Solvency II Standard Formula and NAIC Risk-Based Capital (RBC)

Report 3 of the CAS Risk-Based Capital (RBC) Research Working Parties
Issued by the RBC Dependencies and Calibration Working Party (DCWP)

Abstract: The purpose of this paper is to describe the main features of the Solvency II Standard Formula when applied to a property casualty insurer and compare those features of the Solvency II Standard Formula to the U.S. National Association of Insurance Commissioners Risk-Based Capital formula. The comparison helps clarify the assumptions and methods used by the U.S NAIC RBC and Solvency II Standard Formula. This is one of several papers being issued by the Risk-Based Capital (RBC) Dependencies and Calibration Working Party and the Underwriting Risk Working Party (collectively known as the RBC Working Parties).

Keywords. Risk-Based Capital, Solvency, Capital Requirements, Insurance Company Financial Condition, Internal Risk Models, Solvency Analysis, Analyzing/Quantifying Risks, Assess/Prioritizing Risks, Integrating Risks.

1. Introduction

The Solvency II Standard Formula (Standard Formula) is part of a regulatory framework referred to as Solvency II. One part of the Solvency II framework requires that each insurer[1] calculates its Solvency Capital Requirement (SCR) using a Standard Formula, an internal model, or some combination of the two.

The purpose of this paper is to describe the main features of the Standard Formula as they would apply to a property/casualty insurer and compare these to corresponding features, if any, in the National Association of Insurance Commissioners (NAIC) Risk-Based Capital (RBC) formula.

As the Standard Formula is not final, this paper deals with the Standard Formula as presented in the Quantitative Impact Study Five (QIS5), with the exception of Table 4.1, which reflects a recent change in underwriting risk charges.

We provide comments comparing the Standard Formula to RBC in boxes such as the one around this paragraph.

[1] Solvency II refers to "insurance undertakings," "entities," and "(re)insurers" (to mean both insurers and reinsurers) in order to cover the variety of legal entities within the EU for life, non-life, and health business. For simplicity, in this paper we refer to "insurers" for those entities.

1.1 Terminology, Assumed Reader Background and Disclaimer

This paper assumes the reader is generally familiar with the property/casualty RBC formula.[2]

In this paper, references to "we," "our," "the working party," and "DCWP" refer to the CAS RBC Dependencies and Calibration Working Party.

We use the term "nonlife (NL) insurers" for insurers generally equivalent to U.S. property/casualty insurers.

The description of Solvency II and the comparisons to RBC aim to enhance our understanding of important features of both formulas. As such, we apologize in advance, and welcome feedback, from readers who might observe that the descriptions or comparisons are overly simplistic and do not properly represent important aspects of either formula.

The analysis and opinions expressed in this report are solely those of the authors, the Working Party members, and, in particular, are not those of the members' employers, the Casualty Actuarial Society, or the American Academy of Actuaries.

DCWP makes no recommendations to the NAIC or any other body. DCWP material is for the information of CAS members, policy makers, actuaries, and others who might make recommendations regarding the future of the property/casualty RBC formula. In particular, we expect that the material will be used by the American Academy of Actuaries.

This paper is one of a series of articles prepared under the direction of the CAS RBC Dependency and Calibration Working Party and the Underwriting Risk Working Party (collectively known as the RBC Working Parties).

2. Overview

The SCR, whether calculated from the Standard Formula or otherwise, is the capital level "correspond[ing] to the Value-at-Risk (VaR) of the basic own funds of an insurance or reinsurance undertaking subject to a confidence level of 99.5% over a one-year period."[3,4] This is

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[2] For a more detailed description of the formula and its initial basis, see Feldblum, Sholom, NAIC Property/Casualty Insurance Company Risk-Based Capital Requirements, *Proceedings of the Casualty Actuarial Society*, 1996.

[3] Directive 2009/138/EC of the European Parliament and of the Council of 25 November 2009, on the taking-up and pursuit of the business of Insurance and Reinsurance (Solvency II), Section 99 subsection 3.

[4] Directive, Introduction section 64 says, "The Solvency Capital Requirement should be determined as the economic capital to be held by insurance and reinsurance undertakings in order to ensure that ruin occurs no more often than once

sometimes referred to as the 99.5% one year VaR standard. This is a level intended to be sufficient such that the insurer could withstand a 1 in 200 year shock within one year with sufficient assets remaining to allow for the sale or transfer of its remaining liabilities to another insurer.

In addition to the SCR, each insurer also calculates a Minimum Capital Requirement (MCR). The MCR represents a threshold below which the national supervisor would intervene. The MCR is intended to reflect an 85% probability of adequacy over a one-year period and is bounded between 25% and 45% of the insurer's SCR.

The Standard Formula operates in a Solvency II-defined balance sheet structure that we refer to as Solvency II accounting in this paper. Assets and liabilities are valued based on a "mark-to-market" approach wherever possible and "mark-to-model" whenever mark-to-market is not available. Under Solvency II, loss and premium reserves are replaced for financial reporting by technical provisions that consists of the cash flows both inwards and outwards relating to premiums and claims. These cash flows are reduced (compared to nominal values) by a discount for the time value of money and increased (compared to nominal values) by addition of an explicit risk margin.[5] Stocks, bonds, and other assets are carried at market value. The statement values for receivables, including reinsurance recoverables, are reduced to reflect the probability of non-payments on an ultimate basis, i.e., not just reflecting reinsurers currently facing financial difficulties.

in every 200 cases or, alternatively, that those undertakings will still be in a position, with a probability of at least 99.5 %, to meet their obligations to policy holders and beneficiaries over the following 12 months."

[5] The cash flows in this process are expected values, including low probability events. The interest rate for discounting cash flows is the risk-free rate of appropriate maturity with an illiquidity adjustment. The risk margin is based on a per annum 6% cost (above risk-free interest rates) of holding capital to support the run-off of reserves, a risk margin method often referred as cost of capital approach. The technical provisions including the risk margin is the mark-to-model value intended to represent the price a buyer would require to accept the risk of assuming the liabilities from the company.

RBC also has several levels ranging from Company Action Level (CAL) to Mandatory Control Level (MCL).

There is no target probability safety level specified for the RBC action levels.

While the objective of CAL and MCL levels may not correspond to SCR and MCR levels, we note that RBC MCL is 35% of the RBC CAL, and thus in the middle of the range of ratios of Solvency II MCR to SCR.

U.S. Statutory Accounting reserves are not discounted (other than for tabular indemnity benefits such as workers compensation life table claims and structured settlements) and contain no explicit safety margin beyond the effect of not discounting. Investment grade bonds can be valued at amortized cost rather than market value[6] and the value of reinsurance recoverables are reduced for the risk of non-payment, but often only if non-payment is likely.[7]

3. Risks and Risk Charges

The Standard Formula has separate modules for life, health and non-life insurance. This paper is presented from the perspective of a stand-alone non-life insurer. Certain features of the Standard Formula that are minimally relevant or irrelevant to U.S.-type non-life insurance are noted in Appendix A.

For a non-life company, the main risk categories included in the Standard Formula are as follows:

Underwriting Risk, which includes:

- Premium (loss ratio) risk, excluding catastrophe risk
- Reserve (loss development) risk, excluding catastrophe risk
- Catastrophe risk

[6] Use of amortized cost rather than market value was more prevalent for non-life companies in the 1990s when RBC was implemented than is the case currently. Also use of amortized cost is standard for life insurance companies and the RBC factors for class 1 and 2 bonds are the same for life and non-life companies.

[7] Currently, some U.S. insurers anticipate ultimate uncollectibles in ceded reserves and some do not. When RBC was developed, insurers rarely reflected ultimate uncollectibles.

