CAS Research Working Party on Risk-Based Capital Dependencies and Calibration

Report 1
Overview of Dependencies and Calibration in the RBC Formula

Abstract At the request of the American Academy of Actuaries, the CAS formed the Risk Based Capital (RBC) Dependencies and Calibration Working Party (DCWP) to research how to handle dependencies and calibration in the NAIC P&C RBC formula (RBC or RBC formula), including the extent to which risk diversification should be reflected in the P&C formula.

The research identified a number of gaps in the current RBC formula. This paper presents results of the DCWP's work to date. DCWP research will continue and the results will be presented in a series of reports.

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

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1. Introduction and Summary

1.1 Charge

DCWP was created by the CAS at the request of the American Academy of Actuaries, September 30, 2010. The committee charge is to "research how to handle dependencies and calibration in the NAIC P&C RBC formula (RBC or RBC formula), including the extent to which risk diversification should be reflected in the P&C formula."

Section 11 details of the Academy request to the CAS.

1.2 Background

This is the first of several reports from the CAS RBC Dependencies and Calibrations Working Party (DCWP). Section 10 outlines our plans.

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

This paper assumes the reader is generally familiar with the property/casualty RBC formula.[1]

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

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

1.3 Research Questions

The 2010 NAIC book *Risk-Based Capital Forecasting & Instructions* states (page i):

> *Risk-based capital is a method of establishing the minimum amount of capital appropriate for an insurance company to support its overall business operations in consideration of its size and risk profile. It provides an elastic means of setting the minimum capital requirement in which the degree of risk taken by the insurer is the primary determinant.*

And continues:

[1] For a comprehensive 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.

A company's risk-based capital is calculated by applying factors to various asset, premium and reserve items. The factor is higher for those items with grater underlying risk and lower for less risky items.

Thus, we understand that the RBC formula is intended to provide a risk-related formula for determining minimum capital levels.

In that context, DCWP considers the following questions:

1. Is the current RBC formula appropriate "as-is" with respect to structure and risk charge calibrations?
2. Can the formula be improved[2] significantly, within the current structure,[3] through:
    a. Risk charges within the current structure and/or
    b. Improved measures of dependency within the current structure and/or
    c. Dependency represented by correlation matrices?[4,5]
3. Can the formula be improved significantly with changes beyond those in point 2 by:
    a. Using scenarios to measure risk charges, e.g., use of catastrophe modeling or disaster scenarios for catastrophe risk, revaluation of assets and liabilities based on interest rate movements for interest rate risk, large claim and catastrophe scenarios to assess of the effectiveness of the company's reinsurance program in reducing risk
    b. Increasing the number or complexity of dependency relationships?

In addition, DCWP intends to consider the extent to which the risk-based capital assessment might be improved through:

4. Use of standard "safe-harbor" models by all companies, for all of some of the RBC risks.[6]

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[2] One of the research subjects is to establish a basis for assessing the extent to which two formulas are different and potentially whether one formula is "better" than another, recognizing that there are many formulas that are "different," but not necessarily better or worse than one another with respect to a particular purpose or set of purposes.

[3] The "current structure" means using identical or similar data elements and a formula that might be the same or more complex than currently used, but one which could be applied in a spreadsheet.

[4] Use of correlation matrices compared to RBC dependency (covariance formula, 75% rule, etc.) is conceptually important and may have significant impact on results; however, correlation matrices can be easily handled in spreadsheet formulas, so, in that sense, this does not represent a major change to the present structure.

[5] As we discuss further in Section 7, the Solvency II "correlation matrices" are based on the dependency relationship at the tail of the risk distribution, reflecting a view of the aggregate risk distribution. Technically these are not correlation matrices according the assumptions required of linear correlation. These "correlation matrices" are useful approximations, but might be better described as "weighting factor matrices."

[6] Supported, perhaps, by appropriate professional opinions regarding the suitability of the model and the application to model to the company.

5. Use of own-company models, as in Solvency II Internal Models.[7]

Points 4 and 5 extend beyond the concept of RBC as currently structured, but we consider them because:

a. The analysis informs our thinking on calibration and dependencies with respect to points 1-3.

b. Those approaches might be better starting points for company development of Own Risk Solvency Assessment (ORSA).

c. While own-company models, as in Solvency II Internal Models, are not part of the current regulatory horizon in the U.S. they may become applicable in the longer term.

d. The approaches in points 4 and 5 might be useful as regulatory tools suitable for regulatory decision-making in areas such as dividend approval, merger approval, and new licensing—that is, purposes beyond the "shut-down" level produced by the RBC formula.

1.5 This report

This initial report DCWP covers the following:

Section	Content
2	RBC Design Considerations
	CURRENT METHODS
3	RBC risks and risk charges
4	Dependency
5	RBC target "safety level"
	ASSESSMENT OF ALTERNATIVES
6	RBC risk charges and calibration methods
7	RBC dependency structure and calibration methods
8	RBC safety levels
9	Mitigating Considerations
10	Next Steps
11-14	Appendices including bibliography and glossary

[7] See footnote 6.

Our analysis is based on the following:

1. Review of existing literature.
2. Consideration of Solvency II,[8] Rating Agency and ERM practices in capital modeling.[9]
3. Experience of the members of the working party.
4. New research by some working party members.
5. Results of the CAS Underwriting Risk Working Party.

1.6 Summary of DCWP Assessment to Date

Based on our work to date, we note the following deficiencies in the RBC formula, with respect to our understanding of its objectives, and we also note factors that mitigate the impact of those gaps in practice. As our work progresses, we may need to refine or even correct some of these assessments. These gaps are as follows:

A. Overall the adequacy of the RBC level is lower than the initially established level:
   1. The investment income offset in premium and reserve underwriting factors is based on 5% per annum discount in expected cash flows when current interest rates are significantly lower.
   2. Catastrophe potential is not sufficiently reflected.

B. Charges are relatively too low or too high for certain types of companies:
   3. Premium and reserve underwriting factors by line of business are not properly calibrated to the risk by line of business.
   4. Company-specific catastrophe risk is not reflected (related to point 2 above).
   5. Concentration by state or region (property,[10] liability, workers compensation) is not considered.
   6. Company size is not considered.

C. Safety level standards are not specified.

[8] We use Solvency II for comparison purpose in that Solvency II represents the results of extensive and thoughtful and analysis of capital modeling in a regulatory framework in current context. The comparison helps clarify the assumptions and methods used by NAIC RBC and Solvency II standard formulas.

[9] In making those comparisons the working party is cognizant of the difference between standard formulas, like RBC, that are applied uniformly to all companies and company specific models typical of ERM analyses.

