrophe. For a market event (such as an arena event or some form of pandemic) the constrained capacity within the medical services systems means that it is anticipated that the treatment would be in place of other healthcare treatments that the insurer would be paying for anyway. The types of treatment and their costs would differ. However, it is expected that the overall increase in claim cost would be modest and would be reflected in the ordinary volatility risk.

- The one scenario in which catastrophe capital may be required is under the concentration scenario and the insurer would cover the cost of all medical treatment arising out of the scenario. If medical expense insurance is offered to a group of employees (or similar) then an event effecting those employees would generate an unanticipated increase in claim cost for the insurer and any offset from the substitution effect considered above would be very small. Capital would be required here and should be calculated in a similar manner to that for other types of benefit. As a result medical expenses are only allowed under the Concentration scenario.

- Firms shall also add extra exposure for any Personal Accident riders.

296. Undertakings should then apply any adjustment due to risk mitigation to estimate the net capital charge. Details should be provided on this calculation.

<u>Output</u>

The output is given by:

| | | |
|---|---|---|
| $H_{CAT\_ARENA}$ | = | Capital charge for health catastrophe risk under an Arena scenario net of risk mitigation |

CONCENTRATION SCENARIO

Input

297. Each undertaking will be required to provide:

| | | |
|---|---|---|
| $E_p$ | = | exposure measure i.e. total sum insured by product type p |
| C | = | the number of lives insured by the undertaking in its largest known concentration of lives working in a single building plus those lives known to be covered and working within a 300m radius. |

Calculation

298. The total catastrophe capital charge for the concentration scenario is estimated as follows:

$$H_{CAT\_CONC\_STATE} = C * \sum^{\text{Products}} x_p * E_p$$

$$H_{CAT\_CONC} = \sqrt{\sum_{CTRY} ((CAT_{CONC\_CTRY})^2)}$$

Where

| | | |
|---|---|---|
| $H_{CAT\_CONC}$ | = | is the capital charge for the concentration scenario |
| $X_P$ | = | proportion of accidental deaths/disabilities (short and long term) and injuries (p = product type) |
| P | = | product types |

299. All policies which include one or more of the following product types should be included in the calculation. The product types defined are a representation of the type of benefits paid (so you can have many different products but overall the type of benefits paid under these products should fall into one of the 5 categories below).

300. The factors $x_p$ represent the distribution of injuries by type. These apply in each country as follows:

***Proposed Injury Distributions***

| | % |
|---|---|

| | |
|---|---|
| Accidental Deaths | 10.0 |
| Permanent Total Disability | 1.5 |
| Long Term Disability | 5.0 |
| Short Term Disability | 13.5 |
| Medical/Injuries | 30.0 |
| | |
| **Total percentage** | **60.0** |

301. The CTF considers the product types above to be sufficiently granular that an undertaking should be able to allocate its business to one of them, provided it keeps appropriate records.

302. Where the health product types considered are features of a larger product package (such as workers' compensation) then a calculation of required capital should be made for each of the relevant product types. Disabilities are split in to short-term and long-term in assessing likely claim amounts under disability income policies taking into account the monthly benefit amount and the expected duration of claim.

303. For the estimation of $E_P$, undertakings need to consider:

- In the case of disability where payments are not lump sums, the exposure measure should be the present value of expected future payments for disability claims.
- In calculating the present value of future payments, firms should assume that a short term disability would last for 12 months and a long term disability would last for 10 years (or a shorter period the average policy would make payments) from the date of the catastrophe event; firms should also make allowance for any deferred period before claim payments commence. Where partial disability payments are possible, firms should assume that claimants are entitled to a full benefit for the full duration of the claim.
- For medical expense insurance, the sum insured should be taken as the average claim paid in the last two underwriting years in respect of hospital treatments for accidental causes.
- Firms shall also add extra exposure for any Accident riders.

<u>Output</u>

304. The output is given by:

| | | |
|---|---|---|
| $H_{CAT\_Concentration}$ | = | Capital charge for Health catastrophe risk under a concentration scenario net of risk mitigation |

PANDEMIC SCENARIO

305. The Pandemic scenario, aims to capture the risk that there could be a pandemic that results in non lethal claims, e.g. where victims infected are unlikely to recover and could lead to a large disability claim.

306. The scenario will impact the following products:
- disability income (both long and short term)
- products covering permanent and total disability either as a stand alone benefit or as part of another product, such as a stand alone critical illness product.
- The view of the CTF is that the pandemic risk is small for medical insurance and would be captured in the premium and reserve risk sub-module. The scenario aims to capture the risk that there could be a pandemic that results in non lethal claims, e.g. where victims infected are unlikely to recover and could lead to a large disability claim

Input

307. Each undertaking will be required to provide:

| | | |
|---|---|---|
| $E_p$ | = | exposure measure i.e. total sum insured by product type p |

Calculation

308. The total capital charge is estimated as follows:

$$H_{CAT\_PAN} = R \sum_{product} E_p$$

where

| | | |
|---|---|---|
| $H_{CAT\_PAN}$ | = | the capital charge for the pandemic scenario net of risk mitigation |
| R | = | the proportion of lives affected by the Pandemic = 0.075‰ |

309. Undertakings should then apply any adjustment due to risk mitigation to estimate the net capital charge. Details should be provided on this calculation.

310. For the estimation of $E_P$, undertakings need to consider:
- In the case of disability where payments are not lump sums, the exposure measure should be the present value of future payments for disability claims.
- In calculating the present value of future payments, firms should assume that claimants would not recover and that payments would cease only on death or at the end of the claim payment period specified in the policy conditions; firms should also make allowance for any deferred period before claim payments commence. Where partial disability payments are possible, firms should

assume that claimants are entitled to a full benefit for the full duration of the claim.

311. Undertakings should then apply any adjustment due to risk mitigation to estimate the net capital charge. Details should be provided on this calculation.

Output

312. The output is given by:

| | | |
|---|---|---|
| $H_{CAT\_PAN}$ | = | Capital charge for Health catastrophe risk net of risk mitigation under a pandemic scenario |

### *5.2. Aggregation of Health Catastrophe standardised scenarios*

313. With regards to the aggregation of the Health underwriting risk components with the Health catastrophe risk component, the current consultation paper on Health Underwriting Risk (CP72) proposes the use of correlation matrices as follows:

- The SLT and NSLT sub-modules capital charges are estimated by aggregating the respective sub risk components including catastrophe.
- The two sub-modules (i.e. SLT and NSLT) are then added to give the total Health capital charge.

