NAIC PROPERTY/CASUALTY INSURANCE COMPANY RISK-BASED CAPITAL REQUIREMENTS

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Abstract

The risk-based capital requirements adopted by the NAIC in 1994 are a major advance in the solvency regulation of property/casualty insurance companies. The components of the risk-based capital formula are grounded in actuarial and financial analyses of the risks faced by insurance companies and of the capital needed to guard against those risks.

The intricacy of the risk-based capital formula, the manifold considerations that shaped it, and the lack of explanation provided by the NAIC make the new capital requirements difficult to follow. This paper leads the reader through the formula, illuminating its workings and its rationale.

The paper first takes the reader through the components of the risk-based capital formula, as well as the "covariance adjustment" connecting them. The emphasis is on the development and justification of the charges, not simply on the accounting entries needed.

Casualty actuaries were instrumental in developing several components of the risk-based capital formula: the covariance adjustment, the offset for claims-made business, the offset for loss-sensitive contracts, the treatment of workers compensation tabular loss reserve discounts, and the additional charges for rapidly growing companies. In discussing the actuarial considerations in these five issues, the paper demonstrates how actuarial science has major practical implications for insurance regulation.

To be effective, the risk-based capital formula must be combined with statutory enactments empowering regula-

tory officials to take action against financially distressed companies. The paper explains the "action levels" in the NAIC Risk-Based Capital Model Act, as well as the various potential uses of the risk-based capital results.

The paper concludes with a fully documented illustration, showing how the Annual Statement figures are used to determine the risk-based capital ratio.

Expertise leads to authority. By fully understanding the NAIC capital requirements, casualty actuaries will be more qualified to suggest modifications in future years, as well as to develop their own models and standards for insurance company solvency monitoring.

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1. INTRODUCTION

Risk-based capital (RBC) standards for property/casualty insurance companies were adopted by the National Association of Insurance Commissioners (NAIC) in December 1993, effective for the 1994 and subsequent Annual Statements. Casualty actuaries were instrumental in developing the risk-based capital formula, and they are likely to be involved in determining capital strategies for their employers and clients.

Documentation of the risk-based capital formula has lagged behind its development. This paper explains the workings of the risk-based capital formula: the risks that are measured, the quantification techniques, and the actuarial or financial rationale for each component of the formula. Where appropriate, this paper discusses the arguments for and against various risk charges, and it explains the NAIC resolution of each controversy.

Instructions, Examples, and Analysis

Documentation of the NAIC risk-based capital formula comes in three varieties: instructions, examples, and analyses.

Instructions: Companies completing their risk-based capital report must know what numbers to enter on each line. This paper is not intended to serve this function. Rather, the official instructions for completing the report are found in the "NAIC Property/Casualty Risk-Based Capital Report, Including Overview and Instructions for Companies" (hereafter, *NAIC Instructions*), which is updated each year. If there are any discrepancies between this paper and the *NAIC Instructions*, the *NAIC Instructions* obviously govern.

Examples: Ambiguities in the risk-based capital formula are often resolved by clear examples. This paper includes exhibits for a simulated property/casualty insurance company to illustrate the workings of the risk-based capital formula.

Analyses: In-depth analysis of the risk-based capital charges may be found in the minutes of the NAIC Risk-Based Capital Working Group (NAIC Working Group), in the reports of the American Academy of Actuaries Task Force on Risk-Based Capital (AAA Task Force), and in the NAIC *Research Quarterly*. Many of these reports are difficult for outsiders to understand, since they presume a thorough familiarity with the topic at hand. This paper provides clear descriptions of the actuarial rationale for each charge in the NAIC formula and of the considerations involved in the development of the formula. The

instructions and examples in this paper are secondary to the "analysis."

2. TYPES OF RISK

The property/casualty risk-based capital formula was developed from the corresponding life insurance formula. The life insurance formula groups risks into four categories, C-1 through C-4, which correspond roughly to asset risks, underwriting risks, interest rate risk, and other risks.

This structure was most evident in the first draft of the property/casualty formula, which was released in April 1991 [36], and it is retained in the NAIC "Risk-Based Capital Model Act."[1] The desire to have similar capital charges for life, health, and property/casualty insurers is referred to as a "seamless" capital requirement. In other words, the capital required to protect against any risk should not depend on whether the company is licensed as a life insurer or as a property/casualty insurer.

- For asset risks, which were considered similar for life and property/casualty companies, the capital charge was adopted without modification from the life formula, and the statistical analysis for the charges was done by the life actuarial advisory committee.[2]
- Underwriting risks are entirely different between life and property/casualty products. The property/casualty capital charges were developed by the NAIC Working Group and by the New York Insurance Department staff [33].
- Interest rate risk was not considered in the first draft of the property/casualty formula, though proposed capital charges have since been recommended by the AAA Task Force.

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[1] See NAIC Risk-Based Capital Model Act, Section 2.C on pages 312-3 through 312-4.