Default (Counterparty) Risk, which includes:

- "Non-diversified" counterparties, most significantly reinsurance counterparties
- "Diversified" counterparties, most significantly agents balances and other receivables

Market Risk, which includes:

- Interest rate risk
- Equity risk
- Real estate (Property) risk
- Spread risk
- Currency risk
- Concentration risk
- Illiquidity risk

Operational Risk

RBC has six main risk categories – R0 through R5.

R0 contains off-balance sheet risks and risks arising from insurance subsidiaries. Risks in R0 are not reduced by the covariance formula. The inclusion of insurance subsidiaries in R0, outside the covariance formula, approximates the result that would occur if the calculation were done on a consolidated basis (with regard to insurance subsidiaries). The result effectively allows any capital held by an insurance subsidiary above the RBC requirements to accrue to the benefit of the upstream parent.

In Solvency II there is no Standard Formula risk charge for subsidiaries, but to the extent that the insurer's net asset value (NAV) includes insurance or other financial service subsidiaries (full or partial ownership), the value of those subsidiaries in the parent company financial statement is adjusted to avoid over-counting of NAV between the subsidiary and the parent company.

Both RBC and the Standard Formula have special rules for dealing with valuation of financial subsidiaries in NAV or risk charges like R0 or both.

RBC R1 and R2 address invested asset risk, including investments in non-insurance affiliates, corresponding to the Standard Formula Market Risk.

R1 addresses invested asset risk for fixed-income investments; R1 primarily addresses default[8] risk. The fixed-income risk in Solvency II considers change in market value that includes change in interest rates and market measurement of default risk. The difference in risk treatment might be viewed as related to the difference in time horizon between Solvency II and RBC. Over the one year Solvency II time horizon, risk relates to change in market value. Over the longer RBC time horizon, the risk relates to default.

This difference in risk treatment is analogous to the difference in accounting treatment between SAP and Solvency II. In SAP, many fixed-income assets are valued at amortized cost, and that value does not change with interest rates. In Solvency II fixed-income assets are valued at market, and that value does change when interest rates change.

R2 corresponds to equity and real estate (property) risk.

[8] The R1 factors represent default risk over a 10-year holding period for class 1 and 2 bonds, net of expected recoveries after a default. For class 3+ bonds the risk factor was a judgmental market risk factor with no clear holding period.

R3 corresponds to default (counterparty) risk.[9]

R4 and R5, reserving and premium risk, correspond to Standard Formula Underwriting risk. The R4 and R5 provisions for growth are analogous to the growth component within the Standard Formula provision for Operational Risk.

The RBC provision for catastrophes is implicit in R4 and R5, primarily R5, although work is underway to develop separate RBC charges for hurricane and earthquake risk.

The risk charges for each of these Solvency II risk elements are intended to represent the 99.5% VaR for a one-year time horizon. Risk charges for each risk at this target safety level are determined by one of two methods: the "factor method" or the "scenario method."

For some risks, e.g., premium and reserve risk, the risk charge is calculated by applying a factor to a balance sheet value at the statement date. We refer to this as a factor method.

For other risks the risk charge is determined by taking the difference between the insurer's net asset value, or "NAV" (capital and surplus in U.S. statutory terminology), at the statement date and the insurer's NAV restated, at the same statement date, based on a scenario affecting one or more risk elements. We refer to this as a scenario method. For example, the interest rate risk charge is determined by measuring how specified changes to the interest rate term structures and interest rate volatility affects the NAV due to revaluation of all interest rate sensitive assets and liabilities, (e.g., discounted loss reserves).

The capital charges associated with each of the risks are combined with a "correlation matrix"[10] intended to produce the target of a 99.5% VaR level in total over a one-year time horizon. The correlation matrix values are "tail correlations" appropriate to the 99.5% VaR level and not the more commonly discussed "linear correlation" factors. The resulting capital requirement is compared to the company's actual capital and surplus subject to several adjustments.

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[9] Ceded reinsurance credit risk with R3 is split 50/50 between R3 and R4 when applying the RBC covariance formula. The 50/50 treatment is not applied for fronting companies that retain little to no underwriting risk. For such companies, all the ceded reinsurance credit risk is retained in R3 when applying the covariance formula.

[10] Solvency II "correlation matrices" are intended to represent the dependency relationship at the tail of the risk distribution. Technically these are not correlation matrices according to the assumptions required of linear correlation. These "correlation matrices" are useful approximations, but might be described as "weighting factor matrices." Nonetheless, to be consistent with Standard Formula terminology, we refer to them as correlation matrices. (All the Solvency II matrix values are rounded or selected to be multiples of 0.25.)

RBC target safety level is generally implicit and not the same for each risk element. The risk charge for reserve and premium risk in R4 and R5 has been calibrated to an 87.5% VaR over the claim run-off period (reserves) and 87.5% for one year of new business (premium).

RBC currently uses factor methods only, no scenario methods, although the hurricane and earthquake cat charges being developed would use catastrophe model results (which combine scenarios with probability estimates).

The RBC correlation structure is less extensive than that used by the Standard Formula.

In the remainder of this report, we discuss non-life underwriting risk (Section 4), default or counterparty risk (Section 5), and market risk (Section 6). In Section 7 we discuss how the risks are combined to produce the total SCR, reflecting dependency relationships between the risks and operational risk. In section 8 we discuss the adjustments to Solvency II capital that are made before capital is compared to the SCR result.

4. Non-Life Underwriting Risk Module

4.1 Overview

The main elements of non-life underwriting risk are premium risk, reserve risk, and catastrophe risk. Each of these is described in the sections below.

The underwriting risk charge is determined both net of reinsurance and gross of reinsurance. The risk charge net of reinsurance enters the Standard Formula directly. The difference between the risk charge net of reinsurance and the risk charge gross of reinsurance represents exposure to credit risk. As such, that difference is used in calculating the reinsurance counterparty default risk (credit risk) charge.

4.2 Premium and Reserve Risk Elements

Premium risk is intended to measure the variation in combined ratios, net of reinsurance recoveries and excluding catastrophe losses. Expense risk is implicitly included as part of premium risk.

Reserve risk is intended to measure variation in loss reserve development, net of reinsurance recoveries and excluding catastrophe losses.

The Standard Formula requires insurers to classify non-life business into 12 lines of business.[11] Table 4.1 below shows the standard deviations used to calculate risk charges for premium and reserve risk.

Table 4.1
Standard Deviations by Line of Business – Premium and Reserve Risk
(Updated Dec 2011)

LOB #	LOB	Standard Deviation	
		Gross Premium[12]	Net Reserves[13]
1	Motor vehicle liability	9.6%	8.9%
2	Other motor	8.2%	8.0%
3	Marine, aviation, transport (MAT)	14.9%	11.0%
4	Fire	8.2%	10.2%
5	3rd party liability	13.9%	11.0%
6	Credit and suretyship	11.7%	19.0%
7	Legal expenses	6.5%	12.3%
8	Assistance	9.3%	11.0%
9	Miscellaneous	12.8%	20.0%
10	NP reins (prop)	5.0%	5.3%
11	NP reins (cas)	8.5%	13.9%
12	NP reins (MAT)	8.0%	11.4%

Source: Report of the Joint Working Group on Non-Life and Health NSLT[14] Calibration, "Calibration of the Premium and Reserve Risk Factors in the Standard Formula of Solvency II," 12 December 2011.

The factors are the same for all jurisdictions across the EU.

Proportional reinsurance business is treated as if it were the corresponding primary line of business, based on the assumption that the risk standard deviations are the same for primary and proportional reinsurance business.