314. Below is the correlation matrix proposed in CP72 for the aggregation of SLT sub risks and NSLT sub risks:

| $CorrHealth^{SLT}$ | $Health_{mort}$ | $Health_{longy}$ | $Health_{dis/morb}$ | $Health_{lapse}$ | $Health_{exp}$ | $Health_{rev}$ | $Health_{CAT}$ |
|---|---|---|---|---|---|---|---|
| $Health_{mort}$ | 1.00 | | | | | | |
| $Health_{long}$ | -0.25 | 1.00 | | | | | |
| $Health_{dis/morb}$ | 0.25 | 0.00 | 1.00 | | | | |
| $Health_{lapse}$ | 0.00 | 0.25 | 0.00 | 1.00 | | | |
| $Health_{exp}$ | 0.25 | 0.25 | 0.50 | 0.50 | 1.00 | | |
| $Health_{rev}$ | 0.00 | 0.25 | 0.00 | 0.00 | 0.50 | 1.00 | |
| $Health_{CAT}$ | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 1.00 |

| $CorrHealth^{NSLT}$ | $Health_{premium\ \&\ reserve}$ | $Health_{CAT}$ |
|---|---|---|
| $Health_{premium\ \&\ reserve}$ | 1.00 | |
| $Health_{CAT}$ | 0.25 | 1.00 |

315. Furthermore , CP72 explains how the "SLT" and "Non-SLT" are further aggregated (resulting in a simple addition of the two SLT and NSLT sub-modules):

| $CorrHealth$ | $Health_{SLT}$ | $Health_{NSLT}$ |
|---|---|---|
| $Health_{SLT}$ | 1.00 | |
| $Health_{NSLT}$ | 1.00 | 1.00 |

316. The CTF has studied the creation of the standardised CAT scenarios under Health and how these should be aggregated. Because scenarios have not been estimated by making a distinction between SLT/NSLT, the CTF would like to propose an amendment to the advice which would be rather cosmetic.

317. The task force proposes using a single correlation matrix to aggregate the following separate components:

- Health SLT u/w risk
- Health NSLT u/w risk
- Health CAT risk

318. The Task Force proposes using the following correlation matrices:

| $CorrHealth^{SLT}$ | $Health_{mort}$ | $Health_{longy}$ | $Health_{dis/morb}$ | $Health_{lapse}$ | $Health_{exp}$ | $Health_{rev}$ |
|---|---|---|---|---|---|---|
| $Health_{mort}$ | 1.00 | | | | | |
| $Health_{long}$ | -0.25 | 1.00 | | | | |
| $Health_{dis/morb}$ | 0.25 | 0.00 | 1.00 | | | |
| $Health_{lapse}$ | 0.00 | 0.25 | 0.00 | 1.00 | | |
| $Health_{exp}$ | 0.25 | 0.25 | 0.50 | 0.50 | 1.00 | |
| $Health_{rev}$ | 0.00 | 0.25 | 0.00 | 0.00 | 0.50 | 1.00 |

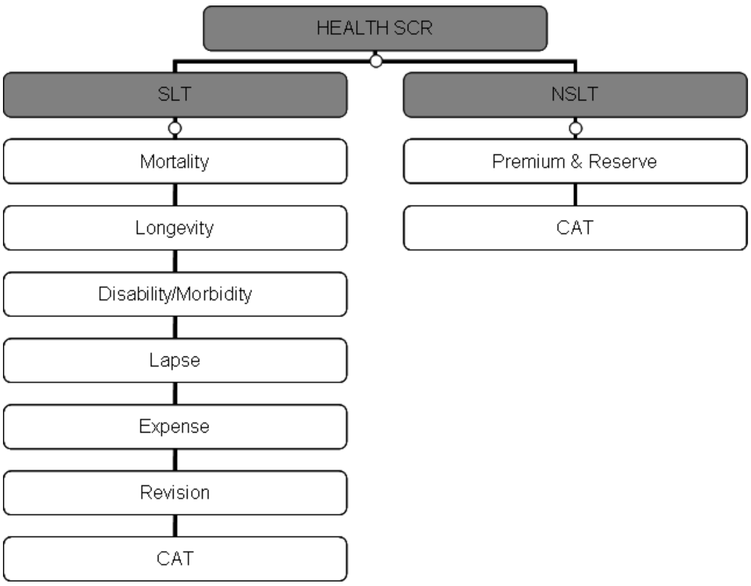
319. A correlation matrix within Health NSLT becomes redundant. The following correlation matrix can then be used.

| $CorrHealth$ | $Health_{SLT}$ | $Health_{NSLT}$ | $Health_{CAT}$ |
|---|---|---|---|
| $Health_{SLT}$ | 1.00 | | |
| $Health_{NSLT}$ | 1.00 | 1.00 | |

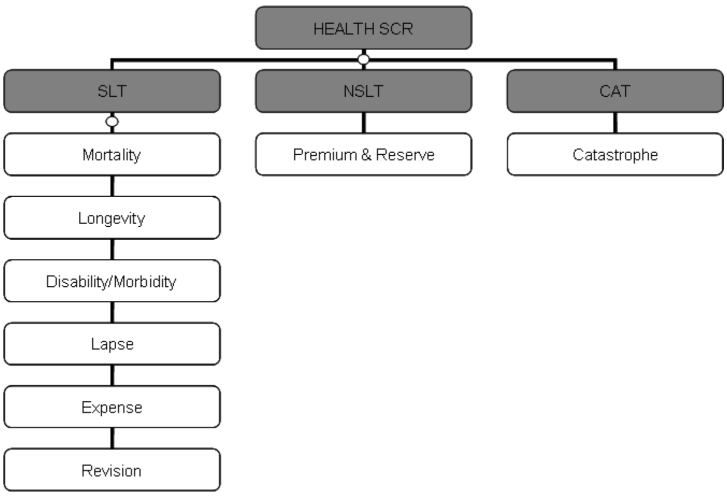
| | | | |
|---|---|---|---|
| $Heallth_{CAT}$ | 0.25 | 0.25 | 1.00 |

320. It is important to note that this new correlation matrix does not change the proposal from CP72 but merely offers an alternative way of aggregating the separate components. The correlation of 0.25 between each u/w risk component (for both SLT and NSLT risks) and the CAT risk is retained.

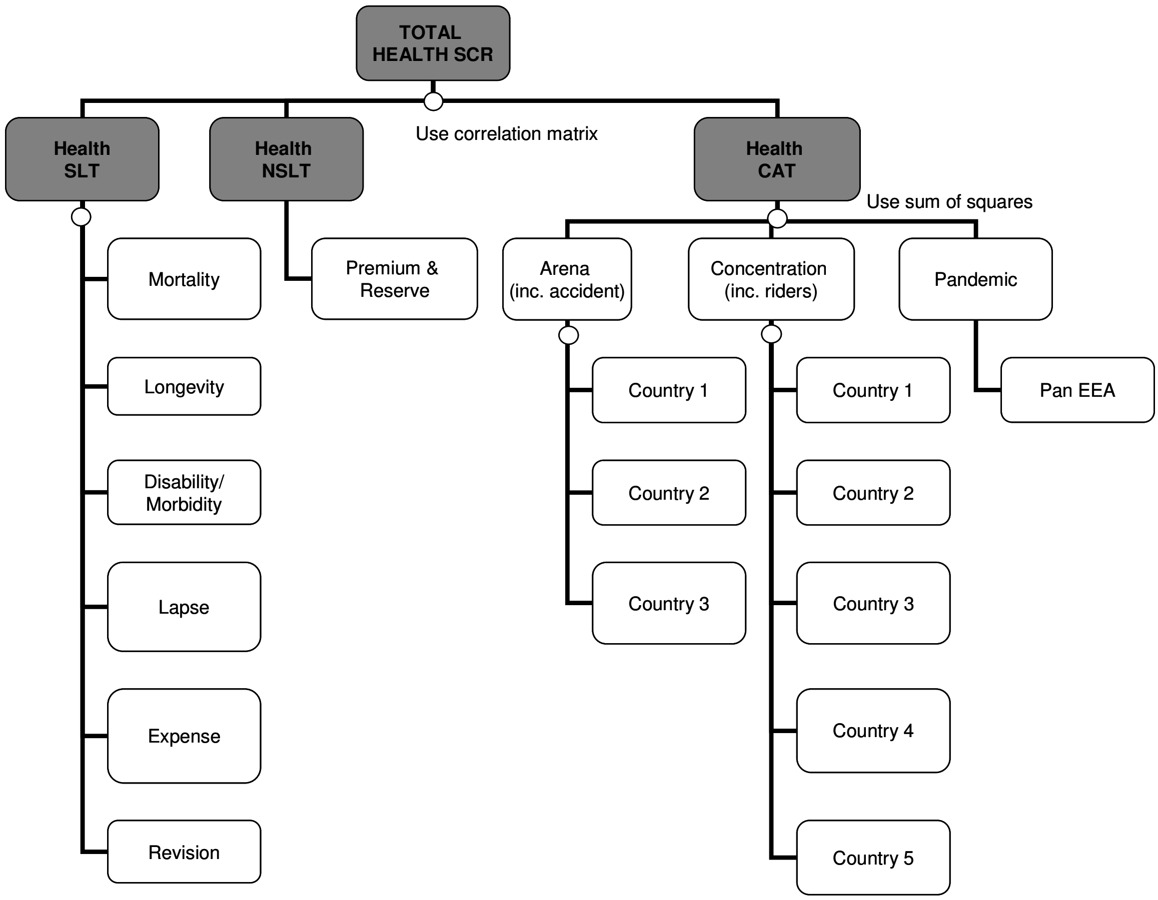
321. From a graphical perspective the change would be from:




to:



The overall aggregation will thus be represented as below:




322. If an undertaking writes business in more than one country then it should assess the impact of arena and concentration scenarios in each of those countries. It should be noted that this can be extended to countries beyond the EEA. These events may be treated as independent so that the capital required for the Arena scenario would be the square root of the sum of squares of each of Arena capital, i.e.

$$H_{CAT\_ARENA} = \sqrt{(H_{CAT\_ARENA\_STATE1})^2 + (H_{CAT\_ARENA\_STATE2})^2 + \ldots + (H_{CAT\_ARENA\_STATEr})^2}$$

323. A similar approach may be adopted for the concentration risk scenario.

324. The pandemic scenario is assumed to be Pan European so that the pandemic capital is the sum of the capital required in each country. However, the pandemic may be considered to be independent of the other scenarios, so that the total capital required for the health catastrophes would be:

$$H_{CAT} = \sqrt{(H_{CAT\_ARENA})^2 + (H_{CAT\_CONC})^2 + (H_{CAT\_PAN})^2}$$

## *5.3. Calibration of Health Catastrophe standardised scenarios*

325. The CTF has decided that the following 3 scenarios are an adequate selection of extreme and exceptional events that can impact the Health SLT and NSLT portfolios:

- Arena disaster
- Concentration scenario
- Pandemic scenario

326. While many different catastrophic scenarios may be considered, the CTF believes these scenarios capture the main exposure and catastrophe risks that affect health products and lines of business.

327. The CTF has proceeded to calibrate each one of these scenarios at a 99.5% level and has taken into account diversification where appropriate.

328. For the Arena disaster the CTF aims to capture the risk of having lots of people in one place at one time and a catastrophic event affecting such location and people. The CTF recognises that while many people will be affected by a major event such as this, not all them will be insured and the insured lives will be covered by all (or almost all) of the insurance firms operating in the country. The formula attempts to reflect this dilutive effect on the exposure of any one firm.

329. For the Concentration scenario, the CTF aims to capture the risk of having concentrated exposures, as would occur in a group insurance portfolio, the largest of which being affected by a disaster. For example: a disaster within densely populated office blocks in a financial hub.

330. For the Pandemic scenario, the CTF aims to capture the risk that there could be a non-lethal pandemic where victims infected are unlikely to recover and could lead to a large disability claim.

*Arena and Concentration*

331. The construction and calibration of the Arena and Concentration scenarios required the calibration of certain inputs as follows and where applicable

a. Definition of number of people affected by the Arena event (S)
b. Footprint for a concentration scenario
c. Definition of Insurance penetration by product type for the Arena scenario($I_p$)
d. Calibration of probability injury distributions for each product type ($X_p$)
e. Duration of benefits

**a) Definition of the number of people affected by the event (S)**

332. A table is included in Annex 4 and has been constructed by collecting information regarding the capacity of the largest arena in each country. It is then assumed that the arena is full at the time of the disaster and that 50% of those people in the arena are affected by the scenario.

**b) Footprint for a concentration scenario**

333. The task force modelled footprints arising from a terrorist attack for the concentration scenario. The Terrorism scenario in the context of property insurance included for the man made events is the same scenario used here.

334. For a 5-ton truck bomb, the largest bomb modelled, fatalities and serious injuries extend in measurable quantities up to 300m in low-rise buildings and 200m in high-rise engineered buildings commonly found in central business districts.

**c) Definition of benefits types affected by the scenario**

335. The fundamental product types that will be affected by such Arena and Concentration scenarios are:

- accidental deaths
- disabilities(short and long term)
- medical expenses
- Total and permanent disability (TPD)
- Personal Accident covers.

336. In particular for medical expense insurance:

- When trying to assess the impact of a catastrophic event on medical expense insurance, it is important to consider the ability of medical services providers to deal with the consequences of the catastrophic event (regardless of whether it is a mass accident or some form of pandemic). The supply of medical services is normally fixed and is generally much less than the demand for those services. As a result, there is little or no surplus capacity within the medical services systems. In addition. the nature of the local medical expense insurance market must be considered.

- In addition, the nature of the local medical expense insurance market must be considered. Medical expense insurance, be it on a SLT or non-SLT basis, may cover all of an insured's medical treatment (such as in the Netherlands or Germany) or may function to top up or provide an alternative to the state health system. In the latter type of market, medical treatment of the consequences of a catastrophe would fall to the state health system rather than to health insurers. As healthcare resources are transferred to deal with the catastrophe within the state health system, it is possible that the claims on the medical expenses insurers would reduce rather than increase. For example, UK products provide access to care from private care providers. These providers attend to acute conditions such as cancer, cardiovascular disease, etc and not emergencies. In emergencies arising from an accident or a pandemic, policyholders would rely on the National Health Service for treatment/care rather than private providers. For markets such as these, no capital requirements are considered necessary for the catastrophe scenarios specified. For the former type of market, insurers would have to pay the medical expenses of those affected by the catastrophe. For a market event (such as an arena event or some form of pandemic) the constrained capacity within the medical services systems means that it is anticipated that the treatment would be in place of other healthcare treatments that the insurer would be paying for anyway. The types of treatment and their costs would differ. However, it is expected that the overall increase in claim cost would be modest and would be reflected in the ordinary volatility risk.

- The one scenario in which catastrophe capital may be required is under the concentration scenario where the insurer would cover the cost of all medical treatment arising out of the scenario. If medical expense insurance is offered to a group of employees (or similar) then an event effecting those employees would generate an unanticipated increase in claim cost for the insurer and any offset from the substitution effect considered above would be very small. Capital would be required here and should be calculated in a similar manner to that for other types of benefit. As a result the CTF has allowed for this under the Concentration scenario.