[2] The major qualifications to this statement are that (i) the default risk charges for category 3, 4, and 5 bonds and (ii) the market risk charges for unaffiliated common stocks are half as large in the final property/casualty formula as those in the life formula. (The rationale for this difference is explained later in this paper.)

- The most important of the "other risks" is the credit risk charge for reinsurance recoverable.

A second draft of the formula, with significant changes from the earlier version, was released in June 1993, and it was adopted by the NAIC in December 1993 after several revisions. The most important change was the incorporation of a "covariance adjustment," which necessitated a different structure for the capital charges. For instance, "asset risks" were divided into three categories: (i) unaffiliated fixed-income investments; (ii) unaffiliated equity investments, which were assumed to be independent risks; and (iii) affiliated investments, which did not enter the covariance adjustment at all. (See below for full treatment of the covariance adjustment.)

The risk-based capital requirements were first effective for the 1994 Annual Statement. Minor modifications continue to be made to the formula, though there are few significant differences to date between the 1994 and the subsequent formulas.

This paper presents the risk-based capital formula as adopted in December 1993, with emphasis on the evolution of several of these charges. When appropriate, the paper comments on a few formula modifications that have been made since the initial adoption.[3]

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[3]Most of the work on the risk-based capital formula was done in four committees:

- The *NAIC Property/Casualty Risk-Based Capital Working Group*, hereafter "NAIC Working Group", chaired by Vincent Laurenzano of the New York Insurance Department. A corresponding working group for the life and health insurance risk-based capital requirements was chaired by Terence Lennon, also of the NY Insurance Department. In December 1993, with the adoption of the property/casualty risk-based capital requirements, the two groups were merged, under the chairmanship of Mr. Laurenzano. The first draft of the formula was developed by this group, working in conjunction with the staff of the NY Insurance Department. This group remains active, monitoring the effectiveness of the formula and overseeing its implementation in the various states.
- The *American Academy of Actuaries Task Force on Risk-Based Capital* (formerly the Actuarial Advisory Committee to the NAIC Risk-Based Capital Working Group), hereafter "AAA RBC Task Force." From 1991 through 1993, during the development of the risk-based capital formula, this task force was chaired by David G. Hartman of the Chubb Group of Insurance Companies. Upon Mr. Hartman's assumption of the

3. ASSET RISKS

The asset risk charges, which were largely adopted from the life insurance formula, stem from the charges in the life insurance Mandatory Securities Valuation Reserves (MSVR). The asset risk charges are the dominant piece of the life insurance risk-based capital formula, though they are of lesser importance for the property/casualty formula, for both practical and theoretical reasons.

- In practice, capital-to-asset ratios differ greatly between life and property/casualty companies. The average property/casualty company has assets about two to three times its capital, whereas life companies have about ten times as much assets as capital. A 5% asset risk charge for life companies translates into about 50% of surplus. The same charge for a property/casualty company is only about 10 to 15% of surplus.
- In theory, asset risks are more important for life insurance companies. Many life insurance products, particularly Universal Life, Variable Life, and Variable Annuities, are seen as a combination of insurance protection (against death or lack of income) and long-term investment (particularly when aided by the tax-deferred or tax-free inside build-up of policy cash values). When investment returns offered by the insurance prod-

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presidency of the American Academy of Actuaries in September 1993, chairmanship of the task force was passed to Frederick O. Kist of Coopers & Lybrand. Most of the "actuarial issues" discussed in this paper stemmed from work of this task force or of its members. This task force remains active, working particularly on several still unsettled issues, such as interest rate risk, liquidity risk, discount factors, and several aspects of the underwriting risk charges.

- The *Model Law Advisory Committee* to the NAIC Risk-Based Capital Working Group, chaired by William Murray of the Chubb Group of Insurance Companies. This committee was instrumental in developing the language for the Risk-Based Capital Model Act.
- The *Accounting Advisory Committee* to the NAIC Risk-Based Capital Working Group, chaired by Peter Storms of the Travelers Insurance Company. This committee was most active in developing capital charges for subsidiaries and affiliates and in revising the capital charge for unaffiliated common stocks.

The last two committees are no longer in existence, having been phased out when the NAIC disbanded all industry "advisory committees."

uct are not competitive, policyholders are more likely to exercise options such as policy loans and surrenders. Proper management of asset returns and asset risks is crucial for the life insurance company.

Property/casualty products, in contrast, are generally designed for insurance protection only, not for investment purposes. Moreover, there are few "policyholder options" in property/casualty products, so asset-liability management, with its balancing of yields and risks, is less essential for property/casualty insurance companies.

Unaffiliated Fixed Income Securities

The major risk for fixed income securities is default risk: the risk that the issuer will not make the required interest or principal payments. The risk factor varies by the NAIC bond class (or "asset class"). The factor ranges from 0% for Treasury securities, since the default risk is virtually non-existent, to 30% for bonds in NAIC Class 6, which are primarily bonds in or near default. The full set of risk-based capital default risk factors is shown in Table 1.[4]

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[4]The *NAIC Instructions*, p. 2, explain that "these bond factors are based on cash flow modeling, using historically-adjusted default rates for each bond category. For each of 2,000 trials, annual economic conditions were generated for the ten-year modeling period. Each bond of a 400-bond portfolio was annually tested for default (based on a "roll of the dice") where the default probability varies by rating category and that year's economic environment. When a default takes place, the actual loss considers the expected principal loss by category, the time until the sale actually occurs, and the assumed tax consequences." (This analysis was performed by the actuarial advisory committee to the life insurance risk-based capital working group.)