[10] Property concentration may be sufficiently considered if the catastrophe treatment is improved.

7. There is no calibration standard to coordinate the selection of charges by risk or among the different types of risks.

D. Dependencies among risks is not properly reflected:

8. RBC includes no dependency between premium and reserve risk.

9. RBC includes no dependency between assets and underwriting risks.

E. RBC contains simplifications that do not properly reflect risk in total or differences by company:[11]

10. The "70% rule"[12] that is used in dependency by line of business for underwriting risk factors.

11. Ten percent of the ceded reinsurance credit risk charge reflects a variety of considerations.

RBC might better reflect risk by company if it allowed greater complexity.

F. There are charges that have not been updated in 20 years with indeterminate effects on the safety level implied by the RBC results.

12. Asset charges have not been reviewed since the early 1990s notwithstanding the current understanding that extreme events may have more effect than previously expected.

DCWP believes improved treatment in all of the areas listed above is technically feasible. DCWP believes the issues listed above are inter-related, but to the extent that the issues are considered separately, the importance of the issues is reflected by the ordering A, B, C... shown above.

With respect to dependency structure in the RBC formula, there are many tools for constructing aggregate distributions needed to measure dependency, but those aggregate distributions are primarily relevant in calibrating an RBC formula, but not relevant in applying RBC to a specific company.

DCWP believes that dependency structure can be applied to individual companies in an RBC formula in two ways as follows:

1. Scenario sets covering relevant risks for single or multiple tail events of interest, e.g., catastrophes, adverse loss ratios, adverse reserve developments, or adverse asset outcomes.

[11] The effect of the simplifications might be to over- or underestimate the safety level in the formula overall, or with different effects on different types of companies.

[12] The premium and reserve risk charges are adjusted for diversification or concentration though premium and loss concentration factors.

2. Sets of weighting factors (that look like correlation factors, or correlation matrices), calibrated to the tail events of interest.[13]

In either case, dependency relationships need to reflect both process risk (smaller business segments have more risk per unit of size) and parameter risk (economic, legal, and other forces create variability that is in proportion to business size). RBC and Solvency II, however, simplify the risk assessment and treat all companies as if they had the same level of process risk. In future reports, DCWP will consider the extent to which both process and parameter risk can be reflected without creating undue complexity.

To the extent that the RBC formula does not reflect difference risk levels by company, it is less effective at providing a risk-related solvency standard. Similarly, to the extent that company decisions are affected by RBC requirements, then improper setting of the RBC requirements will not support appropriate risk decisions by companies.

1.7 Mitigating Considerations

Notwithstanding these observed gaps, we note that regulatory capital management is only one element of a regulatory structure, and it can play a greater or lesser role, depending on the overall structure of the system. Even if gaps exist, the significance can be mitigated by other regulatory activities. For example, the following regulatory mitigation strategies can apply:

1. Catastrophe Risk—Regulators can, independent of capital assessment, assess company reinsurance protection including reinstatement costs and reinsurance credit risk.
2. Credit for Reinsurance—Regulators can, independent of capital assessment, verify that reinsurance risk transfer is sufficient, supporting collateral is available, if required, and provisions have been made for disputed reinsurance collections.
3. Company Size—Regulators can, independent of capital assessment, more closely supervise the company with respect to its risk approval through approval for limited lines of business, limited geography, oversight of management, rate adequacy, reinsurance arrangements, etc.

1.8 Next Steps

In the near term, DCWP plans to prepare additional reports in the following areas:

1. Description of the EU Solvency formula with respect to risks included, risk charges, dependency structure, and method of calibration.

[13] Manistre, John B., A Practical Concept of Tail Correlation, February 11, 2008, published by the Actuarial Foundation, http://www.actuarialfoundation.org/pdf/2008-practical-manistre.pdf

2. The impact and feasibility of alternative structural, calibration and dependency approaches ("what-if" testing) by applying current and possible alternative formulas to individual company data.
3. Observations based on the nature of insolvencies since RBC was implemented.

Beyond that, DCWP will:

4. Evaluate dependency structure in greater depth.
5. Further consider alternative methods of risk charge and dependency calibration, including illustrations where practical.

2. Design Features

The RBC formula is a particular type of capital model. The following table indentifies the main design decisions and our understanding of the RBC treatment in each area.

Table 2-1
Design Features for Capital Models

Design Feature	RBC Treatment
1. Intended Purpose of RBC System[14]	
1.1 "Financing a soft landing"—Prescribe a minimum capital that allows full payment of claims and other obligations with a sufficiently high probability at reasonable cost.	Primary purpose.
1.2 Protect policyholder/consumer welfare in balancing default risk against cost of higher capital requirements (or other potential impediments to innovation).	Alternative primary purpose [Similar to 1.1]
1.3 Encourage companies to manage risks.	Secondary purpose
1.4 Protect other insurers, and, theoretically, their customers, who share risk through the cost of guarantee arrangements.	Only via 1.1-1.3
1.5 Protect other stakeholders.	Only via 1.1-1.3
1.6 Prevent insolvencies.	No
2. Intended Use of RBC	
2.1 Regulatory intervention point followed by mandatory shut-down.	Yes
2.2 Management tool for risk-based decision-making, performance management, and/or company own risk solvency assessment (ORSA).	No
2.3 Regulatory permission to operate across borders (i.e., a "passport" as in Solvency II).	No
2.4 Major element in financial type regulatory decisions, e.g., dividend payment, acquisition capacity, reinsurance adequacy.	No
2.5 Rating agency assessment.	No
3. Intended Role of RBC in Regulation	
3.1 The central solvency management tool.	No
3.2 One of many regulatory tools.	Yes
3.3 The final back-stop; other mechanisms are more important.	Yes
3.4 Closely related to company risk management.	None considered necessary.
3.5 Incentives for the "right risk behaviors."	Desirable, but not a primary goal
4. Mechanism	

[14]

4.1 Standard Formula.	Yes
4.2 Standard Formula with limited own-company adjustments.	Yes, to limited degree, e.g., "50/50 rules"[15] for underwriting risk.
4.3 Own-Company model (e.g., Solvency II Internal Model).	No (note 1)
4.4 Scenario approach—RBC based on set of specified or company-selected scenarios.	No
4.5 Hybrid models (perhaps including some elements of scenario approach):	No (Note 1)
4.5.1 "Narrow"—e.g., application of approved models to measure certain risks, such as catastrophe risk.	No
4.5.2 "Broad" –e.g., standard "actuarially approved" models covering nearly all risks.	No
4.5.3 Own company model applied to specific risks (analogous to Solvency II Partial Internal Model).	No

5. Condition of Company—for Calibration purposes (Basis company)	
5.1 Assumed to be a going concern.[16]	Yes
5.2 Assumed to be a troubled company.[16]	No

6. Relationship to Accounting System	
Designed to work with statutory accounting.	Yes
Designed to work with general purpose accounting.	No

7. Other Decisions	
Applied by company or group.	By company
Judgment in selecting the structure and factors but no judgment in application of the formula.	Yes
Treatment of systemic risk.	Not within RBC system

Note (1)—For life insurance RBC, we understand that certain aspects are based on individual company models.