337. For personal accident riders, because the underlying benefits are the same as for accidental death or disability, any exposure will be treated the same as for accidental death or disability.

**d) Definition of Insurance penetration ($I_P$)**

338. The expression "insurance penetration" is used to measure the degree that a certain insurance product (covering individual and/or group risk) is acquired in the population. It can be viewed as a probability: What is the chance that a randomly drawn member of the population will have acquired the specific product? In case of a catastrophic event, the insurance penetration reflects the proportion of the total casualties who are insured and would make a claim from the insurance industry.

339. This factor is only relevant under the Arena scenario. The CTF is still estimating what these factors should be for some countries. This section is still work in progress. The $I_p$ parameters are stated in Annex 5 and have been estimated as described below:

**UK**

- Income Protection, standalone Critical Illness, and Long Term care: relates to number of in force policies in 2008, published by the ABI.

- Medical expenses: number of people covered by Private Medical Insurance in 2008 written by insurance companies and healthcare trust schemes, published by the ABI.
- Personal accident: relates to total payment protection policies (not only personal accident) written by the 12 largest providers in 2006 (source: OFT).

- Note: Penetration rates have been calculated using the number of in force policies and differs significantly from the consumer survey data published in Swiss Re's Insurance Report (see below).

Swiss Re Insurance report, 2009
- Critical illness, incl. accelerated
- Income protection
- Mortgage payment protection

**France**

- Long Term Care: number of in force policies in 2008 (source: FFSA). Includes business written by insurance companies (2 million) and Mutuelles 45 and Institutions de Prevoyance (1 million)
- Income protection & medical expenses insurance: Data is from a consumer survey published in the AXA protection report, October 2007. This appears to include business written by Mutuelles 45 and Institutions de Prevoyance. The data on medical expenses penetration is quite similar to that published by the OECD (88% in 2006). The FFSA does not appear to publish data on the number of policies for medical expenses and disability.
- Personal accident: Data is for long term unemployment insurance from the AXA survey. Personal accident insurance is significant in France, but the FFSA does not appear to publish number of policies.

**Germany**

- Based on data on number of in force policies from GDV and BAFIN. Includes standalone and rider business, compulsory and supplementary policies, and business written by health insurers (PVK).
- OECD medical expenses penetration data is quite similar (28% in 2007).

**Italy**

- Income protection, medical expenses & personal accident: Data is from a consumer survey published in the AXA protection report, October 2007. There is no way of verifying this data, but apparently a lot of disability and medical expenses is sold as riders to life policies.
- Long term care: estimate based on small in force premium volume (EUR 25m in 2008)

**Netherlands**

- The Netherlands has a large disability insurance market, but data on number of policies does not seem to be available.
- Medical expenses: OECD data for 2007.

**Spain**

- Income protection: market research data on ownership compiled by AXA, October 2007. According to ICEA, the "majority" of life policies in Spain have a disability rider (no data available).
- Medical expenses: based on number in force policies as at Sept. 2009, compiled by ICEA. Includes non-life disability (14% by premium in 2008)
- Long term care: data is for the number of in force standalone policies as at end-Sept. 2009. Most Long term care policies are written as riders of life and non-life policies (data not available).

**Other:**

<u>International sources</u>
<u>Health insurance ownership: AXA protection report, October 2007</u>

| | UK | FR | DE | IT | ES | BE |
|---|---|---|---|---|---|---|
| Health, medical, hospitalisation insurance | 40% | 91% | 85% | 34% | 51% | 88% |
| Disability | 40% | 64% | 71% | 39% | 48% | 39% |
| Long term unemployment insurance | 20% | 18% | n.a. | 5% | 3% | 6% |
| | | | | | | |
| Critical illness, incl. accelerated* | 38% | | | | | |

* Unclear whether CI is included in product categories above.
Source: Market research published in the Axa protection report, October 2007, page 40.

| People covered by private health insurance, 2006: CEA data* | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Millions | **UK** | **FR** | **DE** | **IT** | **ES** | **NL** | **BE** | **AT** | **PT** | **DE**** | **NO** | **CZ.** | **CH** | **SI** | **CY** |
| Number of insured, 2006 | 6 | 14 | 22 | n.a. | 11 | 16 | 5 | 3 | 2 | 1 | 0 | | 2 | 2 | 0 |
| Population, 2008 | 61 | 64 | 82 | 60 | 46 | 16 | 11 | | | | | | 8 | | |
| Penetration | 11% | 22% | 27% | | 25% | 99% | 47% | 34% | 17% | 28% | 1% | | 22% | 71% | 18% |
| | | | | | | | | | | | | | | | |
| * Medical expenses insurance. | | | | | | | | | | | | | | | |
| ** Denmark is for 1996. | | | | | | | | | | | | | | | |

**<u>Notes</u>**

- Figures for France are rough estimates.
- For the Netherlands, the 2006 figure corresponds to the number of people covered by the mandatory system only. The supplementary system is excluded.
- For Switzerland, the data relates to number of contracts.
- Source: Health insurance in Europe 2006. CEA, p. 34 & 56.

**Individuals covered by private health insurance: OECD data**

| Millions | UK | FR | DE | IT | ES | NL | BE | AT | PT | DE** | NO | CZ. | HU | IS | CH | IE | PL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2006 | 2006 | 2007 | | 2006 | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 | 2007 |
| Number of insured | 7 | 54 | 23 | | 6 | 15 | 8 | 3 | 2 | 1 | - | - | - | | | 2 | - |
| Penetration | 11% | 88% | 28% | | 14% | 92% | 77% | 34% | 18% | 16% | 0% | 0% | 0% | 0% | 30% | 51% | 0% |
| * Medical expenses insurance. | | | | | | | | | | | | | | | | | |

## f) Calibration of probability injury distributions affected by each scenario ($X_p$)

340. For each product type defined in c) the CTF had to calibrate the proportion of people that would be claiming under each scenario.

341. This was a difficult task. For such an exercise there is a need for data and statistics collated from similar disasters and these are not necessarily available at the detail required. However two analysis were considered:

<u>Analysis 1</u>

342. One of the documents available which has assisted the CTF is *"World Trade Center Cases in the New York Workers' Compensation System"*, New York State Workers' Compensation Board, September 2009.

343. An extract from the document suggests as follows:

*[National Institute of Standards and Technology (NIST) estimated that approximately 17,400 civilians were in the World Trade Center complex at the time of the September 11, 2001 attacks.]*

Extract from <u>Table 2: Frequency Distribution of WTC Workers' Compensation Claims by Claim Type</u>

Table 1. Proposed Injury Distributions

| | % claims | % workforce |
|---|---|---|
| Accidental Deaths | 32.0 | 11.82 |
| Permanent Total Disability | 0.5 | 0.18 |
| Permanent Partial Disability (scheduled loss) | 2.5 | 0.92 |
| Permanent Partial Disability (non scheduled loss) | 5.5 | 2.03 |
| Temporary Disability | 16.3 | 6.02 |
| Medical only | 9.5 | 3.51 |
| Denied | 4.2 | 1.55 |
| Non-Compensatory | 29.5 | 10.90 |
| | | |
| Total number of claims/workforce | 6427 | 36.93 |

NB: These figures exclude claims from rescue workers.