For investment grade bonds (Classes 1 and 2), the factors in the property/casualty risk-based capital formula are the same as those in the life insurance formula, since these bonds are reported at amortized cost by both sets of insurers. Bonds below "investment grade" (Classes 3, 4, and 5) are reported at market value in the property/casualty statutory statement but may be reported at amortized value in the life insurance statutory statement. To use the same risk-based capital charges for the two sets of companies would amount to a double charge for property/casualty insurers. Consequently, the Class 3, 4, and 5 factors in the property/casualty formula are half as large as those in the life formula. This is the intent of the comment in the *NAIC Instructions* that "the factors for Classes 3 through 6 bonds recognize that the statement value of these bonds reflects a loss of value upon default by being marked to market."

TABLE 1

Bond Class	Risk-Based Capital Factor
Federal government bonds	0.0%
NAIC Class 1: Highest Quality	0.3%
NAIC Class 2: High Quality	1.0%
NAIC Class 3: Medium Quality	2.0%
NAIC Class 4: Low Quality	4.5%
NAIC Class 5: Lower Quality	10.0%
NAIC Class 6: In or Near Default	30.0%

Preferred Stocks

Preferred stocks are similar to bonds in that both provide a steady stream of interest or dividends. The risk-based capital factors for bonds were developed from a statistical analysis of the risk of default by rating class. Comparable data were not available for the default risk on preferred stocks. Instead, the NAIC Working Group assumed "that preferred stocks are somewhat more likely to default than bonds and that the loss on default would be somewhat higher than that experienced on bonds."

The capital charges for preferred stocks were therefore set equal to the capital charges on comparable bonds plus 2%, with two exceptions:

- There are no "federal government preferred stocks."
- The factors are capped at 30%, so the charge for "class 6 preferred stock" is 30%, not 32%.

"Insolvency risk," or "accounting risk," should be distinguished from "economic risk," or "pricing risk." Altman [2] argues that the higher default risk on lower quality securities is more than compensated for by the higher investment yield. However, the default rates on lower quality securities are not independent; rather, depressed economic conditions may lead to higher default rates on all bonds, and particularly on lower quality bonds. Thus, even if the "economic" risk is compensated for by the higher investment yield, the "insolvency" risk is not necessarily reduced. For further comments on this issue, see Feldblum [24].

TABLE 2

Preferred Stock Class	Risk-Based Capital Factor
NAIC Class 1: Highest Quality	2.3%
NAIC Class 2: High Quality	3.0%
NAIC Class 3: Medium Quality	4.0%
NAIC Class 4: Low Quality	6.5%
NAIC Class 5: Lower Quality	12.0%
NAIC Class 6: In or Near Default	30.0%

The complete list of charges by quality class is shown in Table 2.

In the life insurance risk-based capital formula, both the bond charges and the preferred stock charges are included in the "C-1" risk category (asset risks). In the property/casualty risk-based capital formula, the charges are the same except for the covariance adjustment. The bond charges are included in the "R_1" risk category (fixed-income securities) and the preferred stock charges are included in the "R_2" risk category (equities). (See Section 8 below for the classification of the capital charges into the R_0 through R_5 categories.)

Cash Risks

Cash deposited in a banking institution is subject to the risk that the cash may be uncollectible if the bank becomes insolvent. This is similar to the risk that bonds issued by a high quality corporation may default, so the NAIC Working Group chose a 0.3% charge for cash, similar to the charge on Class 1 bonds. Non-government money market funds, which are similar to cash deposits, have the same charge.

Bond Size Adjustment Factor

The bond size adjustment factor adjusts the risk-based capital charge to reflect the degree of diversification in the finan-

cial portfolio. The bond size adjustment factor decreases as the number of bond issuers increases.[5]

If the number of issuers is less than or equal to 50, the bond charge is multiplied by 250%. For the next 50 issuers, the adjustment is 130%. For instance, if the insurance company holds bonds from 80 issuers, the computation is

$$[(50 * 250\%) + (30 * 130\%)] \div (50 + 30) = 205\%.$$

This is the weighted average of the adjustment factor for the first 50 issuers and the corresponding factor for the next 30 issuers.

For issuers between 101 and 400, the adjustment factor is 100%. For all remaining issuers (i.e., issuers above 400), the adjustment factor is 90%.