[15] RBC premium and reserve factors are based 50% on factors calibrated based on industry data and 50% based on the industry data adjusted by the ratio of company experience to industry experience for the most recent 10 years (if 10 years of company data is available, otherwise, there is no adjustment).

[16] RBC factors are based on data from "normal" companies, even though risk charges and dependencies may be different for company's nearing financial difficulty.

Table 2-2 below compares the design decisions for RBC, Solvency II, and rating agency capital models.

Table 2-2
Comparison of Design Decisions

Item		RBC	Solvency II	Rating Agency
1.	**Intended Purpose**	Policyholder protection/ "soft landing"	Policyholder protection	Various stakeholders depending on rating purpose—policyholders, bondholders, equity owners
2.	**Intended Use**	Minimum criteria; One of many regulatory tools— (Note 1)	Passport to operate in other (EU) countries Minimum in certain circumstances. Significant regulatory tool. (Note 1)	Financial strength assessment. One element in assessing management's ability to manage risk.
3.	**Intended Role in regulation**	One of many tools; RBC is the final backstop	A central tool To encourage company risk management	None intended (See row 4 below)
4.	**Mechanism**	Standard formula with limited own company adjustments	Mixture of : standard formula; own company factors in standard formula; partial internal model; internal model	Review of management models. Rating agency's own models.
5.	**Condition of company for calibration purposes**	Going concern	Going concern	Going concern
6.	**Relationship to Accounting System**	U.S. Statutory	IFRS	Not applicable to any balance sheet item. Capacity to meet claim paying or other financial obligations, regardless of accounting framework.
7.	**Other Decisions**	Applied by company	Applied by company and by group	Usually only applied at group level
		Judgment in selecting the structure and factors but no judgment in application of the formula.	Same as RBC	Judgment in model design and individual company assessment
		Systemic risk not addressed by this mechanism	Same as RBC	Same as RBC

NOTE 1: Solvency II—Regulatory action on issues such as dividend paying capacity, reinsurance adequacy, acquisition approval, etc., would be resolved after considering the effect on capital relative to SCR.

3. Risks and Risk Calibration

The quantification of required capital for RBC or other purposes is based on an explicit or implicit view of the distribution of possible financial outcomes, representing the aggregate effect of all the individual component risks (aggregate risk distribution or aggregate distribution). Generally the aggregate distribution is developed by first quantifying the individual risk elements and building the aggregate distribution by reflecting how the individual risks "move together." In this section we consider the individual risk elements that are typically reflected in RBC formulas.

The RBC formula identifies the following major risk categories:

Table 3-1
RBC Risk Areas

R_0	Asset Risk – Subsidiary Insurance Cos.
R_1	Asset Risk – Fixed Income
R_2	Asset Risk – Equity
R_3	Credit
R_4	Underwriting – Reserves
R_5	Underwriting – Premium

NOTES:

There are a number of rules regarding the treatment of assets including the following:

R_1 and R_2 include risk from fixed income and equity investments held by non-insurance subsidiaries.

R_2 includes real estate and Annual Statement items "other invested assets" and "aggregate write-ins for invested assets."

Table 3-2 below provides a more detailed itemization of the risks in the RBC formula and compares the risk charge approaches for RBC and Solvency II.

As rating agency models vary, we provide no comments in Table 3-2.

Table 3-2
Comparison of Basis for Risk Charges

#		Risk Element	RBC	Solvency II
1	R0	Asset Risk—Subsidiary Insurance Cos.	RBC for subsidiary when subsidiary is subject to RBC. 22.5% for U.S. subsidiaries, not subject to RBC. 50% for non-U.S. subsidiaries	Rather than a RBC charge, for subsidiaries, the company capital is reduced to avoid "double counting" capital in subsidiaries within a group. The adjustment could reduce the value to zero for the subsidiary if the EU regulators cannot obtain enough information on the financial condition and risk profile of the subsidiary.
2	R1	Asset Risk—Fixed Income, including subsidiaries that operate as investment vehicles	Assets are valued based on a mixture of market, amortized, or other statutory values. RBC charges are determined by applying a set of factors, varying by asset type and credit quality, to statement values of those assets. Factors are based on circa 1990 analysis of variability in market values and generally the same for life and P&C.	For R1 and R2 risks, Solvency II applies a scenario approach rather than a factor approach. Assets and liabilities[17] are revalued based on alternative scenarios of market conditions. The risk charge is the change in surplus, comparing surplus at current market conditions to surplus if the scenario applies. There is a specified scenario for each of the following: (a) changes in interest rates (by duration)—one change upward/one change downward. (b) change in interest rate spread between fixed income securities with different credit ratings. (c) change in foreign exchange rate between home country and each other country. (d) change in illiquidity premium (a factor that affects reserve discount). (e) fall in market value of equities, separately for equity listed on major exchanges and equities that are not listed or listed on other exchanges.
3	R2	Asset Risk—Equity, including subsidiaries that operate as investment vehicles	15% charge based on competing studies circa 1990.	
4	R2	Asset Risk—Other long-term assets, including property and property loans	Various charges. Typically the same for life and P&C.	

[17] Assets and liabilities are valued using an IFRS fair value approach including discounting of loss reserves based on current market conditions

#		Risk Element	RBC	Solvency II
				(f) fall in property values. (g) a concentration charge for assets relying on the same entity.
5	R3	Credit Risk—Reinsurance	10% of ceded balances for claims reserves and unearned premium. 10% is judgment factor reflecting various elements of reinsurance risk	Reinsurance credit is handled as follows: First, the exposure to credit risk is the sum of: a. The best estimate of the recoverable (ceded balance for unearned premium and claims), plus b. The difference between: i. The capital required, at the target safety level, for underwriting and market risk assuming full credit for the reinsurance compared to ii. The capital required, at the target safety level, for underwriting and market risk assuming no credit for the reinsurance. Then, the risk charge is the percent Loss Given Default (LGD) times the exposure to credit risk. The percentage LGD is 50% of the credit exposure. Finally, the risk charge is adjusted for: a. Collateral, where applicable, and b. The credit rating and diversification of the creditors. However, until the number of credits is substantial, there is no benefit for credit quality or credit rating.
6	R3	Credit Risk—Other than reinsurance	Judgment values, 5% for most receivables, 10% for investment income due and accrued, and no charge for agents' balances, which are subject to statutory accounting valuation rules.	The formula described for reinsurance applies to other risks classified as "non-diversified" including securitizations and derivatives, cash at banks, certain critical LOC or and other guarantees. The LGD factor, though, differs from 50% for different sources