Indemnity benefits are provided to claimants with temporary or permanent disabilities (defined as loss of wage-earning capacity) or to the survivors (spouse, and dependent children) of workers fatally injured at work. A condition that, according to medical opinion, will not improve during the claimant's lifetime is deemed a permanent one.

Permanent disability awards are made after a medical determination that the work related injury has stabilized and the permanent effects of the injury can thus be assessed. Permanent disability benefits too can be either total or partial.

Two principal categories of permanent partial disability awards for workers' compensation are scheduled and non-scheduled. Permanent partial disability scheduled loss benefits are available for permanent disability to a statutorily specified list of selected members of the body and are calculated according to a statutorily prescribed fixed number of weeks of indemnity benefits for loss or loss of use. The specified (or fixed) amount of indemnity benefits compensation for a schedule loss is paid even if the workers' compensation claimant has not experienced actual wage loss. Permanent partial disability non-scheduled benefits pertain to injuries to the internal organs, trunk, nervous system, and other body systems not typically included on the statutory schedule.

Temporary benefits are payable at either a total or partial disability level during one's recovery from the work-related injury.

Medical benefits pay for medical treatment of work-related injuries or disabilities. Medical-only claims pay for medical care but do not pay an indemnity benefit because the claimant was out of work less than the statutorily-specified waiting period of seven days and has not received permanent disability or death benefits.

Denied claims are workers' compensation claims that do not satisfy the statutory criteria for eligibility for benefits, per a ruling of a Board administrative law judge and, if appealed, by a Board panel of commissioners or, potentially, the judiciary.

Non-compensatory claims are claims that have not been established but also have not been denied. They consist in large part of claims filed by the worker but for which the claimant did not produce prima facie medical evidence, and/or did not actively pursue the claim.

344. Based on the interpretation of these categories, the CTF proposal for the percentages of lives affected by the arena or concentration catastrophe would be as below.

Table 2. Inicial Injury Distributions

| | % |
|---|---|
| Accidental Deaths | 12.0 |
| Permanent Total Disability | 1.0 |
| Long Term Disability | 3.0 |
| Short Term Disability | 6.0 |
| Medical/Injuries | 25.0 |
| | |

| | |
|---|---|
| Total percentage | 47.0 |

- Medical/injuries were increased from 3.60 to 25%. The analysis above shows "Medical only" at 3.51% but also showed "Non-compensatory" at 10.90%. The view was that these were potential medical claims that were filed but were either not pursued or had insufficient evidence to support them, but were potentially claims that should be included. The increase to 14.41% (3.51+10.90) - i.e. 15% - would make the number of medical expense/injury claims more in line with experience from other disasters which had far more medical claims than deaths. Furthermore the CTF also added a further 10% to allow for the fact that those disabled (the 1%+3%+6%) would also need treatment.

Analysis 2

345. The CTF concluded that the WTC bombings were unusual in that there was a lack of damage upon impact to the lower 2/3 of the buildings and a relatively low occupancy at the time of the attack. This resulted in an injury to fatality ratio that was lower than is typically observed when the death rate is ~12%. Egress rates and subsequently, fatality and injury rates in triggered building collapse are highly dependent on occupancy rates and most likely buildings will be targeted during the highest occupancy periods.

346. The type of injuries sustained in a bomb blast is going to increase the number of permanent injuries when compared to building collapse. In addition to head and spinal cord injuries, bombs have been shown to cause disabling soft tissue injuries, hearing and sight loss due to the blast wave, and burns.

347. Using a 300m radius for a 5-ton bomb consistent with 45% structural damage as outlined in the Terrorism scenario for the man-made, the following table would be the corresponding injury distributions.

348. As a result the final factors proposed are:

Table 3. Proposed Injury Distributions

| | % |
|---|---|
| Accidental Deaths | 10.0 |
| Permanent Total Disability | 1.5 |
| Long Term Disability | 5.0 |
| Short Term Disability | 13.5 |
| Medical/Injuries | 30.0 |
| | |
| Total percentage | 60.0 |

*Pandemic*

349. For the Pandemic Scenario, unlike life insurance where we are concerned about Pandemics that lead to a large number of deaths (such as a lethal influenza

pandemic), in health insurance we are concerned with pandemics that could potentially lead to a large number of health claims.

350. The CTF consulted with a number of Chief Medical Officers on this matter and came to the conclusion that such a pandemic could be Encephalitis Lethargica (EL) which occurred at or around the same time as the Spanish Flu outbreak of 1918 -19 and similar pandemics are believed to have occurred in earlier centuries. Sufferers from this illness would not be able to work and would be eligible for disability income benefits and, with a very poor prognosis for recovery, would not be expected to recover and return to work. For more information: http://en.wikipedia.org/wiki/Encephalitis_lethargica.

351. In order to calibrate R, the proportion of lives affected by the pandemic the CTF made reference to:

- The Vilensky reports: *Sleeping Princes and Princesses: The Encephalitis Lethargica Epidemic of the 1920s and a Contemporary Evaluation of the Disease, Joel A. Vilensky Ph.D. Indiana University School of Medicine Fort Wayne:*
    - Page 6 states that there were in excess of some 1 million cases reported over the long period that the last known pandemic of Encephalitis Lethargica (EL) took place. The precise period is not quoted but could be up to 25 years (1916 to 1940).
    - It is unclear how a total in excess of 1 million can be reconciled to the "official" case count being a maximum of 10,000 in 1924 (page 6).
    - There is no information to determine what a 1 in 200 year event is. In the absence of other information, the CTF has assumed that the 1 million cases occurred as the result of one event and all occurred in one year.
    - Vilensky estimated (page 30) that 15% of all cases die (without discussing how quickly). Of the 85% that survive some 34% become chronic invalids – long term disabled for our purposes.

- A UN Population Study ("The World at Six Billion" page 5) suggests that at the height of the EL pandemic the world's population was roughly 2 billion.
- Benjamin Malzberg: "Age of first admissions with encephalitis lethargica". (Psychiatric Quarterly, Volume 3, Number 2 / June, 1929) which suggest that slightly under half of those affected by EL were aged under 20. This group is very unlikely to have disability insurance cover.

352. This suggests a population incidence rate of EL of 0.5‰ but that this can be reduced to a rate of 0.3‰ to reflect the average age in an insurance population. It would be reasonable to expect modern medicine to have a greater impact on the diagnosis and treatment of EL, even if its true cause is still unknown.

353. Taking this incidence rate and applying it to the proportion who would be expected to be long term disabled, we get a factor of:

$R = 0.3‰ * 0.85 * 0.34 = 0.087\ ‰$ of the capital value of the sums at risk.

354. This is approximately one-twentieth of the lethal pandemic factor in the life underwriting module. The CTF view would be to round it down to at most 0.075‰ of the capital value of the sums at risk to reflect the impact of modern medicine.

355. So the final R factor is 0.075‰

356. The CTF considered whether it would be appropriate to divide the injuries from encephalitis lethargica into short-term and long-term or whether to keep all injuries as long-term. Medical reports outlined in the references below indicate that residual neurologic symptoms persisted beyond the acute phase in virtually all patients. Since the overwhelming majority of patients were young and likely to live more than 10 years after their illness it seems to make sense to uniformly assume long-term disability.