The "bond size" factor is defined as the weighted average of the adjustment factors minus unity. For instance, suppose that the insurer's investment portfolio contains securities from 500 issuers subject to the bond size adjustment factor. The weighted average of the adjustment factors is

$$[(50 * 250\%) + (50 * 130\%) + (300 * 100\%) + (100 * 90\%)]$$
$$\div (500) = 1.16.$$

The "size factor" is $1.16 - 1.00 = 0.16$, or 16%. The "bond size factor RBC charge" is 16% of the "pre-size-factor bond RBC charge" for the bonds subject to the size factor. The "bond size factor RBC charge" is added to the "pre-size-factor bond RBC charge" to get the "total bond RBC charge."[6]

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[5]The number of bond issuers is based on the first six digits of the CUSIP number. In other words, one aggregates different bond series from the same issuer. Three types of bonds are not considered in determining the number of issuers and are not subject to the bond size factor:

- U.S. government bonds;
- Class 1 bonds that are issued by a U.S. government agency; and
- Bonds of parents, subsidiaries and affiliates.

[6]For property/casualty insurers, the bond size adjustment factor has little effect on the final risk-based capital ratios, though calculating the factor is time-consuming. The AAA Task Force is presently (mid-1996) preparing a recommendation that this factor be

Unaffiliated Common Stocks

The charge for unaffiliated common stocks elicited the most controversy among all the asset risk charges, leading eventually to different capital requirements in the life insurance and property/casualty risk-based capital formulas. The arguments summarized below are likely to re-emerge in the coming years, as the NAIC strives for a "seamless" formula: that is, a formula where the charge for a given risk does not depend on whether the company is licensed as a life insurer or as a property/casualty insurer. Moreover, these arguments show the different perspectives on asset-liability management, time horizons for solvency monitoring, and calibration methods for the charges that have influenced the risk-based capital formula.

The first (April 1991) draft of the property/casualty insurance risk-based capital formula had the same asset risk charges as the corresponding life insurance formula had. The life insurance formula has a 30% charge for investments in non-affiliated common stocks. Few life insurers have substantial common stock investments, so the magnitude of this charge elicited little industry opposition.[7]

In contrast, many property/casualty insurers have significant common stock holdings, and the original 30% common stock charge had a considerable effect on the risk-based capital requirements for property/casualty insurers. Some observers considered the charge to be excessive.

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dropped from the risk-based capital formula. Moreover, since the number of issuers subject to the bond size adjustment factor is not shown in the Annual Statement, errors in calculating the factor abound. Michael Barth, the research associate at the NAIC in charge of analyzing the risk-based capital results, has commented that "it is hard to argue that the bond size factor is meaningful when so many companies report it incorrectly" [4].

[7]The life insurance appointed actuary must prepare an asset adequacy analysis (in states that have adopted the NAIC's 1990 Standard Valuation Law) that compares the cash inflows from the investment portfolio with the cash outflows from benefit obligations. Such analyses are most easily prepared for fixed income securities, which have regular coupon or interest payments. They are harder to prepare for equity investments, many of which provide uncertain cash payments.

Three Perspectives

Members of three risk-based capital committees offered critiques of the 30% charge, leading to the reduction of the charge to 15% for property/casualty companies. Many regulators are uncomfortable with differing charges in the life insurance and property/casualty formulas for the same risk, and one can expect efforts in the coming years to equalize the charges in the two formulas.[8] The key issues involved are well represented by the following three perspectives on the common stock risk charge.

1. Robert Bailey, deputy insurance commissioner of the State of Michigan and a member of the NAIC Working Group, thought the 30% charge was too high, both for life insurers and for property/casualty insurers. However, since the life insurance risk-based capital actuarial advisory committee would not revise their 30% charge, Mr. Bailey recommended that this charge differ between life insurers and property/casualty insurers, for the following reason:

   Many life insurers, especially those selling traditional whole-life insurance policies, have liabilities that are expressed in fixed dollar terms, such as $100,000 of life insurance. For such insurance contracts, common stocks can be a risky investment, since the market value of the stocks may fluctuate while the insurance liability remains fixed. Property/casualty insurers, however, have inflation-sensitive liabilities: when inflation accelerates, the dollar amount of required liability loss reserves also increases. Property/casualty insurers may use inflation-

[8]During late 1993, for instance, consideration was given to reducing the common stock charge in the life insurance risk-based capital formula as well. In early 1994, however, the life insurance actuarial advisory committee to the NAIC Working Group again concluded that 30% is an appropriate charge, and it should not be reduced to 15%.

sensitive assets, such as common stocks, to match their inflation-sensitive liabilities.[9]

2. William Panning (Hartford) and Peter Storms (Travelers), members of the Accounting Advisory Committee to the NAIC Working Group, reexamined the work of the life insurance risk-based capital actuarial advisory committee on common stock risks, using different investment years and different holding periods. Using 90% and 95% confidence intervals, they concluded that the 30% charge was excessive; a more appropriate number would be between 10% and 12%.