#		Risk Element	RBC	Solvency II
				of risk. For credit risks from "diversified sources" including agents balances, small bank accounts the credit risk charge is: a. 15% of the sum of credit exposures less amounts from intermediaries overdue by more than 3 months; plus b. 90% of receivable from intermediaries overdue by 3 months or more. The diversified and non-diversified credit risk charges are combined, assuming a 75% correlation, to produce the total credit risk charge.
7	R4/ R5	Underwriting – Reserves and Premium	Premium and reserve factors applied to year-end reserves and latest year written premium, respectively, net of reinsurance.	Reserve factor applied to technical provisions, which include unpaid claims and unearned premium, net of reinsurance. Premium factor applied to the expected future year's net written premium, but not less than the maximum of the actual prior year written or earned premium.
8	R4/ R5	Value of future investment income on assets corresponding to loss and loss adjustment expense reserves (discount)	Assumed 5% interest rate and industry payment pattern by line of business. 5% selected circa 1990 when embedded yields were greater than 5%.	Technical provisions valued on discounted basis. Reserve risk and unearned premium risk is therefore independent of investment income issues. Premium factors are applied as if risk is net of investment income.
9	R3/ R4/ R5	Treatment of reinsurance	Risk mitigation from reinsurance is reflected in that:	
			1. Risk charge percentages are calibrated to risk net of reinsurance.	Charges calibrated to risk gross of reinsurance (but net of catastrophes, which is handled separately).
			2. Risk charges are reduced, in effect, because percentages are applied to premium and reserve net of	Same as RBC

#		Risk Element	RBC	Solvency II
			reinsurance premium.	
			All types of reinsurance (quota share, excess, other) are treated the same.	There is an optional adjustment to give more credit, per unit (e.g., Euro) of gross claims, for excess insurance than for quota share reinsurance.
10	R4/ R5	Growth—feature affecting underwriting risk	Reserves—Yes Premium—Yes A percentage based on growth in excess of 10% per year.	An operational risk charge applies if forecast premium exceeds 110% of prior year premium. (Charge = 3% times forecast premium less 110% of prior year premium) Applies as if added to R0 rather than as addition to R4/R5
11	R4/ R5	Size of Company—feature affecting underwriting risk	No—charge percentages are the same for all companies, regardless of size. RBC amount increases with size of company.	No—same as RBC; geographic diversification gives some benefit to larger companies.
12	R4/ R5	Loss Sensitive Premium—feature affecting reserve risk	Yes—otherwise applicable risk charge is reduced based on study circa 1995.	No provision for P&C loss sensitive contracts, which are less common in the EU than in the U.S.
13	R4/ R5	Use of own-company data for risk charges	50/50 rule for underwriting risk	Allows use of own-company risk charges, partial internal models and full internal models.
14	R5	Catastrophe risk	Implicit in net premium risk charges	Explicit— Formula provides a set of specific disaster scenarios and requires companies to extend that if necessary. Company-specific reinsurance mitigation is applied to the gross disaster scenarios. Where a company cannot apply the disaster scenarios, the formula provides maximum gross loss ratios by line of business as an alternative. Company-specific reinsurance is applied to the loss ratio scenarios.
15	NA	Unearned Premium (UEP)	No charge. As there is no Statutory Accounting credit for Deferred Acquisition Costs, there is an automatic safety margin.	Not directly applicable as financial reporting is on written premium basis, i.e., unpaid claims includes unpaid for all "written" risks and

#		Risk Element	RBC	Solvency II
				profit/loss on "unearned" business in parted of reported profits.
16	NA	Operational Risk	Not treated	Yes. Operation risk charge is the smaller of (a) 30% of SCR before operational risk and (b) greater of (b-i) (3% EP+ growth charge) and (b-ii) 3% of technical provisions.[18]
17	NA	Group risk—from parent, affiliates, and subsidiaries (not reflected as asset risk)	No charge.	No charge
18	NA	Assumed financial reporting regime	Based on U.S. Statutory (SAP)	Based on IFRS.
			There are many differences between SAP and IFRS. Among the significant differences is that IFRS surplus is higher than SAP surplus are: 1a. IFRS Technical provisions are discounted; 1b. profit in unearned premium is effectively part of surplus. 1c. (1a) and (1b) are offset, usually, in part, in that reserves include an explicit risk margin. IFRS surplus is also higher than SAP surplus because of other conservative measures included in SAP: 3. Limited credit for uncollected salvage and subrogation 4. Schedule F penalties 5. Agents balances "written off" after 90 days IFRS values all assets at market or fair value. SAP values some assets at amortized costs, historical cost, or other specified values. SAP values might be higher or lower than IFRS values.	
19	NA	Role of judgment in determining the RBC amount	Only in model design and calibration.	In model design and calibration; Judgment also permitted in Internal Model, Partial Internal Model, or Own-Company Risk charges, if properly controlled by company and approved by regulator.

[18] Premium plus claim reserves discounted for interest plus a added risk margin

#		**Risk Element**	**RBC**	**Solvency II**
20	NA	Systemic risk beyond the scope of single company RBC.	Not considered in RBC formula.	Not considered in solvency capital required.
21	NA	Group issues	No assessment of group capital requirements.	Each company must have adequate capital on its own. In addition, RBC is calculated for groups. Group RBC reflects the degree of concentration or diversification within the group.

4. Dependency Structure

In this section we discuss the manner in which the individual risks "move together" to form the aggregate risk distribution from which capital requirements are derived. The manner in which the risks "move together" can be called dependency (or dependencies). We use the term "dependency" rather than the often used term "correlation" because correlation is often interpreted as linear correlation, which describes a specific kind of dependency that may not be appropriate for insurer risk-based capital requirements.