The underwriting risk charges are applied to premiums and reserves net of reinsurance (for net risk) and to premiums and reserves gross of reinsurance (for gross risk), with the difference

[11] This paper does not compare the Solvency II risk charge values to RBC values. Any such comparison is complicated (or impossible) because the lines of business are not directly comparable.
[12] Premium factors were selected based on data gross of reinsurance.
[13] Reserve factors were selected based on data net of reinsurance.
[14] Health is separated into (a) business analyzed using techniques "similar to life insurance techniques" (SLT) and (b) health analyzed using techniques like non-life or not-SLT (NLST).

between the two risk charges (the "ceded risk exposure") used to determine reinsurance credit risk. For premium risk, the standard deviation in Table 4.1 can be reduced using a formula to reflect the extent the ceded reinsurance is non-proportional reinsurance.[15]

The factors in the table are *standard deviations*, applied separately for premium and reserve risk. There are several steps required to produce the combined premium and reserve risk charge by line of business and then for all lines combined.

First, for each line of business, the premium risk and reserve risk standard deviations are volume weighted together assuming a correlation coefficient of 50% between premium and reserves as follows:

$$\sigma_{LOB} = \text{Square Root } \{(\text{Premium}^2 * \sigma^2_{\text{Premium}} + \text{Reserve}^2 * \sigma^2_{\text{Reserve}} + \text{Premium} * \text{Reserve} * \sigma_{\text{Premium}} * \sigma_{\text{Reserve}} *)/ (\text{Premium} + \text{Reserve})^2 \}.$$

Second, the volume measure(s) for each line of business are adjusted to reflect geographic diversification as follows:[16]

$$\text{Volume}_{LOB, r} = (\text{Premium}_{LOB\ r} + \text{Reserve}_{LOB, r}) * (75\% + 25\% * \text{Diversification}_{LOB, r}),$$

where the r subscript represents geographic segments, generally countries.

$$\text{Geographic Diversification}_{LOB} = \{\sum (\text{Premium}_{LOB, r} + \text{Reserve}_{LOB, r})^2 / (\sum (\text{Premium}_{LOB, r} + \text{Reserve}_{LOB, r}))^2\}.$$

Third, the standard deviation for all lines combined is determined with the following formula, summing over all pairs of LOB J and K, using the LOB Correlations from Table 4.2:

$$\sigma_{TOTAL} = \text{Square Root } \{(1/(\text{Volume}_{TOTAL})^2 * [\sum \text{Correlation LOB}_{LOB\ J, LOB\ K)} * \sigma_{LOB\ J} * * \sigma_{LOB\ K} * \text{Volume}_{LOB\ J} * * \text{Volume}_{LOB\ K}]\}.$$

[15] Insurers must assess whether net-to-gross ratio of premiums or reserves at the 99.5% level are less than (or at least not significantly greater than) the net-to-gross ratio of best estimate provisions. That might be the case due to loss ratio limits and the like. If so, the reduction in the capital charge resulting from reinsurance is reduced. (QIS 5 Technical Specifications SCR 13.9)

[16] Rather than adjusting the standard deviation to reflect this diversification, the formula adjusts the volume measure.

Table 4.2
Standard Formula Underwriting Risk Covariance Matrix for Premium and Reserves
(LOB numbers in the first column follow the numbering in Table 4.1)

LOB/ LOB	1	2	3	4	5	6	7	8	9	10	11	12
1	1.00											
2	0.50	1.00										
3	0.50	0.25	1.00									
4	0.25	0.25	0.25	1.00								
5	0.50	0.25	0.25	0.25	1.00							
6	0.25	0.25	0.25	0.25	0.50	1.00						
7	0.50	0.50	0.25	0.25	0.50	0.50	1.00					
8	0.25	0.50	0.50	0.50	0.25	0.25	0.25	1.00				
9	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	1.00			
10	0.25	0.25	0.25	0.50	0.25	0.25	0.25	0.50	0.25	1.00		
11	0.25	0.25	0.25	0.25	0.50	0.50	0.50	0.25	0.25	0.25	1.00	
12	0.25	0.25	0.50	0.50	0.25	0.25	0.25	0.25	0.50	0.25	0.25	1.00

Note that each of the correlation factors is 0.25, 0.50, or 1.00. These are tail correlations and are intended to represent the relationship between line of business outcomes (premium and reserves combined) at the one-year 99.5% VaR level.

The non-life underwriting risk charge is approximately as follows:

$$\text{Underwriting Risk Charge} \approx [\text{Volume (after geographic diversification)}_{\text{Total}}] * (3.0 * \sigma_{\text{Total}}).$$

The factor 3.0 is the rough number of standard deviations required to reach the 99.5% level for a lognormal distribution.

RBC treats premium risk and reserve risk as independent. The Standard Formula treats them as having some degree of covariance.

RBC has a line of business diversification credit (dependency relationship) expressed by the 70% rule.[17] The Standard Formula specifies a covariance relationship between each pair of lines of business.

RBC does not have a specific credit for geographic diversification or charge for geographic concentration. RBC risk charges are derived from data that implicitly includes an average geographical diversification effect for U.S.-domiciled insurance companies. The Standard Formula geographical diversification credit has a 75% rule that is applied like the 70% rule for LOB diversification in RBC.

RBC uses the same factors for business regardless of the state in which the business is written. The Standard Formula takes the same approach.

RBC does not evaluate risk gross of reinsurance as that information is not used in the RBC credit risk calculation.[18]

For R4, RBC includes an investment income offset.[19] The Standard Formula does not include an investment income offset in that investment income is already reflected in the discounted unpaid claim reserves. Thus, investment income is treated as a reduction in the risk charge in RBC while it is treated as an increase in capital and surplus in the Solvency II accounting basis.

For R5, RBC measures the risk as potential operating loss net of the investment income offset. The standard formula measures premium risk based on an unexpected increase in the loss ratio. Thus, the RBC risk charge is net of expected profit while the Standard Formula is gross of expected profit.[20]

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[17] For premium risk the concentration factor is 70% plus 30% times (premium for largest Schedule P line of business/total premium). For reserve risk the concentration factor is the same formula using reserves instead of premium. The result is 100% for a monoline company and approaches 70% for a hypothetical insurer evenly spread across an infinite number of lines. The minimum value for the factor is limited by the number of Schedule P lines. The 70% rule was selected considering observed risk for all-lines combined compared to risk by line of business.

[18] Ceded reinsurance risk is considered in the credit risk charge, R3.

[19] Applied to reserves "grossed up" for any company non-tabular discount.

[20] An offsetting factor is that under Solvency II accounting profits are recognized more quickly than under SAP. Under Solvency II accounting, underwriting profit is reflected as premium is written and investment income on assets corresponding to unearned premium and unpaid claims is recognized in part immediately and in part as the risk margin

Own-Company Experience

Subject to regulatory approval, an insurer can choose to use a credibility-weighted combination of its own specific parameters (such as standard deviations) or the industry standard parameters for premium and reserve risk under the Standard Formula. The insurer experience must be analyzed in a prescribed manner analogous to the manner in which the industry data was evaluated. Insurer-specific parameters for premium and reserve risk would be treated as 100% credible if sufficient years of data are available. Insurers with at least five years of experience in a line of business start with 34% credibility. The credibility weights increase to 100% for 10 years of experience (most lines of business) or 15 years of experience (for longer-tailed lines of business such as third-party liability, motor vehicle liability, and credit and suretyship).

RBC includes an own-company adjustment using the 50-50 rule in which company experience modifies the RBC charge based on the ratio of company loss ratios to industry loss ratios or company-incurred development to industry-incurred development, as long as the company has 10 years of experience and meets certain other requirements regarding consistency of volume over the 10n years.[21]

4.3 Catastrophe Risk

As with the non-catastrophe underwriting risk charges, the Solvency II catastrophe underwriting risk charge is determined both net and gross of reinsurance. The charge net of reinsurance is a component of the total underwriting risk charge. The difference between the gross and net risk charges is referred to as the catastrophe risk mitigation effect and is a measure of reinsurance credit risk used in the counterparty default risk calculation.