- Kroker, Kenton.
  Epidemic Encephalitis and American Neurology, 1919-1940
  Bulletin of the History of Medicine - Volume 78, Number 1, Spring 2004, pp. 108-147

- Association for Research in Nervous and Mental Disease, P. B. Hoeber, 1921, Acute epidemic encephalitis (lethargic encephalitis): an investigation by the Association for research in nervous and mental diseases; report of the papers and discussions at the meeting of the association, New York city, December 28th and 29th, 1920, Volume 1 of Series of investigations and reports, Association for Research in Nervous and Mental Disease

- http://books.google.com/books?id=3pMPAAAAYAAJ&dq=age+distribution+of+encephalitis+lethargia+cases&source=gbs_navlinks_s

**ANNEX 1.** List of countries that are materially affected by perils.

| Country | Windstorm | Earthquake | Flood | Hail | Subsidence |
|---|---|---|---|---|---|
| AT | X | X | X | X | |
| BE | X | X | X | X | |
| BG | | X | X | | |
| CR | | X | | | |
| CY | | X | | | |
| CZ | X | X | X | | |
| CH | X | X | X | X | |
| DK | X | | | | |
| EE | | | | | |
| FI | | | | | |
| FR | X | X | X | X | X |
| DE | X | X | X | X | |
| HE | | X | | | |
| HU | | X | X | | |
| IS | X | | | | |
| IE | X | | | | |
| IT | | X | X | X | |
| LV | | | | | |
| LT | | | | | |
| LU | X | | | X | |
| MT | | | | | |
| NL | X | | | X | |
| NO | X | | | | |
| PL | X | | X | | |
| PT | | X | | | |
| RO | | X | X | | |
| SK | | X | X | | |
| SI | | X | X | | |
| ES | X | | | X | |
| SE | X | | | | |
| UK | X | | X | | |
| Guadeloupe | X | X | | | |
| Martinique | X | X | | | |
| St Martin | X | X | | | |
| Reunion | X | | | | |

The 'X' indicates that the CTF believes this peril is material for this particular country when compared to other perils. A complete scenario for this particular peril and country has been developed. Where the factor fails the significance test (smaller than 1/15th of the largest country-wide factor), no factor has been provided.

## *Annex 2. List of 1 in 200 gross loss damage ratios by country*

| Country | Windstorm | Earthquake | Flood | Hail | Subsidence |
|---|---|---|---|---|---|
| AT | 0.08% | 0.10% | 0.15% | 0.08% | |
| BE | 0.16% | 0.02% | 0.10% | 0.03% | |
| BG | | 1.60% | 0.15% | | |
| CR | | 1.60% | | | |
| CY | | 2.35% | | | |
| CZ | 0.03% | 0.10% | 0.40% | | |
| CH | 0.08% | 0.25% | 0.15% | 0.06% | |
| DK | 0.25% | | | | |
| EE | | | | | |
| FI | | | | | |
| FR | 0.12% | 0.06% | 0.10% | 0.01% | 0.05% |
| DE | 0.09% | 0.10% | 0.20% | 0.02% | |
| HE | | | | | |
| HU | | 0.20% | 0.40% | | |
| IS | 0.03% | | | | |
| IE | 0.20% | | | | |
| IT | | 0.80% | 0.10% | 0.05% | |
| LV | | | | | |
| LT | | | | | |
| LU | 0.10% | | | 0.03% | |
| MT | | | | | |
| NL | 0.18% | | | 0.02% | |
| NO | 0.08% | | | | |
| PL | 0.04% | | 0.30% | | |
| PT | | 1.20% | | | |
| RO | | 1.70% | 0.40% | | |
| SK | | 0.15% | 0.45% | | |
| SI | | 1.00% | 0.30% | | |
| ES | 0.03% | | | | |
| SE | 0.09% | | | | |
| UK | 0.17% | | 0.10% | | |
| Guadeloupe | 2.74% | 4.09% | | | |
| Martinique | 3.19% | 4.71% | | | |
| St Martin | 5.16% | 5.00% | | | |
| Reunion | 2.50% | | | | |

### *Annex 3. List of CRESTA relativity factors by country and peril for Nat cat scenarios*

Due to the size of the tables this information has been included as a excel file: Parameters Non life catastrophe.xls

## Annex 4. *Full arena capacity by country*

| Stadium/Arena information | | | |
|---|---|---|---|
| **Country** | **Name** | **Location** | **Capacity** |
| AT | Ernst Happel Stadion | Vienna | 50,000 |
| BE | Koning Boudewijn Stadion | Brussels | 50,000 |
| BG | Vasil Levski National Stadium | Sofia | 43,632 |
| CZ | St. Jakob-Park | Basel | 38,512 |
| CR | Maksimir Stadium | Zagreb | 37,168 |
| CY | Neo GSP Stadium | Nicosia | 22,859 |
| CZ | Synot Tip Arena (Eden) | Prague | 21,000 |
| DK | Parken | Copenhagen East | 50,000 |
| EE | A. le Coq Arena | Tallinn | 9,700 |
| FI | Helsinki Olympic Stadium | Helsinki | 50,000 |
| FR | Stade de France | Saint Denis | 80,000 |
| HE | Athens Olympic Stadium | Athens | 72,000 |
| DE | Signal Iduna Park | Dortmund | 80,552 |
| HU | Puskás Ferenc Stadion | Budapest | 56,000 |
| IS | Laugardalsvöllur | Reykjavík | 20,000 |
| IE | Croke Park | Dublin | 82,300 |
| IT | Giuseppe Meazza | Milan | 83,679 |
| LV | Mezaparks | Riga | 45,000 |
| LT | Siemens Arena | Vilnius | 12,500 |
| LU | Rockhal | Esch-sur-Alzette | 7,700 |
| MT | Ta' Qali National Stadium | Ta' Qali | 35,000 |
| NL | Amsterdam Arena | Amsterdam South East | 51,628 |
| NO | Ullevaal Stadion | Oslo (North) | 25,600 |
| PO | National Stadium | Warsaw | 55,000 |
| PT | Estádio da Luz | Lisbon | 65,400 |
| RO | Arena Romana | Bucharest | 50,000 |
| SK | Tehelne pole | Bratislava | 30,000 |
| SI | Ljudski vrt | Maribor | 12,435 |
| ES | Camp Nou | Barcelona | 98,787 |
| SE | Nya Ullevi | Gothenburgh | 43,000 |
| UK | Wembley Stadium | London | 90,000 |

Source: This information was provided by CEIOPS member states.