4.1 RBC structure:

The combined RBC is the result of the covariance formula:[19]

RBC = R0 + square root $[(R1)^2 + (R2)^2 + (R3')^2 + (R4')^2 + (R5)^2]$

The treatment or R0 is equivalent to setting the subsidiary company RBC as if the subsidiary is identical to the parent company in risk structure, although varying by size. The treatment produces more parent company RBC than any other risk structure assumption for the subsidiary.[20]

There are four levels of regulatory action depending on the relationship between the "adjusted surplus" held by the company and the "risk-based capital" value as follows:

(1) Company Action Level (CAL), at which point a company must submit a plan to improve its capital position (CAL = 2.0 * CAL = RBC)

(2) Regulatory Action Level (RAL), at which point the insurance commissioner will issue an order specifying corrective actions (RAL = 1.5 * ACL = 0.75*RBC)

(3) Authorized Control Level (ACL), at which point the insurance commissioner is authorized to take action to protect the interests of policyholders and creditors of the company, including action to place the company under regulatory control (ACL = .5*RBC)

(4) Mandatory Control Level (MCL), at which point the company is authorized to place the company under regulatory control. (MCL = .7*ACL = .35*RBC)

Within those rules the following dependency rules are reflected:

[19] In the above formula, R3 and R4 are adjusted. Usually half of the R3 resulting from reinsurance credit risk is added to R4, giving R4´. And R3´ is half the remaining reinsurance credit risk plus all other credit risk. In the unusual case in which R3 for reinsurance credit risk is greater than R4, then R3 and R4 are not adjusted in this way.

[20] This treatment may also be intended to address that risk that fungibility of funds between companies within a group is sometimes limited, especially in times of financial or other business stress.

In R3 and R4: Premium or loss concentration adjustment—70% rule in combing lines of business in Premium and Reserve Risk.

In R1: Bond concentration adjustment

In R2: Equity concentration adjustment

In all other respects, the covariance formula treats risks as independent, i.e., having zero dependency.

4.2 Solvency II Structure

The main elements of Solvency II dependency structure and comparative comments relative to RBC are as follows:

A. Within Underwriting Risk Solvency II has:

1. A correlation matrix describes the dependency between each pair of the 12 lines of business identified in the Solvency II framework.

   This addresses the same concentration / diversification issue as the 70% rule in RBC.

2. Within each line of business the correlation between reserve risk and premium risk for each line of business is 50%.

   RBC treats premium and reserves as independent risks.

3. There is a credit for diversification across major geographic areas by line of business for premium and reserve risk separately, applied prior to application of correlation between premium and reserves, item 2 above. This is expressed with a formula similar to the RBC 70% rule.

   RBC contains no adjustment for concentration or diversification of risk by region.

4. Correlations between normal and catastrophe claims by line of business.

   RBC includes catastrophe risk charge and dependency between normal and catastrophe claims implicitly in the premium risk charge.

B. Within Market Risk Solvency II has:

5. Correlations between components of market risk—interest, equity, property, etc.

   RBC treats fixed income and equity asset risks as independent.

C. Between non-life underwriting risk and other risks Solvency II has:

6. Correlations between market risk and underwriting risk in nonlife, life, and health risk business segments, for companies with more than one of nonlife, health and life business segments.[21,22]

   RBC treats market risk as independent of underwriting risk.

   In the U.S. life, health and P&C businesses are often placed in different companies, and RBC, through R0, assumes the parent and subsidiary risks are 100% correlated even if they operate in these different types of business.

[21]Market and underwriting correlation applied only if the correlation is positive. Zero is used if expected correlation is negative.

[22] In the U.S., while health and casualty may be in the same company, generally life, nonlife, and health are underwritten in different companies. If the companies are affiliated, the R0 risk assumes the different types of insurance risks are 100% correlated.

5. Safety Levels

Table 5-1 below indentifies the main decisions in the selection of safety levels in the RBC system and compares those decisions to decisions in Solvency II and Rating Agency models.

Table 5-2
Comparisons of Safety Margin Specifications

Item	RBC	Solvency II`	Rating Agency
Time Horizon – Premium	One year of earned premium as if no UEP[23] risk (or risk included elsewhere)	Written basis – risk arises from UEP and one year written premium	Going concern
Time Horizon – Claim Reserves	Runoff	One year including risk margin at the end of the year	Going concern
Safety level structure	Implicit	VAR	Various – usually explicit
Safety level margin	Implicit	99.5%	Various – usually explicit

[23] In RBC there is no risk charge for unearned premium (UEP). A rationale is that under SAP there is a risk there is no credit for deferred expenses, and under that treatment, generally, there is no remaining risk of inadequate UEP.

6. Assessment—Risks and Risk Charge Calibration

6.1 Evaluation of Current Situation

With respect to each of the risks and calibration approaches described in Sections 3, the types of gaps that might exist are:

1. The overall RBC charge is not at the intended level.
2. Charges by company are systematically above/below the intended level, even if the overall charge is at the intended level.
3. Calibration is deficient in some respect other than the above.
4. Calibration might be correct, but it has not been reviewed since the initial RBC formulation.
5. There are risks for which there are no risk charges.
6. The risk is not measured in the same way that a company would typically assess its risks (e.g., ERM) thereby creating an unnecessary difference between regulatory and company (and probably rating agency) risk assessment.

Table 6-1 below summarizes DCWP view of the gaps in the current risk selection calibration. It is listed in a priority order, called "rank" as shown in the first column. The ranking incorporates DCWP view of the significance of the gaps and the feasibility of correcting those gaps. All risks for which the only "gap" is "not current" (type 4) are listed at the end of the table.

Table 6-1
Assessment of Risk Selection and Calibration

Rank	Item #*	Risk Element	Gap	See Note
1	8	Value of future investment income on assets corresponding to loss and loss adjustment expense reserves and future premium (Investment Income Offset or IIO)	1 – Overall charge too low 4 – Calibration is not current	URWP
2	14	Catastrophe risk	1- While there are offsets because cats are implicitly included, overall there is a shortfall 2- Shortfall larger in some companies than others 3- Calibration method can be improved. 4- The method is inconsistent with the way a company would assess the risk (cat models).	A
3	7	Underwriting—Reserve and Premium—Factors	3 - Calibration method can be improved	URWP
4	5	Reinsurance credit risk	1 - 10% factor likely too high 2 - Charges do not fit individual company circumstances; do not reflect differences between types of reinsurance, e.g., quota share vs. excess. 3 - Calibration method can be improved.	B
5	9	Treatment of Reinsurance	2 - Does not reflect differences between companies with different reinsurance programs	C
6	1	Asset Risk—Subsidiary Insurance Cos	3 - Calibration can be improved	D
6	2	Asset Risk—Fixed Income	2 - Charges do not fit individual company circumstances regarding asset duration relative to liability duration 3- Possibly calibration can be improved 4- Calibration not current	E
6	3	Asset Risk—Equity	3 - Possibly calibration can be improved 4 - Calibration not current	E
7	11	Size of Company—feature affecting reserve and premium risk	2 - No charge currently	F
8	15	Unearned Premium (UEP)	2 - Charge might be low for some (low expense) companies	G
9	10	Growth—feature affecting reserve and premium risk	4 - Calibration is not current	H
9	12	Loss Sensitive Premium—feature affecting reserve and premium risk	4 - Calibration is not current	H
10	4	Asset Risk—Other long-term assets	4 - Calibration is not current	E
9	12	50/50 Rule	Never tested for relevance	H
10	6	Credit—Other than reinsurance	4 - Calibration is not current	H
11	16	Operational Risk	1 - No charge currently	F
12	17	Group risk—from parent, affiliates, and subsidiaries not reflected as asset risk or R0	1 - No charge currently	F

*Order in which listed in Table 3-2.