3. Robert Butsic of the Fireman's Fund Insurance Companies, a member of the AAA RBC Task Force, calibrated the common stock charge using a 1% "expected policyholder deficit." He also concluded that the 30% charge was excessive, and that a more appropriate number would be 15%.[10]

In early 1993, in light of these recommendations, the NAIC Working Group revised the non-affiliated common stock charge

[9]On the inflation sensitivity of property/casualty loss reserves, see Butsic [10]. The inflation sensitivity of common stocks is a much debated issue; see Fama and Schwert [18] and Feldblum [19]. Bailey's position is best summed up in his July 6, 1992, letter to Sholom Feldblum: "I supported a lower RBC charge for common stocks for casualty insurers on the theoretical grounds that casualty insurers have a greater proportion of their liabilities that are inflation-sensitive and therefore need more assets that are inflation sensitive in the same direction."

[10]Butsic chose a 1% "expected policyholder deficit" (EPD) ratio because the reserving risk charges in the risk-based capital formula, when viewed from an expected policyholder deficit perspective, produce an expected policyholder deficit ratio of about 1%. See Butsic [11] for a discussion of the expected policyholder deficit concept and its application to risk-based capital requirements. Butsic argues that the various components of the risk-based capital formula should be internally consistent: each should be calibrated to approximately the same "solvency" level.

With regard to the Accounting Advisory Committee comments on the "holding period," see Butsic's Exhibit 4 and the related text regarding the "time horizon" for the risk-based capital system. For common stock investments and casualty loss reserves, the longer the time horizon, the greater the capital needed to satisfy a given EPD ratio.

for property/casualty companies to 15%. The NAIC interprets this charge by saying that "the factor for other unaffiliated common stock is based on studies which indicate that a 10% to 12% factor is needed to provide capital to cover approximately 95% of the greatest losses in common stock values over a one-year future period. The higher factor of 15% contained in the formula reflects the increased risk when testing a period in excess of one year."

Asset Concentration Factor

The "asset concentration factor" doubles the risk-based capital charges for the ten largest investments, with a maximum charge of 30% for any one security. Certain investments are not included in the asset concentration factor, such as Treasury securities, Class 1 bonds, affiliated investments, and home office real estate.[11]

The asset concentration factor may be viewed as an additional incentive for diversification, or as a penalty for investments in only a small number of securities.[12] To determine the asset concentration factor, investments are first aggregated by "name." For instance, suppose that the ABC Insurance Company owns $100,000 of common stock of the XYZ Corporation, $20,000 of preferred stock of the XYZ Corp., and $250,000 of XYZ bonds. The total "investment" in XYZ is therefore $370,000.

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[11] See the *NAIC Instructions*, p. 10, for the exact list of which investments are excluded from computation of the asset concentration factor.

[12] The asset concentration factor is a more flexible regulatory tool than the existing insurance company investment statutes in most states. Most current investment statutes *prohibit* investment of more than, say, 10%, of the insurer's surplus in stock of any one company, or ownership or control of more than say, 25%, of the stock of any one company. The risk-based capital formula does not prohibit any investments. It simply requires additional capital for an investment portfolio that seems insufficiently diversified, just as it requires more capital for an investment portfolio that seems more "risky." Note, however, that the risk-based capital formula does not replace existing state investment statutes, and NAIC efforts to strengthen investment regulation continue alongside the NAIC risk-based capital efforts.

The risk-based capital charges for the assets included in the ten largest investments are doubled, with the exceptions and limitations noted above. For the purposes of the covariance adjustment (see Section 8 below), the extra charges are included with the asset category in which each security is placed. Thus, in the XYZ Corp. example above, the asset concentration factor charges for the common stocks and preferred stocks are included in the R_2 category, and the asset concentration factor charge for the bonds is included in the R_1 category.

Interest Rate Risk

The risk-based capital formula has no charge for "interest rate risk," defined as the adverse effects on a company's statutory surplus that may be caused by a shift in market interest rates. In 1993 and 1994, the AAA RBC Task Force developed a charge for "interest rate risk" for possible inclusion in the risk-based capital formula. In June 1994, the NAIC Working Group voted to defer consideration of an "interest rate risk" charge until further data are compiled to evaluate its importance for property/casualty insurance companies.[13]

Insurance Affiliates

The risk-based capital charge for investments in subsidiaries was one of the most intensely contested issues in the NAIC formula. Many insurance "companies" are complex and layered organizations comprising dozens of legal entities. Initially some regulators desired high capital charges, as much as 100% of carrying value, for subsidiaries that they could not effectively regulate, such as off-shore insurance subsidiaries. Many U.S. in-

[13]For a complete discussion of this issue, see Hodes and Feldblum [30]. The corresponding A. M. Best capital adequacy measure, "BCAR," does contain an interest rate risk component; see Simpson and Kellogg [41], [42]. During the summer of 1996, the AAA RBC Task Force analyzed the asset exhibits included by property/casualty companies with their 1995 risk-based capital submissions and calculated the resulting interest rate risk charges. The results were consistent with expectations, and the task force has recommended that the interest rate risk charge be incorporated into the risk-based capital formula.

surers, however, retorted that such charges would hamper their ability to compete in international markets. The subsections below explain the general principles for treatment of subsidiaries in the final risk-based capital formula. A full analysis of the more complex insurance fleets must take into consideration the legal form and capital structure of each corporate entity.