Catastrophe risk charges consider both natural catastrophes and man-made catastrophes. Natural catastrophes consist of windstorm, flood, earthquake, hail, and subsidence.[22] Storm surge is included with the windstorm peril. Man-made catastrophes include motor, fire, aviation, marine, liability, credit and suretyship, and terrorism.

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reduces. Under SAP underwriting profit in the written premium is not reflected until the premium is earned and investment income is recognized as realized.

[21] The exact rule for including company experience is more complex. See NAIC instructions for precise statement of the rule.

[22] Not all perils apply to all countries.

The risk charges are based on a combination of scenarios and factor methods. Scenario methods (Method 1) are for use in calculating capital requirements for natural catastrophes in the EEA.[23] The Scenario methods are described later in this section.

Factor methods (Method 2) are used when application of Method 1 may not be appropriate, e.g., for natural catastrophe exposures outside of the European Economic Area (EEA), miscellaneous business, and non-proportional reinsurance business. For the factor method, the Standard Formula provides selected gross loss ratios by line of business.

With either Method 1 or Method 2, insurers calculate their gross catastrophe losses based on either the prescribed scenarios (Method 1) or the prescribed gross loss damage ratios and gross written premiums (Method 2).

Insurers then net down the calculated gross loss damages using their own reinsurance programs including any excess covers, any proportional covers, excess retentions and reinstatement premiums as well as recoveries from any national pools.

The aggregate capital requirement for non-life (NL) natural catastrophes is determined as:

$$\text{NL\_CAT} = \text{Square Root } \{(\text{Method 1})^2 + (\text{Method 2})^2\}$$

Thus, it is assumed that Method 1 and Method 2 apply to independent catastrophe exposures.

Scenario Methods—Natural Catastrophes

The Standard Formula provides tables showing the gross loss damage ratio ($Q_{country}$) for 1-in-200 year catastrophe events, by peril, within each CRESTA[24] zone, separately by country. The capital requirement for each CRESTA zone and each peril gross of reinsurance is $Q_{country}$ times the aggregated value of geographically weighted total insured value by peril for each country, where the weights are the zone relativity factors for each country provided by the Standard Formula.

[23] The only company data required to apply the scenario methods is Total Insured Value (TIV) by line of business, reflecting the company's proportional share if on a co-insurance basis, without allowance for deductible, limits, and sub-limits, See "CEIOPS-DOC-79-10-CAT-TF-Report" page 9) by CRESTA zone. As that level of data is expected to be commonly available, it is expected that companies can apply the scenario method within the EEA.

[24] CRESTA, the Catastrophe Risk Evaluating and Standardizing Target Accumulation organization (founded in 1977) is an independent body established for the technical management of natural peril coverage. CRESTA determines country-specific zones for the uniform and detailed reporting of exposure data relating to natural perils.

The capital requirements for each peril are aggregated across CRESTA zones within each country using a prescribed correlation matrix intended to reflect tail dependency for 1-in-200 year events. The correlation coefficients strongly depend on proximity and, for flood, the shape of river networks. The aggregation by-country-by-peril allows application of national pool arrangements. Then the capital charges are aggregated across countries, by peril and finally across perils using prescribed covariance matrices between countries and between perils.

Insurers must allow for multiple events for wind, flood, and hail as follows. Each insurer evaluates the effect of two scenarios, A (one large event plus a second smaller event, with initial loss A1 and subsequent loss A2) and B (two moderate events, with initial loss B1 and subsequent and loss B2), on a gross basis and then net down for reinsurance. For each peril, the insurer calculates a capital requirement as the maximum of A (net) and B (net). Specifically, the capital charge for each peril is the maximum value of capital charges for scenario A and B net of reinsurance; where the capital charge for scenario A is equivalent to A1%, say 80%, of the capital charge for scenario A1 plus A2%, say 40%, of capital charge for scenario A2 (80% + 40% is greater than 100% reflecting the chance of more than one event); and where the capital charge for scenario B is equivalent to B1%, say 100%, of the capital charge for scenario B2 plus B2%, say 20%, of capital charge for scenario B2. The standard formula provides the 1-in-200 $Q_{country}$ values for A1%, A2%, B1%, and B2% for each peril.[25] For example:

- Alternative A: 80% of the capital charge for the first windstorm (net) and 40% of the capital charge for subsequent windstorm (net).
- Alternative B: 100% of the capital charge for first windstorm (net) and 20% of the capital charge for subsequent windstorm (net).

The insurer would select the maximum catastrophe loss from these two scenarios.

Scenario Methods—Man-Made Catastrophes

For each man-made catastrophe, the Standard Formula describes specific incidents to illustrate what is considered to be a possible man-made catastrophe scenario (for example, an explosion in the oil refineries at the port of Rotterdam, a fire in a building housing a major

[25] "CEIOPS-DOC-79-10-CAT-TF-Report," page 11

armament company with 10 fighter jets destroyed) and the capital requirement for each such man-made catastrophe peril.

For example, the preferred method to determine the capital charge for fire man-made catastrophe as described above is 100% of the sums insured of largest known concentration of exposures for the fire and other damage line of business in a 150-meter radius, then reduced to reflect risk mitigation effects (option 1). If option 1 cannot be applied, the capital charge is the maximum value resulting from the largest single risk loss across all sub-lines or from the sum across all sublines of prescribed factors for subline X times the of total insured values for subline X (X=residential, commercial, and industrial), then reduced to reflect risk mitigation effects (option 2).

Assuming independence between each man-made catastrophe, the capital charge for total man-made catastrophe is the squared root of sum of squares of the capital charges for each man-made catastrophe peril reduced to reflect risk mitigation effects.

Scenario Methods—Total Capital Charge

The aggregate capital requirement net of reinsurance for natural and man-made catastrophes under scenario method (Method 1) is

Square Root [(Natural Cats net capital charge) ^{2} + (Man-made cats net capital charge) ^{2}].

Factor Methods—Cat Capital Charge Net of Reinsurance

For the factor-based method (Method 2), the capital requirement for gross of reinsurance is initially determined as the product of expected gross written premiums (in the relevant lines of business) and prescribed gross factors by event, including multiple perils if relevant, applicable to all countries. For example, flood events are estimated to result in losses equal to 113% of the gross written flood premiums. Similar calculations are done for all perils where Method 2 is being used. Losses are then combined by assuming events are independent, except for direct insurance and proportional reinsurance and the corresponding non-proportional reinsurance, which are 100% correlated.[26]

The total cat capital requirement net of reinsurance for Method 2 is obtained by netting down the gross capital requirement for the risk mitigation effect in the same way as under Method 1

[26] Details at "QIS 5 Technical Specifications," page 242-243, section 9.178-9.179.

and applying the dependency relationship for the Factor Method gross risk charges described in the paragraph above.

In RBC, catastrophe risk is implicit in premium risk and reserve risk, and it does not reflect the individual insurer's catastrophe exposure or the insurer's reinsurance protection and related credit risks.[27]

4.4 Combing the Non-Life Underwriting Risks—Treatment of Dependency

The Standard Formula combines the premium/reserve and catastrophe risk modules with the following specified tail correlation matrix:

Table 4.3
Non-Life Tail Correlation Matrix

	Premium+Reserve	Catastrophe
Premium+Reserve	1.00	0.25
Catastrophe	0.25	1.00

Total underwriting risk charge = Square root {(Premium/reserve charge)^2 + 0.25 * (Premium/reserve charge)*(Cat charge)+ (Cat charge)^2}.

5. Counterparty Default Risk Module

The counterparty default risk module reflects possible losses due to the unexpected default, or deterioration in credit standing, of counterparties and debtors of the insurer over the next 12 months. This includes default risks from risk-mitigating contracts (reinsurance), securitizations, derivatives, receivables from intermediaries, and any other credit exposures not covered in the credit spread risk sub-module (not usually applicable to property/casualty companies).