Brief comments on the basis for these assessments are provided below:

Table 6-2
Notes on basis for assessment in Table 6-1

Item	Comments
URWP	**Underwriting Risk Working Party report—**reserve and premium factors and future investment income offsets
A	**Catastrophe Risk—**DCWP believes there is a shortfall in part because of increasing population and property density in catastrophe exposed areas is not reflected in historical data; in part because the calibration of UW factors may exclude some of the historically observed risk; and in part because terrorism risk in not included.
B	**Risk Mitigation and reinsurance credit risk—**DCWP believes the current factors represents risk perception relevant in early 1990s but does reflect current conditions including actuarial opinions on gross reserve, actuarial opinion reporting on financial reporting, CFO/CEO attestation regarding reinsurance risk transfer, nor available modeling capabilities.
C	**R3/R4/R5-Reinsurance Ceded—**Net risk is lower than gross risk. The reduction is determined as if all companies had equivalent reductions in risk per dollar of premium (R5) or dollar of unpaid claims (R4). We expect there are differences by company in reinsurance strategy that affect required capital.
D	**R0 risk—**The current method is a practical simplification but might be improved. Treatment as reduction to capital rather than add-on to risk charge might be considered.
E	**Fixed Income, Long term assets, Other long term assets—**The calibration is not current and conditions have changed since establishing these charges.
F	**Company size, Operational risk, Group risk, from parents and affiliates not reflecting in R0 or asset risk—**No charge.
G	**Unearned Premium—**The current approach may be too conservative for most companies and too low for low-expense, high-risk companies. Does not reflect differences between companies in distribution by line of business.
H	**Growth charge, Loss sensitive premium, Credit risk other than reinsurance, 50/50 rule—**The calibration is not current and conditions may have changed since establishing these charges.

6.2 Possible Improvements in risks and risk charge calibration

Table 6-3 describes a number of ways to address the gaps identified in Table 6-2 above. These options include:

1. Updated calibrations of risk charges.
2. Calibration based on data from new sources.
3. Use of scenarios rather than factors to determine the RBC charge.
4. Application of charges at a greater level of detail than now applicable.

Table 6-2 below identifies alternative data and calibration approaches.

Table 6-2
Alternative Calibration Approaches

Item	Calibration Approach
IIO offset	Consider method that allows factors to vary over time, reflecting current interest rates for premium risk and movements in current average returns on assets for reserve risk.
	Consider patterns based on actuarial analysis rather than IRS payment patterns.[24]
	Consider a risk measurement that considers the effect of changes in difference between (a) discounted reserves and (b) assets at market value, at specified scenarios(s) of interest rates, by duration , rating quality, etc.
Catastrophe risk	Consider use of catastrophe modeling results.
	As alternative and/or supplement for hard-to-model risks, consider Realistic Disaster Scenarios, specified by regulator or by company.
UW factors (premium and reserve)	Consider results of a principles-based actuarial analysis of premium and reserve risk reflecting a variety of methods, data sources, and appropriate professional judgment, including factors such as the approaches described in the boxes below:
	Model-based distributions of variations in loss ratio or reserves.
	More extensive schedule P analysis—more years; company group rather than company Schedule Ps, etc.
	The proper weighting of companies within the risk factor (currently weighted equally by company rather than weighted by size of company or other choice method to develop the appropriate risk charge when there are different size companies within the data set).
	Use of data beyond that available in the Annual Statement, for example line of business segmentation more refined than that available in Schedule P.
	Common Shock Models (e.g., loss ratio and loss reserve variability driven by movement in interest rates that relates to movement in medical and other insurance-related expenses). Use Economic Scenario Generators (ESGs) or other tools to develop inflation models to "drive" the common shock models.
	Calibration including an underwriting cycle model to supplement/replace empirical observation of underwriting cycle effects.[25]

[24] The IRS approach is used for all lines other than workers compensation and reinsurance liability.
[25] http://www.risklighthouse.com/papers/2011%20ERM%20Symposium%20Paper%203_22_11.pdf

Continued—[UW factors (premium and reserve)]	Calibration to reflect geographic diversification or concentration, beyond catastrophe effects, e.g., for workers compensation, automobile, medical malpractice, and other liability lines.
	Evaluate the extent to which the current reserve position of the industry or individual companies might be assessed and this information used to adjust RBC charges.[26]
	Assess whether the 50/50 rule is appropriate and where there are alternative ways to reflect differences by company.
	Other recommendations from URWP.

Reinsurance—Mitigation effectiveness and credit risk	Actuarial analysis of various elements of reinsurance risk, including extent of risk transfer, risk of reinsurance disputes, risk of reinsurer default.
	RBC reflects premium and reserve risk net of reinsurance and then considers the risks associated with ceded reinsurance. Alternatively, the risk could be assessed gross of reinsurance and the benefit of reinsurance allowed depending on the type of reinsurance and then the risk of ceded reinsurance considered. Consider alternatives such as that.

Risk Transfer	Effect of risk mitigation by type of reinsurance, e.g., quota share vs. excess vs. aggregate.

Risk Transfer	Company models of risk transfer effectiveness.

Credit Risk	Reinsurer credit quality information—from financial markets, credit agencies, or otherwise.

Assets: Fixed Income, Equity, Other long term assets	Update risk factors based on up-to-date economic scenario generators and in light of experience in the past 20 years.
	Consider the use of scenarios rather than factors. Measure the effect of changes in interest rate on the company's actuarial portfolio, probably best if done relative to the company liability duration.
	Evaluate the risk measures appropriate when variability on market values is the available data, but assets have an amortized value or other statutory non-market valuation basis.
	Consider foreign exchange and other fixed income risks to the extent those are relevant to the company.

Assets: Subsidiaries	Consider market value of subsidiaries, or fair value when market is not available, as assessing risk charge so that the combined charge for R0 and statutory accounting do not overstate risk of subsidiaries.

[26] This is a feature in some rating agency models, but not typical of standard formulas.

	Non-insurance subsidiaries may pose risks from their operations that are beyond the risk of default with by RBC. Consider the extent to which such risks can be reflected in RBC (see also group risk).
	Effect of addressing "R0" risk by adjusting capital rather than adding R0 to RBC.