Domestic Insurance Subsidiary

The charge for investments in insurance affiliates depends on whether the affiliate is U.S.-domiciled or an alien company. The risk-based capital requirement for a *domestic* insurance subsidiary is passed up to the parent. For instance, suppose that the Parent Insurance Company owns the Subsidiary Insurance Company. If the total risk-based capital requirement for Subsidiary is $10 million, then the risk-based capital charge to Parent for its investment in Subsidiary is $10 million.

Alien Insurance Subsidiary

The charge for alien insurance subsidiaries is 50% of the reported value of the enterprise or of the securities that it has issued, such as stocks or bonds. For instance, if Parent Insurance Company owns $12 million of stock issued by Off-Shore Subsidiary Insurance Company, or $12 million of bonds issued by Off-Shore Subsidiary Insurance Company, the risk-based capital charge to Parent Insurance Company is $6 million.

The NAIC Working Group would have liked to treat alien insurance affiliates in the same manner as it treats U.S.-domiciled insurance affiliates: that is, by passing up the risk-based capital requirement for the subsidiary to the parent. However, there is no risk-based capital requirement for an alien subsidiary, and because of the different accounting statements used in other countries, a risk-based capital equivalent would be difficult to determine. Since the average risk-based capital charge for U.S.-domiciled companies is about 50% of their carrying values, the

NAIC Working Group chose 50% as a proxy for the appropriate risk-based capital requirement for alien insurance companies.

Investment Subsidiary

The risk-based capital charge for an investment in an "investment subsidiary" is determined by "looking through" the subsidiary to its investment holdings. An investment subsidiary is "any subsidiary engaged … primarily in the ownership and management of investments for the insurer … " (*NAIC Instructions*, p. 4).[14]

For instance, suppose that the Parent Insurance Company has $10 billion of stocks and bonds. To more effectively manage its financial portfolio, it forms the Subsidiary Investment Fund, which invests in common stocks and bonds. Suppose also that if the Parent Insurance Company itself owned these stocks and bonds, the risk-based capital R_1 and R_2 charges for them would have been $300 million. Then the risk-based capital charge to Parent for its investment in the Subsidiary Investment Fund is $300 million. In other words, the risk-based capital charge to Parent for its investment in the Subsidiary Investment Fund is equal to the risk-based capital charge it would have had if it owned the specific securities held by the Subsidiary Investment Fund.

Non-Insurance Subsidiaries

The risk-based capital charge for an investment in a non-insurance affiliate, whether domestic or alien, is 22.5% of its carrying value.

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[14]Ron Sweet, Vice President of USAA's Capital Management Department, explains that many of these investment subsidiaries "have low capitalization and do not have operations of their own; they exist primarily to hold investment assets for the parent company." In particular, there are statutory limitations on the type of assets or the amount of liabilities that the investment subsidiary may have.

Three Principles

The actual risk-based capital charges for investments in affiliates are more complex than indicated by the brief descriptions above. See the *NAIC Instructions*, pp. 28–29, for the complete rules. Three additional principles cover most instances:

1. The risk-based capital charge for a parent company is generally capped at the carrying value of the subsidiary. For instance, suppose that Parent Insurance Co. owns Subsidiary Insurance Co., whose carrying value on Parent's books is $100 million. If Subsidiary has a total risk-based capital requirement of $125 million, then Subsidiary falls within the "company action level" of regulatory attention. However, the risk-based capital charge for Parent's investment in Subsidiary is only $100 million.

2. Suppose that Parent Insurance Co. owns Non-Insurance Holding Co., which in turn owns Subsidiary Insurance Co. In other words, Subsidiary Insurance Co. is *indirectly* owned by Parent Insurance Co. Moreover, suppose that Non-Insurance Holding Co. has a carrying value of $200 million, and that Subsidiary has a carrying value of $100 million and a risk-based capital requirement of $50 million. The risk-based capital charge to Parent for its investment in Non-Insurance Holding Co. is the risk-based capital requirement of Subsidiary (capped at its carrying value) plus 22.5% of the difference between the carrying values of Non-Insurance Holding Co. and of Subsidiary Insurance Co. In this illustration, the risk-based capital charge to Parent is $50 million + 22.5% ($200 million – $100 million) = $72.5 million.

3. If Parent Insurance Co. owns preferred stock or bonds of Affiliated Insurance Co., then the risk-based capital charge to Parent is limited to the smaller of (a) the car-

> rying value of the preferred stock or bonds and (b) the amount of "excess risk-based capital" above the amounts allocated to common stock investments in affiliated insurance companies. The *NAIC Instructions* explain the computation of the "excess risk-based capital" (pp. 28, 29).

The proper classification of investments in affiliates is particularly important because of their treatment in the covariance adjustment, which is explained in Section 8. Investments in *insurance* affiliates and subsidiaries are included in the R_0 charge. Investments in *non-insurance* subsidiaries are included in either the R_1 or R_2 charge, depending on whether the investments are fixed income or equity securities. This difference is significant, since the R_1 or R_2 charges are included in the covariance adjustment, whereas the R_0 charge is not.