Types of Default Risk

There are two exposure types included in this module, which the Standard Formula refers to as "Type 1" and "Type 2."

[27] There may be some implicit reflection of the individual insurer's past cat exposure via the company experience adjustment, but only through its share of industry cat losses in the last 10 years. Note that a cat charge is currently in development that would utilize the results of third-party hurricane and earthquake cat models at the 1-in-100 aggregate annual loss exceedence level.

Type 1 exposures cover the exposures that may not be diversified and where the counterparty is likely to be rated. Most importantly, for non-life insurers, these exposures include reinsurance arrangements, securitizations and derivatives, and any other risk-mitigation contracts. Type 1 exposures also include cash in banks, deposits with ceding institutions (when there are relatively few, defined as up to 15 independent counterparties), and some forms of capital (and other similar commitments such as initial funds and letters of credit) called up but not yet paid (similarly, when there are relatively few, defined as up to 15 independent counterparties).

Type 2 exposures cover the exposures that are usually diversified and where the counterparty is likely to be unrated. These exposures include receivables from intermediaries, policyholder debtors (including mortgage loans), deposits with ceding institutions (16 or more independent counterparties), some forms of capital (and other similar commitments such as initial funds and letters of credit) called up but not yet paid (16 or more independent counterparties).

Capital Requirements—Type 1

The capital requirement for counterparty default can be considered in two steps: first determine the loss given default (LGD) and second determine the capital required given that exposure to loss. These are described below.

Loss given Default—Type 1 Exposure

Loss-given-default (LGD) is the loss of own funds if a particular counterparty defaulted.

For reinsurance arrangements (or securitizations), LGD has three parts:

1. The risk mitigating effect of reinsurance: the difference between the capital required for underwriting risk without and with the reinsurance contract(s).
2. Balance sheet risk: existing recoverables under the reinsurance contracts(s), (including the equivalent of recoverables on unearned premium).
3. Collateral: LGD implied by the above, is reduced by the amount of collateral supporting the contract(s).

The LGD is normally[28] 50% of [(1) + (2)- ()-(3)]. The 50% represents an estimate of the amount that the insurer would be unable to recover if the counterparty defaulted.

For reinsurance, the risk mitigating effect of reinsurance is calculated as described in the underwriting risk section 4.2. The underwriting risk charges are applied to premiums and reserves net of reinsurance (for net risk) and to premiums and reserves gross of reinsurance (for gross risk). The difference between the two risk charges is the risk mitigating effect of reinsurance. For premium risk, the underwriting risk net of reinsurance can be adjusted to reflect the extent the ceded reinsurance is non-proportional reinsurance.[29] This adjustment reduced the otherwise applicable premium risk but increases the risk-mitigating effect of reinsurance and the capital for reinsurance credit risk.

For derivatives, LGD is the difference between the capital required for market risk without and with the derivative(s). The balance sheet risk is the market value of the derivative. The risk is reduced by any collateral supporting the derivative(s). LGD is calculated as 90% of the total exposure.

For Type 1 exposures other than risk-mitigating contracts, the LGD is the value of the asset marked-to-market (or marked-to-model, if mark-to-market is not possible) for exposures not dependent on the credit rating of the counterparty. For those assets whose value is dependent on the credit standing of the counterparty, the LGD is the difference between the nominal value and the market value of the receivable.

Calculation—Type 1 Exposure

The Standard Formula includes an algorithm to calculate the standard deviation of the distribution of costs of Type 1 defaults, $\sigma_{\text{Type 1 default risk}}$. The value of $\sigma_{\text{Type 1 default risk}}$ depends on the probability of default per counterparty. That probability of default varies according to seven different credit ratings (AAA, AA, A, BBB, BB, B, and CCC or lower). A

[28] If the counterparty financial position is such that more than 60% of the counterparty assets would be required as collateral for its obligations, then the LGD is 90% of sum of (1)-(3), as less counterparty assets would be available to the insurer in the event of its default.

[29] Insurers must assess whether net-to-gross ratio of premiums or reserves at the 99.5% level are less than (or at least not significantly greater than) the net-to-gross ratio of best estimate provisions. That might be the case due to loss ratio limits and the like. If so, the reduction in the capital charge resulting from reinsurance is reduced. (QIS 5 Technical Specifications SCR 13.9)

common stress function is assumed to affect all counterparties and probability of default increases as the level of stress increases.

The counterparty default charge is based on the probability of default at the 99.5% probability level. As such, normally,[30] the capital requirement is 3[31] times $\sigma_{\text{Type 1 default risk}}$. The effect is that for a single counterparty of various expected default levels the risk charges are based on formula that produces risk charges as shown in Table 5.1.

Table 5.1
Probability of Default for Risk Charge Compared to Expected Average Probability of Default

Credit quality[32]	Expected Default Probability	Default probability used for counterparty credit risk
AAA	.002%	1.3%
AA	.010%	3.0%
A	.050%	6.7%
BBB	.240%	14.7%
BB	1.200%	54.5%
B	6.040%	100.0%
CCC or lower	30.41%	100.0%

Source: CEIOPS, "Advice for Level 2 Implementing Measures on Solvency II: SCR standard formula – Counterparty default risk module," October 2009

Thus, for a program covered by one A-rated reinsurer, the default probability for reinsurance credit risk evaluation is 6.7%, even though the long-term average default probability is .05%.

For ten A-rated counterparties, each with an expected default rate of 0.05%, the required capital would be 4.5% of LGD, rather than 6.7% of LGD, reflecting credit for diversification but recognizing that there is a systemic component to the risk.

Appendix B shows a counterparty risk calculation.

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[30] If the $\sigma_{\text{Type\_1\_Default\_Rrisk}}$ is greater than 5% of the total LGD, then the capital requirement is 5 times σ Type 1 default where 5 replaces 3 because the large standard deviation suggests that the LGD distribution may be more extreme than expected and the 99.5%-ile risk level would be more than 3 standard deviations from the mean.

[31] The factor 3.0 is the rough number of standard deviations required to reach the 99.5% target safety level for a lognormal distribution.

[32] For counterparties without a standard credit rating, the Standard Formula provides a table of expected default rates based on the ratio of own-funds to SCR.

RBC applies a 10% charge to the total ceded balances, reduced for any Schedule F penalty applicable to those balances. These balances include ceded loss reserves, unearned premium, and amounts billed but not yet collected.

The 10% charge is applied regardless of the quality of the reinsurers, except that a 0% charge is applied to ceded balances with U.S. affiliates and with mandatory pools (such as residual market pools), and does not vary based on whether the reinsurer has provided collateral. Those features were based on conscious decisions by the NAIC when RBC was developed.[33]

The RBC charge is the same for all types of reinsurance, e.g., quota share, excess, and catastrophe, and for all types of business, e.g., property vs. liability.

The RBC formula does not explicitly deal with the percentage of loss given default (LGD) in case of reinsurer failure, and it does not explicitly deal with the extent to which ceded balances (and therefore size of potential credit risk) would be higher in adverse circumstances than in normal circumstances. However, those features, which are explicitly recognized in the Standard Formula, could be viewed as being implicit in the selection of the 10% charge.

The reinsurance portion of the RBC charge is split 50/50 between two RBC components (R3 and R4), in the covariance formula. This is mathematically differently, but conceptually closely related to the Standard Formula, which has a 50% correlation between Credit Risk and Underwriting Risk.

Capital Requirements—Type 2

The capital requirement for counterparty default risk of Type 2 exposures is

- 15% of all Type 2 exposures, except for receivables from intermediaries due for over three months), plus
- 90% of the exposures due more than three months.

[33] It is beyond the scope of this paper to review the basis for those decisions and their current applicability.