Operational Risk	Identify ways to utilize operational risk databases.

Group risk	Membership in an insurance group creates risks for subsidiaries, affiliates, and parents beyond those reflected in RBC formulas. Consider the extent to which such risks can be reflected in an RBC formula.

Company/Line of business size	Actuarial analysis of the nature of risk vs. size.
	Consider the effect of "age" and homogeneity or risks as well as "size," as those other factors may be more important than size.
	Lines of business with low premium are more subject to process risk than lines of business with higher premiums companies. That fact means that for low premium businesses or segments, individual risk charges are higher, but that might partly offset by increased effect of diversification.

Growth	Update the factors with current data.
	Consider whether growth charge should be combined with underwriting risk or treated in R0 or elsewhere in the formula.

Loss Sensitive Contracts	Update the factors with current data.

Unearned Premium	Consider evaluating the extent to which profit implicit in UEP might differ by company to increase or decrease the otherwise applicable RBC.

Role of judgment	Consider the extent to which expert judgment should play in the selection of factors. [For a factor-based model like RBC, judgment has limited, if any, role in the application of the formula.]

7. Assessment—Dependency Structure and Calibration

There are many tools[27] available to construct aggregate risk distributions that describe in detail how risks "move together." The aggregate risk distribution might be expressed as a formula or as the result of random simulation of possible future events and the resulting financial outcomes for the business.

These aggregate distributions are most useful for testing multiple risk levels and multiple risk measurements (VaR, TVaR, etc., at levels of 1/10, 1/50, 1/100, 1/250, etc.) as might be useful in testing capital adequacy for business strategy, in making reinsurance purchasing decisions and the like. For RBC, however, once a safety level and safety measure is selected, the risk charges are needed only at the selected risk level. As such, the aggregate distribution and simulation approaches are primarily relevant in calibrating an RBC formula, but not relevant in determining company-specific RBC.

Rather, the dependency structure can be applied to individual companies in two ways:

1. Scenario sets covering relevant risks for single or multiple tail events of interest: catastrophes, adverse loss ratios adverse reserve events, adverse asset outcomes, etc.
2. Sets of weighting factors (that look like correlation factors, or correlation matrices), calibrated to the tail events of interest.[28]

In either case, dependency relationships need to reflect both process risk (smaller business segments have more risk per unit of size) and parameter risk (economic, legal, and other forces create variability that is proportion to business size). RBC and Solvency II, however, simplify the risk assessment and treat all companies as if they had the same level of process risk. In future reports, DCWP will consider the extent to which both process and parameter risk can be reflected without creating undue complexity.

This section evaluates the current dependency structure and calibration methods and then discusses alternative dependency structures and calibrations methods.

[27] The creation of aggregate risk discussion uses tools like copulas, common shock models, Iman-Conover methods, etc. New tools and new methods to apply the tools continue to emerge.

[28] Manistre, John B., A Practical Concept of Tail Correlation, February 11, 2008, published by the Actuarial Foundation, http://www.actuarialfoundation.org/pdf/2008-practical-manistre.pdf

7.1 Evaluation—Dependency Structure

Some of the most significant differences between the RBC and Solvency II dependency structure are in the following areas:

1. RBC does not measure geographic concentration.

   RBC risk factors have been derived largely from companies that are diversified across geography, and RBC assumes all companies are equally diversified geographically with respect to reserve and premium risks.

2. In RBC, premium risk and reserve risk (R4 and R5) are assumed to be independent of each other.

3. In RBC, underwriting risk (R4, R5) and asset and market risk (R1, R2) are assumed to independent.

4. RBC uses the 70% rule the measure diversification across lines of business. Solvency II uses a "correlation matrix" that describes how each pair of business lines "moves together."

These items represent simplification in the RBC formula. Items 1-3 probably understate the RBC required for all companies, for a given level of security. The current 70% rule might either over or understate the RBC..

Neither RBC nor Solvency II considers a number of factors, for example, variations in correlations between premium and reserves by accident year or between assets and particular lines of business (driven by common relationship to inflation).

7.2 Evaluation—Dependency Calibration

For both RBC and Solvency II, the correlation factors are constructed primarily from judgments regarding the nature of the relationships in extreme conditions.

For RBC the correlation factors are generally 0% or 100%. For Solvency II the "correlation matrix" values are always 0%, 25%, 50%, 75%, or 100%.

7.3 Possible Improvements—Dependency Structure

Areas of possible improvements to the RBC dependency structure include the following:

1. Address the simplifications 1-4 (Section 7.1) in RBC dependency structure, including the use of more extensive weighting or "correlation" matrices.[29]

[29] Correlation matrices can be implemented readily in spreadsheets like Excel.

2. Apply correlation arrangements to more detailed levels of risk factors, e.g., assets correlated more strongly to workers compensation reserves than personal automobile reserves or equity risk greater for companies with faster paying claim obligations (property) than for companies with slower paying obligations (liability), various risks affected by company size, premium risk related to reserve risk differs by accident year age, etc.
3. Assess the extent to which process risk (size related) and parameter risk (affecting all size) can be reflected in risk charges and dependency while maintaining the desired level of simplicity/complexity in the RBC formula.

7.3 Possible Improvements—Dependency Calibration

While RBC and Solvency II dependency relationships have been calibrated primarily through judgment, other methods include:

1. Modeling historical data with attention to unusual events.
2. Modeling the relationship between common drivers like interest rate driving inflation rates that affect premium and reserve risk (common shock models).
3. Determine calibrations based on integrated aggregate risk models expressed in formulas or simulation.

8. Assessment—Safety Levels

8.1 Specifying the Safety Level in the RBC Formula

As described in Section 5, the current RBC formula does not set an explicit target overall safety level.

As such, it is difficult to assess whether a particular risk margin is appropriate. The key decisions required to specify a target level, the degree to which RBC includes a specification and alternative decisions are shown in table 8.1 below.

Table 8-1
Safety margin Specifications

	Feature	Alternatives	RBC Approach
1	Time horizon—new business	No new business One or two years Long-term going concern (Also treatment of unearned premium, to the extent relevant in the underlying accounting system.)	1 year
2	Time horizon—claims	One year, including reserve risk at the end of the year Run-off	Run-off
3	Safety margin structure	Explicit (e.g., solvency 99.5%) Implicit (e.g., RBC) Mixed, different for different risk elements	Not explicit. Enough RBC to fund a "soft landing" is one cited description
4	Safety margin metric	VaR or TVaR, i.e., expected chance of failure vs. expected cost of failure.	Implicit (Note 1)
5	Safety level	Say, 5%, 1%, ½% VaR; or 10%, 2% 1% Tail VaR	Implicit (Note 1)

Note 1: The current RBC formula was set with explicit safety levels assigned to certain, but not all, risk factors. For example, underwriting factors in the recent revisions were based on an 87.5% chance that actual results will not exceed the expected value plus the risk charge.