Off Balance Sheet Risks

Most of the risk-based capital charges relate to balance sheet entries. For instance, if the company has a balance sheet entry of $100 million of unaffiliated common stocks, the associated risk-based capital charge is $15 million.

Sometimes, a company may have assets or potential liabilities that are not shown on the balance sheet. For instance, suppose a class action sex discrimination lawsuit has been filed against the company by some of its employees, seeking $10 million in damages. The company believes the suit is groundless, and it makes no entry for this in its balance sheet. Nevertheless, it discloses the potential liability in the notes to its financial statements.

Three types of such "off balance sheet" items are shown in the Notes to the Financial Statements. A risk-based capital charge was judgmentally chosen as 1% of the amount that is shown in the notes (*NAIC Instructions*, p. 14):

- *Non-controlled assets*: These are assets which are not under the exclusive control of the company.[15]
- *Guarantees for affiliates*: These are guarantees made to affiliated companies that may have a material effect on the company's liabilities.
- *Contingent liabilities*: These are liabilities that are too uncertain for an entry in the company's balance sheet.

4. CREDIT RISK

The first (April 1991) draft of the risk-based capital formula, as well as the final version adopted in December 1993 (with the exceptions noted below), contained a 10% charge for reinsurance recoverables. No statistical rationale for this factor was put forth, and many reinsurers and trade organizations argue that the charge is excessive.

Rationale for the Reinsurance Charge

The apparently high charge on reinsurance recoverables was motivated by three considerations:

- Reinsurance collectibility problems contributed to several major insurance company insolvencies in the mid-1980s.[16]

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[15]This category actually encompasses two types of assets:

- Assets that do appear on the balance sheet but over which the company does not have exclusive control.
- Assets that the company has sold subject to a put option that is still in force. In other words, the purchaser has the right to sell the assets back to the company for the exercise price stated in the put option.

[16]The most commonly cited example of this was the Mission Insurance Company insolvency of the mid-1980s, which was the largest property/casualty insolvency until 1990, and which was a focus of Representative Dingell's Congressional scrutiny of state insurance department financial regulation. Interestingly, large recoveries in 1991, 1992, and 1994 have vastly reduced the cost of the Mission insolvency to only $111 million, removing it from the "top ten" highest cost insolvencies. (See Kenney [35].)

- Some financially troubled companies have allegedly used "sham" reinsurance transactions with affiliated companies to hide their financial problems.
- Many reinsurance contracts do not contain full risk transfer. For instance, a reinsurance treaty may specify that if losses are higher than expected, then the ceding company must remit additional premium to the reinsurer. Since there is no consideration of this additional reinsurance premium in the risk-based capital formula, the charge for reinsurance recoverables is set at a high ("conservative") level.[17]

Criticism of the Reinsurance Charge

In response, several criticisms were leveled against the charge for reinsurance recoverables in the risk-based capital formula.

1. *Incentives*: The high charge for reinsurance recoverables serves as a disincentive to reinsure primary insurance business. In practice, reinsurance is one of the primary tools for reducing risk, by transferring either layers of loss or proportional parts of the exposure to reinsurers. The high charge for reinsurance recoverables in the risk-based capital formula may exacerbate insolvency problems rather than reduce them.

   The NAIC Working Group has responded to this criticism by noting that the credit risk charge, even at 10%, is lower than most reserving risk charges. Insurers would still lower their capital requirements by reinsuring their business, even if not to the extent that they would like.[18]

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[17]For instance, suppose the reinsurance treaty provides no risk transfer at all. That is, the primary company reimburses the reinsurer for all losses if experience is poor and it receives all profits if experience is good. Then the appropriate solvency charge for reinsurance collectibles should be the same as the reserving risk charge, since the cession of the reserves to the reinsurer does not affect the primary company's obligations.

[18]See Laurenzano [37, p. 108]: "More importantly the current (risk-based capital) charge (for reinsurance recoverables) is less than the underwriting capital charge contained in the formula, thus leaving intact the incentive to reinsure and spread risk while discouraging wholesale reinsurance or excessive gross leverage."

2. *Quality of Reinsurer*: The risk-based capital charge does not differentiate by type of reinsurer. Reinsurance placed with well-capitalized domestic reinsurers is presumably less "risky" than reinsurance placed with small, unauthorized off-shore reinsurers.

   The AAA RBC Task Force recommended to the NAIC Working Group that the credit charge for reinsurance recoverables be graded by quality of the reinsurer. The NAIC Working Group felt that this would result in the NAIC becoming a rating agency for reinsurers, which would be inappropriate, so no change was made in the risk-based capital formula.