With respect to Type 2 exposures, which, most significantly for nonlife companies, consist of "uncollected premium and agents balances in course of collection," RBC, operating in SAP, reflects a zero asset value for (i) agents balances and (ii) many other receivables over 90 days due. The Standard Formula includes a risk charge of 15% premium on non-overdue receivables and a risk charge of 90% on overdue receivables. Thus the risk of premium receivables is treated as a reduction to reported capital in RBC and as a risk charge in the Standard Formula.

RBC has 5% and 1% charges for a number of other categories of receivables. Solvency II accounting requires for provisions to reflect the probability of default on all receivables, however small.

Calculation of Total Capital Requirement for Counterparty Default—Type 1 + Type 2

Total capital for counterparty default reflects a 75% correlation between Type 1 and Type 2 exposures.

$$\text{Total Capital} = \text{square root } [(\text{Capital}_{\text{Type 1}})^2 + 1.5 * (\text{Capital}_{\text{Type 1}}) * (\text{Capital}_{\text{Type 2}}) + (\text{Capital}_{\text{Type 2}})^2].$$

The reinsurance portion of the RBC charge is split 50/50 between two RBC components (R3 and R4), in the covariance formula. This is mathematically different, but conceptually related to the Standard Formula, which has a 50% correlation between Credit Risk and Underwriting Risk.

In RBC the remaining reinsurance credit risk is combined with other credit risks as if they were 100% correlated.

6. Market Risk Module

6.1 Overview

The Standard Formula market risk includes seven sub-risks:

1. Interest rate risk reflecting an "up" rate and a "down" rate stress.
2. Equity risk reflecting prescribed decreases in equity values.
3. Real Estate (Property) risk reflecting a prescribed decrease in the value of real estate investments.
4. Currency risk reflecting changes of foreign currencies against the insurer's home country currency.

5. Spread risk reflecting changes in the level or volatility of credit spreads over the risk-free interest rate term structure (for bonds, structured capital products, and credit derivatives).
6. Concentration risk reflecting risk of accumulation of exposures with the same counterparty. The scope of concentration risk includes assets considered in the equity risk, spread risk and property risk sub-modules and excludes assets considered in the counterparty default module.
7. Illiquidity premium risk reflecting decreases in the value of the illiquidity premium. For non-life insurers this only affects loss reserve discounting.

6.2 Interest Rate Risk

Interest rate risk is calculated using a scenario approach. The Standard Formula prescribes specific upward and downward stress in interest rates that vary by years to maturity. Irrespective of the prescribed stress factors, the absolute change of interest rates in the downward scenario should be at least one percentage point (with interest rate not to be less than zero). The insurer calculates the change in NAV resulting from these rate stresses. The capital requirement for interest rate risk is derived from the up or down shock, whichever gives rise to the highest capital requirement.

The effect on NAV from an interest change is the combination of (a) the change in asset market values as interest rates change, and (b) the change in liabilities as discounted loss reserves are also affected by change in interest rates.

RBC determines asset charge, R1, for fixed-income securities by applying a factor to statutory annual statement balance sheet items. The factor varies by NAIC Classification of the investment.

NAIC R1 relates to default risk (on a loss given default basis) for investment grade bonds rather than change in market value (although the charges for non-investment grade bonds, which are higher, are supposed to reflect market value risk). R1 charges for U.S.-government securities, for example, are zero. The focus on default risk rather than risk of market value movements might be viewed as the difference in time horizon. RBC takes a run-off view, over which market value changes are less relevant as assets can be liquidated gradually over time. The Standard Formula measures risk based on market values one year ahead. Logically, the one-year market value risk charge in the Standard Formula should be larger than the run-off default risk charge in RBC.

Standard Formula does not have a separate charge for asset default risk as that is part of market value risk.

6.3 Equity Risk

The risk charge for equity risk is calculated as the change in an undertaking's NAV resulting from pre-defined stress scenarios:

- 30%[34] decline in the value of "global" equities (listed in regulated markets); and
- 40%[35] decline in the value of "other" equities (emerging markets, non-listed equity, hedge funds, and other investments not included elsewhere).

These two risk charges are combined with the assumption that global equities are 75% correlated with "other" equities.

The aggregate SCR for equity risk is calculated as:

> Square Root {(global equity charge)^2 + 0.75 * (global equity charge) * (other equity charge) + (other equity charge) ^{2}}.

[34] The risk charge is 39% in normal conditions, and reduced to 30% after a stress event such as the financial crisis.
[35] The risk charge is 49% in normal conditions, and reduced to 40% after a stress event such as the financial crisis.

The equity risk is part of NAIC R2. R2 uses a 15% charge for unaffiliated common stocks and charges from 0.3% to 30% for various types of preferred stocks and hybrid securities. The lower R2 charges could be viewed as related to the difference in time horizon between RBC and Solvency II Standard Formula, as discussed above with respect to R1.

6.4 Property Risk

Property risk is calculated as the change in an undertaking's NAV resulting from a pre-defined scenario of 25% decrease in the value of real estate investments. Investments in companies engaged in real estate management, project development, or similar activities are considered in the equity risk sub-module.

Owned property risk is part of the NAIC R2 and has a 10% risk charge.

6.5 Currency Risk

Currency risk is calculated as the change in an undertaking's NAV resulting from a pre-defined scenario of an instantaneous rise (or fall) of 25% (-25%) of the foreign currency against the home country currency. The capital requirement for each currency risk is derived from the up shock or down shock, depending on the one that gives rise to the highest capital requirement. The capital requirement includes any investment in foreign instruments where the currency risk is not hedged. The stresses for interest rate, equity, spread and property risks have not been designed to incorporate currency risk. The total capital requirement is summed over all of currencies of the SCRs for currency risk.

Currency risk is not reflected in NAIC RBC. For the bulk of U.S. companies, currency risk is rare, arising perhaps in the international LOB, Canadian business or in some reinsurance companies. To the extent liabilities in a non-U.S. currency are supported by assets in that some currency, a common practice, currency risk is minimized.

6.6 Spread Risk

Spread risk is calculated as the change in an insurer's NAV resulting from specified changes in the level or volatility of credit spreads over the risk-free interest rate term structure. Separate calculations are done for bonds, structured credit products, and credit derivatives. The spread risk

scenario depends on the credit rating of the assets. In cases where several ratings are available for a given credit exposure, the second-best rating is applied.

The spread risk on bonds reflects the immediate effect on the NAV expected in the event of an instantaneous decrease of values in bonds due to the widening of credit spreads. The calculations vary by issue quality and duration.

The spread risk on structured credit products equals the effect on the NAV in the event of an instantaneous decrease of values in structured products due to the worst of two shock scenarios prescribed in the Standard Formula: (1) the widening of credit spreads of bonds of the underlying assets and (2) the widening of credit spreads of the structured credit products. The calculations are determined based on issue quality/credit rating, tenure/duration, attachment point, and detachment point.

The spread risk on credit derivatives equals the effect on NAV in the event of an instantaneous widening (decrease) of credit spreads for credit derivatives due to the worst of two shock scenarios defined by the Standard Formula, whichever gives rise to the highest capital requirement: (1) widening of spreads (in absolute terms) and (2) decrease of spreads (in relative terms) that vary by issue quality.

There is no spread risk component of RBC. Spread risk is a market value issue rather than an issue for assets held to maturity. (See discussion of interest rate risk.)

6.7 Concentration Risk

Concentration risk includes assets considered in the equity risk, spread risk, and property risk sub-modules. Concentration risk excludes assets considered in the counterparty default risk. Concentration reflects concentration in a single entity rather than concentration by geography or industry segment. The calculation is performed in three steps.

(1) The "excess exposure" to each counterparty (i) compares the percentage of portfolio assets exposed to counterparty (i) to a "concentration threshold." The concentration threshold is 3% for counterparties rated A or better and 1.50% for counterparties rates BBB or lower.