## Annex 5. *Health catastrophe: Insurance penetration statistics ($I_P$)*

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | UK | FR | DE | IT | ES | NL | BE | AT | PT | DK | NO | CZ | FI | HE | HU | IE |
| % population | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| Income protection | 5% | 64% | 21% | 39% | 48% | 33% | 5% | 0% | 2% | 42% | | | | | | |
| Medical expenses insurance: including hospital cash, etc. | 10% | 91% | 25% | 34% | 24% | 99% | 50% | 12% | 17% | 16% | 1% | 0% | | | 0% | 51% |
| Medical expenses insurance: reimbursement only | | | 11% | | | 18% | 5% | | 4% | 37% | | | 10% | | | |
| Long term care | 0% | 5% | 13% | 1% | 0% | | 3% | 1% | | | | | | | | |
| Standalone critical illness | 1% | | | | | | | | | 47% | | | 1% | | 1% | |
| Personal accident | 20% | 18% | 15% | 5% | 3% | 55% | 6% | 47% | 48% | 70% | | 13% | 20% | | 9% | |
| | | | | | | | | | | | | | | | | |

| | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PL | CH | SK | SE | SI | LU | LT | LV | IS | BG | CR | CY | EE | MT | RO |
| % population | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| Income protection | 10% | | 1% | 78% | 0% | 1% | | | | | | | | | |
| Medical expenses insurance: including hospital cash, etc. | 1% | | 1% | 82% | 74% | 15% | 1% | | | | | | | | |
| Medical expenses insurance: reimbursement only | 4% | | | | 0% | | | | | | | | | | |
| Long term care | 2% | | | | | | | | | | | | | | |
| Standalone critical illness | 9% | | 0% | | 0% | | | | | | | | | | |
| Personal accident | 5% | | 20% | 52% | 25% | | 14% | | | | | | | | |
| | | | | | | | | | | | | | | | |

Where factors are missing, this may be due to the fact that the product type is not present in the market or because the member state has not provided the information.

## Sources below:

**UK**

- IP, standalone CI, and LTC: relates to number of in force policies in 2008, published by the ABI.
- Medical expenses: number of people covered by PMI in 2008 written by insurance companies and healthcare trust schemes, published by the ABI.
- Personal accident: relates to total payment protection policies (not only personal accident) written by the 12 largest providers in 2006 (source: OFT).
- Note: Penetration rates have been calculated using the number of in force policies and differs significantly from the consumer survey data published in Swiss Re's Insurance Report (see below).

Swiss Re Insurance report, 2009

- Critical illness, incl. accelerated
- Income protection
- Mortgage payment protection

**France**

- LTC: number of in force policies in 2008 (source: FFSA). Includes business written by insurance companies (2 million) and Mutuelles 45 and Institutions de Prevoyance (1 million)
- Income protection & medical expenses insurance: Data is from a consumer survey published in the AXA protection report, October 2007. This appears to include business written by Mutuelles 45 and Institutions de Prevoyance. The data on medical expenses penetration is quite similar to that published by the OECD (88% in 2006). The FFSA does not appear to publish data on the number of policies for medical expenses and disability.
- Personal accident: Data is for long term unemployment insurance from the AXA survey. Personal accident insurance is significant in France, but the FFSA does not appear to publish number of policies.

**Germany**

- Based on data on number of in force policies from GDV and BAFIN. Includes standalone and rider business, compulsory and supplementary policies, and business written by health insurers (PVK).
- OECD medical expenses penetration data is quite similar (28% in 2007).

**Italy**

- Income protection, medical expenses & personal accident: Data is from a consumer survey published in the AXA protection report, October 2007. There is no way of verifying this data, but apparently a lot of disability and medical expenses is sold as riders to life policies.
- Long term care: estimate based on small in force premium volume (EUR 25m in 2008)

**Netherlands**

- The Netherlands has a large disability insurance market, but data on number of policies does not seem to be available.
- Medical expenses: OECD data for 2007.

**Spain**

- Income protection: market research data on ownership compiled by AXA, October 2007. According to ICEA, the "majority" of life policies in Spain have a disability rider (no data available).
- Medical expenses: based on number in force policies as at Sept. 2009, compiled by ICEA. Includes non-life disability (14% by premium in 2008)
- Long term care: data is for the number of in force standalone policies as at end-Sept. 2009. Most Long term care policies are written as riders of life and non-life policies (data not available).

**Other:**

<u>International sources</u>
<u>Health insurance ownership: Axa protection report, October 2007</u>

| | UK | FR | DE | IT | ES | BE |
|---|---|---|---|---|---|---|
| Health, medical, hospitalisation insurance | 40% | 91% | 85% | 34% | 51% | 88% |
| Disability | 40% | 64% | 71% | 39% | 48% | 39% |
| Long term unemployment insurance | 20% | 18% | n.a. | 5% | 3% | 6% |
| | | | | | | |
| Critical illness, incl. accelerated* | 38% | | | | | |

* Unclear whether CI is included in product categories above.

Source: Market research published in the Axa protection report, October 2007, page 40.

| **People covered by private health insurance, 2006: CEA data*** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Millions | **UK** | **FR** | **DE** | **IT** | **ES** | **NL** | **BE** | **AT** | **PT** | **DE**** | **NO** | **CZ.** | **CH** | **SI** | **CY** |
| Number of insured, 2006 | 6 | 14 | 22 | n.a. | 11 | 16 | 5 | 3 | 2 | 1 | 0 | | 2 | 2 | 0 |
| Population, 2008 | 61 | 64 | 82 | 60 | 46 | 16 | 11 | | | | | | 8 | | |
| Penetration | 11% | 22% | 27% | | 25% | 99% | 47% | 34% | 17% | 28% | 1% | | 22% | 71% | 18% |
| | | | | | | | | | | | | | | | |
| * Medical expenses insurance. | | | | | | | | | | | | | | | |
| ** Denmark is for 1996. | | | | | | | | | | | | | | | |

**Notes**

- Figures for France are rough estimates.
- For the Netherlands, the 2006 figure corresponds to the number of people covered by the mandatory system only. The supplementary system is excluded.
- For Switzerland, the data relates to number of contracts.
- Source: Health insurance in Europe 2006. CEA, p. 34 & 56.

**Individuals covered by private health insurance: OECD data**

| Millions | **UK** | **FR** | **DE** | **ES** | **NL** | **BE** | **AT** | **PT** | **DE**** | **NO** | **CZ.** | **HU** | **IS** | **CH** | **IE** | **PL** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2006** | **2006** | **2007** | **2006** | **2007** | **2007** | **2007** | **2007** | **2007** | **2007** | **2007** | **2007** | **2007** | **2007** | **2007** | **2007** |
| Number of insured | 7 | 54 | 23 | 6 | 15 | 8 | 3 | 2 | 1 | - | - | - | | | 2 | - |
| Penetration | 11% | 88% | 28% | 14% | 92% | 77% | 34% | 18% | 16% | 0% | 0% | 0% | 0% | 30% | 51% | 0% |
| * Medical expenses insurance. | | | | | | | | | | | | | | | | |

## Annex 6. **Return Period of Encephalitis Lethargia Scenario**

The age distribution is a key factor in determining the return period of the event. The following calculation can provide some colour around a ballpark return period using fatalities as a proxy.