As such, it is difficult to assess whether a particular risk margin is appropriate.

8.2 Other Issues

There are a number of issues that are not addressed directly, if at all, by current RBC systems, and which will not be addressed by our work. These include the following:

1. Systemic Risk
2. Relationship to Guarantee Arrangements
3. Real-world effects of higher capital standards.

Systemic Risk

If 1% failure rate might be acceptable if it means 1% of companies fail each year; a 1% chance that 5% or 10% or more of the industry fails in a year, due to systemic effects, would be far less acceptable. Two sources of systemic risk are:

1. There is a concentration of ceded reinsurance risk with a small number of major reinsurers. A 1% failure rate among reinsurers, particularly if resulting from an event like a catastrophe, could trigger a number of failures among other companies.
2. With the underwriting cycle, reserve and premium risk can become highly correlated across companies and further concentrated within the reinsurance industry.

Setting Safety Levels—Unintended Consequences

Company actual capital will often be set to give management sufficient confidence that surplus will not fall below the level prescribed by regulation. Thus, an increase in regulatory capital levels can lead to an increase the held capital, even if regulatory capital is well below the held capital, and even if the held capital is sufficient for policyholder protection. The result can be unnecessary excess capital within in the industry.

Relationship to Guarantee Arrangements

The existence of guarantee arrangements shifts the cost of insolvency from individual consumers to all consumers (through premiums charged by remaining solvent insurers).

We understand that RBC safety levels are not intended to consider that effect, partly to avoid cost shifting and partly because not all consumers are covered. Solvency II and Rating Agency approaches also do not consider the existence of guarantee arrangements.

9. Mitigating Considerations

Notwithstanding these observed gaps we note that regulatory capital management is only one element of a regulatory structure, and can play a greater or lesser role, depending on the overall structure of the system. Even if gaps exist, the significance can be mitigated by other regulatory activities. For example, the following regulatory mitigation strategies can apply:

1. Catastrophe Risk—Regulators can, independent of capital assessment, assess company reinsurance protection including reinstatement costs and reinsurance credit risk.
2. Credit for Reinsurance—Regulators can, independent of capital assessment, verify that reinsurance risk transfer is sufficient, supporting collateral is available if required, and provision has been for disputed reinsurance collections.
3. Company Size—Regulators can, independent of capital assessment, more closely supervise the company with respect to its risk approval through approval for limited lines of business, limited geography, oversight of management, rate adequacy, reinsurance arrangements, etc.

10. Next Steps for DCWP

In the near term, DCWP plans to prepare additional reports in the following areas:

1. Description of the EU Solvency formula with respect to risks included, risk charges, dependency structure and method of calibration.
2. The impact and feasibility of alternative structural, calibration and dependency approaches ("what-if" testing) by applying current and possible alternative formulas to individual company data.
3. Observations based on the nature of insolvencies since RBC was implemented.

Beyond that, DCWP plans to:

4. Evaluate dependency structure in greater depth than in this report.
5. Further consider alternative methods of risk charge and dependency calibration, including illustrations where practical.

11. Working Party Charge

Working Party Charge as requested by American Academy of Actuaries—September 30, 2010, is as follows:

> **CAS Dependency and Calibration Working Party: Project A:**
>
> **Research geared toward developing a solvency monitoring framework appropriate for the U.S., with a specific emphasis on (1) capturing risk interdependence and (2) proper calibration of RBC formulas.**
>
> This analysis will include validating the existing ways of capturing risk dependence in RBC frameworks and/or the development of new approaches. Calibration of RBC formulas involves careful choice of appropriate risk metrics. You may find it useful to examine the work already performed by our Committee, which we would be pleased to provide, as well as developments in other countries.
>
> The analysis need not be limited to the risks already reflected in the current RBC formula in the U.S. or the interdependence of these risks. Other risks, including those that are not directly captured in the current formula, may be taken into account.
>
> In developing a general framework for capital requirements, including methods of measuring risk interdependence, our preference is to use methodologies that may also be applied in the analysis of life and health insurance companies.
>
> We ask that the research support provided by the CAS incorporate evaluating alternative approaches, including the identification of their strengths and weaknesses, and quantitative illustrations of possible application of alternative approaches. This research is focused on solvency monitoring by regulators, which may present constraints not found in internal company modeling performed as part of enterprise risk management and capital optimization.
>
> The Academy P/C RBC Committee intends to use the results of this research to assist it in replying to the request from the NAIC to provide:
>
> *Recommendations for improving the correlation/covariance methodologies used in RBC, including the merits of replacing current formulas with correlation matrices and also the extent to which improved correlation/covariance methodologies developed by the Academy's P&C RBC Committee and Health Solvency Working Group may be applicable to Life RBC.*

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13. Glossary

50/50 rule	RBC premium and reserve factors are based 50% on factors calibrated based on industry data and 50% based on the industry data adjusted by the ratio of company experience to industry experience for the most recent 10 years (if 10 years of company data is available, otherwise, there is no adjustment).
70% Rule	For premium risk the concentration factor is 70% plus 30% times (1- premium for largest line of business/total premium). For reserve risk the concentration factor is the same formula using reserves.
ACL	Authorized control level
APD	Automobile physical damage
AY	Accident year
DAC	Deferred acquisition cost
DCC	Defense and cost-containment expense
DTA	Deferred tax asset
DCWP	Dependency and Calibration Working Party
ERM	Enterprise Risk Management
ESG	Economic Scenario Generator
IFRS	International financial reporting standards
IIO	Investment income offset
Internal Model	A risk management system including a capital calculation tool used to determine SCR, replacing the SCF
LGD	Loss Given Default, a term used in credit risk analysis.
NAIC	National Association of Insurance Commissioners
ORSA	Own-Risk Solvency Assessment
Partial Internal Model	A company model replacing the SCF for certain risks.
RBC	Risk Based Capital formula of the NAIC
Scenario Approach	Recalculation of financial statement position based on specified set of assumptions, for example regarding catastrophes, change in interest rates, or operation of reinsurance programs.
SAP	Statutory Accounting Practices
SCF	Standard Formula, or Standard Capital Formula A formula for determining SCR under Solvency II as distinct from internal models for determining SCR
SCR	Solvency capital required, produced by either the SCF, and Internal Model or combination of those tools, as approved by relevant regulatory authority
Solvency II	EU regulation and related implementing measures
UEP	Unearned premium
URWP	Underwriting risk working party