For example, if 3.50% of assets are with an A-rated counterparty, there is a 0.50% excess exposure, 3.5% actual minus 3.0% threshold.

(2) The risk concentration capital requirement reflects the effect on the NAV of a decrease in the value of the "excess exposure" for each counterparty multiplied by a parameter that also varies with counterparty rating.

For example, if there is a 0.5% excess exposure, the related capital requirement for concentration risk is 0.1%, 0.50% "excess" times the 0.21 risk factor for excess concentration on to A-rated counterparties.

(3) Finally, the aggregate capital requirement for concentration risk assumes no correlation among the counterparties [aggregate = (sum (concentration^2)) ^ 0.50].

Concentration risk is considered in R1 through a bond size adjustment factor that decreases as the number of bond issuers increases.

Concentration risk is considered in R1 and R2 through an "asset concentration" adjustment that doubles the RBC charges for all the investments in a single issuer for the ten largest issuer exposures, with a maximum charge of 30% for any one security.

6.8 Illiquidity premium risk

Illiquidity premium risk reflects the immediate effect on the net value of assets and liabilities expected in the event of a 65% decrease in the value of the illiquidity premium observed in the financial markets. Except for the discounting of loss reserves, this risk is not relevant for non-life insurers.

There is no provision for this risk in RBC. The risk is not relevant for RBC unless loss reserves are discounted at a rate that depends on the liquidity premium.

6.9 Treatment of Dependency

The Standard Formula market risk capital requirement combines all seven risk types with a tail correlation matrix. There are two correlation matrices, one for an interest rate "up" stress and one for an interest rate "down" stress.

Table 6.1
"Down" Tail Correlation Matrix

Down	Interest	Equity	Property	Spread	Currency	Concentration	Il-liquidity
Interest	1.00						
Equity	0.50	1.00					
Property	0.50	0.75	1.00				
Spread	0.50	0.75	0.50	1.00			
Currency	0.25	0.25	0.25	0.25	1.00		
Concentration	0.00	0.00	0.00	0.00	0.00	1.00	
Illiquidity	0.00	0.00	0.00	-0.50(a)	0.00	0.00	1.00

Table 6.2
"Up" Tail Correlation Matrix

Up	Interest	Equity	Property	Spread	Currency	Concentration	Il-liquidity
Interest	1.00						
Equity	0.00	1.00					
Property	0.00	0.75	1.00				
Spread	0.00	0.75	0.50	1.00			
Currency	0.25	0.25	0.25	0.25	1.00		
Concentration	0.00	0.00	0.00	0.00	0.00	1.00	
Illiquidity	0.00	0.00	0.00	-0.50(a)	0.00	0.00	1.00

Note (a): The correlations for spread risk represent widening spreads, so a negative correlation between illiquidity premium risk and spread risk is set at -0.50.

The capital requirement for market risk is calculated as follows:

The maximum of

Square root (∑ correlated interest rate "up" scenarios), and

Square root (∑ correlated interest rate "down" scenarios).

RBC treats R1 and R2 as separate terms within its covariance formula, thereby assuming that these are independent risks over the run-off period.

R2 combines real estate (property) and equity risks as if they were 100% correlated.

7. Solvency Capital Requirement (SCR)

The overall standard formula capital requirement (SCR) for Non-Life insurers is determined by summing up the Basic Solvency Capital Requirement (BSCR) and Solvency Capital Requirement for Operation Risk (SCRop):

SCR = BSCR + SCRop.

Two steps are required to determine the BSCR.

First, the insurer combines the market, default, and underwriting risks using the correlation matrix in table 7.1.

Table 7.1
Market Risk Tail Correlation Matrix

	Risks Considered in this paper				
				For "composite" companies	
	Market Risk	**Default Risk**	**Non-Life U/W Risk**	**Life U/W Risk**	**Health U/W Risk**
Market	1.00				
Default	0.25	1.00			
Non-Life	0.25	0.50	1.00		
Life	0.25	0.25	0.00	1.00	
Health	0.25	0.25	0.25	0.25	1.00

Notes:
U/W risk is the "combined" reserve risk and premium risk discussed in section 4.
In this paper we have not discussed Life or Health U/W risks, as we have focused on a non-life company.

Second, to the extent the insurer includes the value of intangible assets[36] in its capital, there is a risk charge equal to 80% of that value.

The Basic Solvency Capital Requirement (BSCR) is the sum of these two items as follows:

BSCR = Intangible assets capital + Square Root [Sum over risk categories I, J of (Correlation $_{IJ}$* Required Capital $_{I}$ * Required Capital $_{J}$)].

The Solvency Capital Required for operational risk (SCRop) equals the minimum of:

(a) 30% of BSCR, calculated as described above, and

[36] See further discussion of intangible assets in section 9, "Capital."

(b) The maximum of solvency capital required for operational risk associated with premium and technical provisions, where:

(i) The premium based operational risk is (i) 3% of earned premium plus (ii) for an insurer whose earned premiums increase by more than 10% over the prior year, an additional 3% of the earned premium increase over 10%. (Where earned premium in those calculations is before deduction for ceded reinsurance.)

(ii) The technical provision based operational risk is 3% of technical provisions[37] without the risk margin.

RBC includes six risk types with one outside of the square root and only "squared" terms inside the square root, no explicit correlation coefficients terms as follows:

RBC = R0 + [(R1^2) + (R2^2) + (R3^2) + (R4^2) + (R5^2)] ^ (0.50), where

R0 = off-balance sheet risks and investments in insurance affiliates[38]

R1 = fixed-income securities

R2 = equity investments

R3 = non-reinsurance credit risk + half the ceded reinsurance credit risk (note 1)

R4 = reserving risk + half the ceded reinsurance credit risk (note 1)

R5 = written premium risk

In RBC intangibles would be valued based on statutory in NAV, and usually have lower than market value, often zero.

Note: For insurers with low reserve risk relative to ceded reinsurance credit risk (e.g., fronting companies), all the ceded reinsurance credit risk remains in R3.

[37] As outlined in this paper "Overview" (Section 2), technical provisions are analogous to unearned premium and loss reserves, discounted for interest.

[38] R0 will include Deferred Tax Asset risk charges beginning with year-end 2012.

8. Capital

The result of the Standard Formula is compared to the company adjusted "own funds" or adjusted "capital and surplus" in U.S. terminology.

Several points are important here.

First, the accounting structure within which the Standard Formula operates differs from SAP. Some key differences were identified in section 2, "Overview."

Second, there are adjustments to values of intangible assets to determine the NAV which is compared to the required capital from the Standard Formula. First the economic value of goodwill for solvency purposes is reduced to zero in the insurer's capital. Then, for all other intangible assets, capital includes a value for intangibles only where (a) it is probable that the expected future economic benefits will flow to the insurer and (b) the value of the assets can be measured reliably. If a fair value measurement of an intangible asset is not possible, then the asset is valued at zero in the insurer's capital. If there is a non-zero value for intangible assets, the risk capital requirement for intangible assets is 80% of the value of those intangibles.

Third, participations in other financial sector entities are generally consolidated through the equity method. Specific capital requirements for other financial sector entities are calculated separately according to the requirements of that other financial sector. These capital requirements are then added to the SCR without any recognition of diversification effects.

Fourth, capital available for "own funds" is classified into one of three tiers reflecting the availability of these sources of capital in stress situations. The Tier definitions address a number of issues that are relevant to EU life and non-life insurers. Tier 1 capital includes amounts that would correspond to capital and surplus under SAP and includes surplus notes with original maturity greater than 10 years. Tier 1 excludes the value of the insurer's participations in financial or credit institutions. Tier 2 includes contingent capital that would be available in distressed situations and includes and surplus notes with original maturity greater than five years. Tier 3 includes Deferred Tax Assets and surplus notes with original maturity greater than three years.