The initial assumptions are as spelled out in the scenario and referenced in The Vilensky reports Sleeping Princes and Princesses: The Encephalitis Lethargica Epidemic of the 1920s and a Contemporary Evaluation of the Disease, Joel A. Vilensky Ph.D. Indiana University School of Medicine Fort Wayne)

- 1 million cases reported over the last known pandemic of Encephalitis Lethargica (EL) as stated on page 6.
- 15% of all cases result in fatality as stated on page 30
- World population of 2 billion as the denominator as stated by the The UN Population Study (page 5)
- This suggests an incidence rate of EL of 0.5‰.
- Taking this incidence rate and applying it to the proportion expected to die results in:
- .05% incidence * .15 fatal = 7.5 fatalities /100,000 population

The assumptions for the age and gender distribution in the tables that follows were found in

Benjamin Malzberg. Age of first admissions with encephalitis lethargica. Psychiatric Quarterly, Volume 3, Number 2 / June, 1929

| | Male | | Female | | Total | |
|---|---|---|---|---|---|---|
| | Number | Percent | Number | Percent | Number | Percent |
| 5 - 9 | 29 | 11.5 | 9 | 5.1 | 38 | 8.9 |
| 10 - 14 | 42 | 16.7 | 29 | 16.5 | 71 | 16.6 |
| 15-19 | 51 | 20.3 | 40 | 22.7 | 91 | 21.3 |
| 20-24 | 32 | 12.7 | 28 | 15.9 | 60 | 14.1 |
| 25-29 | 27 | 10.8 | 21 | 11.9 | 48 | 11.3 |
| 30-34 | 18 | 7.2 | 12 | 6.8 | 30 | 7 |
| 35-39 | 17 | 6.8 | 13 | 7.4 | 30 | 7 |
| 40-44 | 19 | 7.6 | 11 | 6.3 | 30 | 7 |
| 45-49 | 5 | 2 | 6 | 3.4 | 11 | 2.6 |
| 50-54 | 6 | 2.4 | 3 | 1.7 | 9 | 2.1 |
| 55-59 | 4 | 1.6 | 3 | 1.7 | 7 | 1.6 |
| 60-64 | 1 | 0.4 | 1 | 0.6 | 2 | 0.5 |

The UK (England and Wales) was used as the representative baseline all cause mortality. Estimates were obtained from the UK office on National Statistics for 2008. (http://www.statistics.gov.uk/downloads/theme_health/DR2008/DR_08.pdf)

The fatality rates per 100,000 population are as follows:

| Age | Males | Females |
|---|---|---|
| **All ages** | 907 | 962 |
| **0-4** | 130 | 107 |
| **5 - 9** | 12 | 9 |
| **10 - 14** | 11 | 9 |
| **15-19** | 43 | 20 |
| **20-24** | 65 | 25 |
| **25-29** | 76 | 33 |
| **30-34** | 99 | 51 |
| **35-39** | 135 | 71 |
| **40-44** | 182 | 114 |
| **45-49** | 274 | 175 |
| **55-59** | 669 | 433 |
| **60-64** | 1044 | 673 |
| **65-69** | 1720 | 1075 |
| **70-74** | 2776 | 1808 |
| **75-79** | 4752 | 3211 |
| **80-84** | 8213 | 5940 |
| **85-89** | 13369 | 10463 |
| **90 and over** | 24113 | 22532 |

With a weighting of 55% male and 45% female consistent with the Malzberg study the annual baseline mortality is 85/100,000.

An increase on 7.5/100,000 from encephalitis Lethargica fatalities would be an excess mortality of 8.8% from the pandemic.

Using the RMS infectious disease model as a benchmark, an infectious disease event in the UK with an excess mortality in the age groups specified above of 8.8% has a return period of 75 years. The short return period is due primarily to the large number of children who are infected. Children are assumed to have a larger infection and mortality rate in most pandemics.

If we exclude children, who are unlikely to be insured, and renormalize the event with the following age distribution the scenario becomes ~1/200 fatality event.

| | Male Percent | Female Percent |
|---|---|---|
| 5 - 9 | 0 | 0 |
| 10 - 14 | 0 | 0 |
| 15-19 | 0 | 0 |
| 20-24 | 24.66% | 28.55% |
| 25-29 | 20.97% | 21.36% |
| 30-34 | 13.98% | 12.21% |
| 35-39 | 13.20% | 13.29% |
| 40-44 | 14.76% | 11.31% |
| 45-49 | 3.88% | 6.10% |
| 50-54 | 4.66% | 3.05% |
| 55-59 | 3.11% | 3.05% |
| 60-64 | 0.78% | 1.08% |

## 7. *Examples of estimation of net catastrophe risk charge*

A 1 Country; Cat Excess of loss cover
Assume 850 excess 100 with 1 reinstatement cost 40

| | |
|---|---|
| **Gross loss** | **1,000** |
| ri recovery | 850 |
| ri premium | 40 |
| **Net loss** | **190** |

B 1 Country; Cat Excess of loss cover with 10% quota share
Assume 850 excess 100 with 1 reinstatement cost 40
Quota share applies after Cat XL programme

| | |
|---|---|
| **Gross loss** | **1,000** |
| Cat XL ri recovery | 850 |
| net loss after Cat XL | 150 |
| QS ri recovery | 15 |
| Cat XL ri premium | 40 |
| **Net loss** | **175** |

C 1 Country; Cat Excess of loss cover with 10% quota share
Nat Cat type event
Assume 800 excess 100 with 1 reinstatement cost 40
Quota share applies before Cat XL programme

| | |
|---|---|
| **Gross loss** | **1,000** |
| QS ri recovery | 100 |
| net loss after Cat XL | 900 |
| Cat XL ri recovery | 800 |
| Cat XL ri premium | 38 |
| **Net loss** | **138** |

D 2 countries; Global Cat Excess of loss
Nat Cat type event affects 2 countries
Same currency in each country
In this situation the firm aggregates its gross losses across countries using 3.4
It then applies its RI programme to the result.
Assume 1900 excess 100 with 1 reinstatement cost 100

Assume the 2 countries have a correlation of 75%

| | **Total** | **Country A** | **Country B** |
|---|---|---|---|
| **Gross loss** | **1,414** | **1,000** | **500** |
| RI recovery | 1,314 | | |
| RI premium | 69 | | |
| **Net loss** | **169** | | |

Note: need to take care if different currencies are used in different countries. This will depend on the details of the reinsurance treaty

E 2 countries; Separate Cat Excess of loss covers
Nat Cat type event affects 2 countries
Same currency in each country
In this situation the firm applies its RI programme to the gross loss in each country
Then aggregates the net results using 3.4
Assume 1350 excess 50 with 1 reinstatement cost 65 for country A
Assume 550 excess 50 with 1 reinstatement cost 35 for country B
Assume the 2 countries have a correlation of 75%

| | Total | Country A | Country B |
|---|---|---|---|
| **Gross loss** | **1,414** | **1,000** | **500** |
| RI recovery | | 950 | 450 |
| RI premium | | 46 | 29 |
| **Net loss** | **163** | **96** | **79** |

Note: need to take care if different currencies are used in different countries

F 2 countries; Global Cat Excess of loss
Nat Cat type event affects 2 countries
Same currency in each country
Allocating the RI cover pro-rata to the countries to get net results by country
Then aggregates the net results using 3.4
Assume 1266 excess 67 with 1 reinstatement cost 67 for country A, and appropriately scaled down for country B.

Assume the 2 countries have a correlation of 75%

| | Total | Country A | Country B |
|---|---|---|---|
| **Gross loss** | **1,414** | **1,000** | **500** |
| RI recovery | | 933 | 467 |
| RI premium | | 49 | 25 |
| **Net loss** | **174** | **116** | **58** |

Note: need to take care if different currencies are used in different countries
- will depend on the details of the reinsurance treaty
This is the same example as D, but aggregated in a different way