The use of different capital tiers to satisfy the SCR and MCR are limited such that:

Tier 1 must be at least 50% of the SCR and at least 80% of the MCR.

Tier 3 must be less than 15% of the SCR.

Only Tier 1 and Tier 2 are eligible to meet the MCR.

The result is an adjusted own funds that is compared to the results of the Standard Formula for SCR or MCR and determine whether the company meets the capital standards.

Capital for RBC purposes is based on Statutory Accounting Practices which, by comparison to Solvency II Own Funds, has the implications discussed below.

First, loss reserves are not generally discounted in SAP,[39] so that, if all else is unchanged, capital under SAP is lower than under Solvency II. However, in RBC, the reserving risk is reduced by the effect of discounting, so that, if all else is unchanged, risk charges under SAP are also lower than under Solvency II.

Second, insurance subsidiaries are recorded at statutory book value in capital and surplus, but there is a capital charge equal to the subsidiary RBC.

Third, intangibles are generally recorded as at zero value in SAP.[40]

RBC has a limitation on the amount of capital that can be provided by capital notes and surplus notes and uses conservatism in determining what assets and liabilities are reflected in capital.

[39] If reserves are discounted then statutory capital and surplus is adjusted downward for RBC purposes to remove the benefit of the discount

[40] Goodwill is a temporary exception as it is allowed as an asset, but is amortized down to zero over a 10-year period.

Appendix A—Aspects of Standard Formula not Relevant to U.S. Non-Life Business

In this paper we have focused on issues related to a stand-alone non-life insurer and we have not described aspects of the Standard Formula that would not be relevant to U.S.-type non-life business.

These include the following:

1. Lapse risk, which is largely a life insurance risk in the U.S., while it does apply to some non-life companies in the EU.
2. Life or Health U/W risk, as those are usually part of separate companies.
3. An adjustment for "loss absorbance in technical provisions" as that applies to life insurance dividend arrangements.

RBC includes an adjustment for "loss absorbance in technical provisions" through the Loss Sensitive Contracts adjustment to premium and reserve risk. Retrospectively adjustable premium are not as common in Europe as in the U.S., particularly in that workers compensation, as such, is not a major line of business in Europe.

There is no Solvency II equivalent to the loss-sensitive reinsurance adjustment in RBC R4 and R5, even though loss-sensitive reinsurance contracts exist in Europe as in the U.S.

This paper also does not discuss captive insurance companies. There are simplifications to the Standard Formula that can apply for single parent captives meeting certain other criteria.

Appendix B—Counterparty Default Risk Example

The detailed calculation of counterparty default risk for a quota share reinsurance treated is shown below.

Table B.1
Counterparty Default Risk—Quota Share Reinsurance Example

#		Item		Amt in Million	Notes
A. Basic business data					
1		Gross premium		100	Assumption
2		Ceded premium		25	As if 25% quota share
3		Net premium		75	Line (1) – Line (2)
4		Gross OS claims		150	Assumption
5		Ceded OS claims		37.5	25% of Line (4)
6		Net OS claims		112.5	Line (4) – Line (5)
7		Total recoverable		50	Ceded OS plus 50% of ceded premium Line (5) + 0.5 * Line (2)
8		One A-rated reinsurer			

B. Solvency II risk characteristics					
9		$\sigma_{LOB,\ Prem}$		10%	Standard formula parameter
10		$\sigma_{LOB,\ Rsv}$		7%	Standard formula parameter

C. Risk mitigation calculation					
		C.1 – Premium term			
11		Ceded Premium		25	Line (2)
12		$\sigma_{LOB,\ Prem}$		10%	Line (9)
13		99.5% factor		3	99.5%-ile of lognormal
14		Term 1 - premium risk		7.5	Lines (11)*(12)*(13)
15		Term 1 squared		56.3	Square of Line (14)
		C.2 – Reserve term			
16		Ceded OS		37.5	Line (5)
17		$\sigma_{LOB,\ Rsv}$		7%	Line (10)
18		99.5% factor		3	99.5%-ile of lognormal
19		Term 2 - OS risk		7.875	Lines (16)*(17)*(18)
20		Term 2 squared		62.0	Square of Line (19)
		C.3 – Cross term			
21		Ceded OS		37.5	Line (5)
22		Ceded Prem		25	Line (11)
23		$\sigma_{LOB,\ Rsv}$		7%	Line (17)
24		$\sigma_{LOB,\ Rsv}$		10%	Line (12)
25		99.5% factor squared		9	99.5%-ile of lognormal
26		Term 3 - cross term		59.1	Lines (21)*(22)*(23)*(24)*(25)
		C.4 – Combined risk			
27		Sq Rt of Total		13.3	Sq Root of (Line 15+Line 20+Line 26)

D. Loss given default					
28		Recovery ratio		50%	Assumption
29		Collateral		0	Assumption
30		Risk mitigation		13.3	Line (27)
31		Recoverables		50.0	OS claims plus 50% of ceded premium
32		Loss given default (LGD)		31.7	Line (28)*(Line31+ Line30+-Line29)

E. Probability of default at 99.5% level					
33		p_i		0.05%	Probability of single default Standard Formula parameter
34		Γ		0.25	Coefficient reflecting systemic risk Standard Formula parameter
35		y_j		31.7	Total LGD - Line (32)
36		z_j		1,002.2	Sum of LGD squared - Line 32
37		v_i		0.030%	Intermediate calculation (See QIS 5 Technical Specifications, SCR 6.14, page 137 of 330)
38		u_{ij}		0.020%	Intermediate calculation (See QIS 5 Technical Specifications, SCR 6.14, page 137 of 330)
39		σ^2		0.5009	Line 36 * Line 36 + Line 35 * Line 35 * Line 38
40		Σ		0.71	Square root of line 39
41		99.5% factor		3	99.5%-ile of lognormal
42		$SCR_{def,1}$		2.12	Line 40 * Line 41
43		$SCR_{def,1}$ as % of LGD		**6.7%**	Risk charge % of LGD - Line 42/Line 32 (6.7% if Table 5.1 A-rated reinsurer row)
44		$SCR_{def,1}$ as % of recoverable		4.2%	Risk charge % of recoverables - Line 42/Line 7

Line 43 depends only on the nature of the counterparties (how many and what credit rating).
Line 44 depends on line 43 and the relative amounts of (a) balance sheet receivables (OS and UEP) and (b) risk mitigation.

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Glossary

CRESTA, Catastrophe Risk Evaluating and Standardizing Target Accumulation organization (founded in 1977).
DCWP, Dependencies and Calibration Working Party.
EEA, EU + Norway and Lichtenstein.
IFRS, International Financial Reporting Standards.
LGD, Loss Given Default.
NAV, Net asset value; largely equivalent to statutory and surplus for purposes of RBC.
NL, Non-life or property/casualty or general insurance.
Risk charge, the risk-based capital amount for a particular risk.
Risk margin, an addition to loss reserves or other balance sheet items.
Safety level, the level of probability VaR or other metric used calibrate risk charges for individual risks or groups of risks.
SCR, solvency capital required under Solvency II; determined from Standard Formula or internal model.
Standard Formula, a way to determine capital requirements under Solvency II.

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[3] "Annexes to the QIS5 Technical Specifications," July 2010, https://eiopa.europa.eu/fileadmin/tx_dam/files/consultations/QIS/QIS5/Annexes-to-QIS5-technical_specifications_20100706.pdf.

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[5] "Solvency II Final L2 Advice, Index," https://eiopa.europa.eu/publications/sii-final-l2-advice/index.html.

[6] "Solvency II Calibration Paper," (CEIOPS Main background document for Level 2 advice as to calibration), April 2010, https://eiopa.europa.eu/fileadmin/tx_dam/files/publications/submissionstotheec/CEIOPS-Calibration-paper-Solvency-II.pdf.

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