3. *Collateralization*: The risk-based capital formula does not differentiate between reinsurance recoverables that are secured (or "collateralized"), such as by letters of credit or by funds deposited with the ceding company, and reinsurance recoverables that are not secured. Collateralized reinsurance presents a lower credit risk than uncollateralized reinsurance, particularly when the ceding company controls both the collateral and the loss reserve evaluations.[19]

   Similar issues arise in the banking industry, where the risk-based capital requirements consider the collateralization of loans. Some actuaries have argued that since the property/casualty risk-based capital formula does not deal with this issue, an incentive for prudent collateralization is missing. Others have argued that collateral is generally sought only from unauthorized reinsurers (to avoid the "Schedule F penalty"). Reducing the risk-based capital charge for collateralized reinsurance recoverables might result in lower capital requirements for unauthorized reinsurance than for authorized reinsurance.

[19]This type of situation is particularly likely to arise when a captive reinsurer is wholly owned by a single parent.

A recurring question is how any capital requirement affects the costs of the insurance business. Consider the issue of risk-based capital requirements for collateralized reinsurance recoverables. On the one hand, requiring capital even for collateralized reinsurance recoverables may be unnecessary, thereby increasing the costs for an insurer seeking a specified return on its equity. On the other hand, differentiating between collateralized and uncollateralized reinsurance recoverables provides incentives to seek collateral for all recoverables, which also increases costs.

The RAA Study

In 1992, the Reinsurance Association of America (RAA) prepared a study on the insolvency risks facing reinsurers. This RAA report showed that failing reinsurers formed about 4% of the reinsurance industry by premium volume, implying that the appropriate risk-based capital charge for reinsurance recoverables should be about 4%.

The RAA noted two caveats on this implication:

- Although failing reinsurers had only 4% of the reinsurance premium volume, they had a far larger proportion of the reinsurance losses. This makes sense, since the financial reflection of insurance failure is a high ratio of losses to assets (or to equity, or to premium). Thus, the amount of uncollectible reinsurance would be greater than 4% of reinsurance recoverables, implying that a higher capital charge is needed.
- Not all reinsurance recoverables are uncollectible when a reinsurer fails. In many instances, a large proportion of the reinsurance obligations are indeed paid to ceding companies, particularly when the failed reinsurer is taken over by another company. Thus, the amount of uncollectible reinsurance would be less than 4% of reinsurance recoverables, implying that a lower capital charge is needed.

Some participants in the RAA study argued that these two effects are offsetting, though sufficient data to properly quantify

them were lacking. In addition, the NAIC argued that the RAA study included data only for reinsurance companies, but it did not include coverage provided by the reinsurance departments of some large primary companies that failed, such as the Mission Insurance Company.

The RAA study, though, addresses expected uncollectibility amounts, not capital requirements. Consider the 15% risk-based capital charge on unaffiliated common stocks. The risk-based capital formula is not saying that the *expected* value of common stocks is 15% less than the reported value. In fact, the expected value equals the market value, which equals the reported value. Rather, the formula says: "Given the volatility of common stock values, companies should hold 15% of the reported value as capital to guard against surplus impairment resulting from stock market declines."

For common stocks and corporate bonds, there is sufficient financial data to allow rigorous "probability of ruin" and "expected policyholder deficit" analyses. For reinsurance recoverables, the historical data are poor, the marketplace changes continually, and there are so many other factors affecting expected collectibility (e.g., "quality of reinsurer") that statistical analyses of capital requirements are difficult. The NAIC Working Group therefore retained the 10% credit risk charge, despite its "judgmental" nature.

The Provision for Reinsurance

The statutory "provision for reinsurance" (that is, the "Schedule F penalty") is deducted from the reinsurance recoverables subject to a risk-based capital charge. To do otherwise would "double-count" the liability or the capital requirement.

Suppose the insurance company has a $100,000 recoverable from an unauthorized reinsurer, none of which is secured by funds withheld or letters of credit. The statement values on the balance sheet show the $100,000 as a contra-liability or as an as-

set, depending on whether the loss payment to the claimant has already been made. The "provision for reinsurance," however, sets a statutory liability of $100,000, thereby reducing policyholders' surplus by that amount.

Thus, in statutory accounting, there is no net receivable of $100,000, so there is no need for surplus to ensure that this receivable is collectible.

The same procedure is used for receivables from authorized insurers. In this case, the provision for reinsurance relates to overdue receivables and to receivables from slow-paying reinsurers. The provision for reinsurance is deducted from the reinsurance recoverable to determine the amount of the recoverable subject to the risk-based capital charge.[20]

Involuntary Market Pools

Several changes to the credit risk charge for reinsurance recoverables were made to the risk-based capital formula between the first (April 1991) and second (June 1993) drafts. The first draft of the risk-based capital formula imposed the 10% credit risk charge on reinsurance recoverable by servicing carriers from involuntary market pools.[21] Some insurers objected to this, noting that this credit risk charge would serve as a disincentive for companies to service the involuntary markets. The states already had enough consumer dissatisfaction with insurance availability, and exacerbating these problems by hampering the involuntary market mechanisms was not in the public interest.

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[20]For a complete explanation of the components of the provision for reinsurance and of their calculation, see Feldblum [21].

[21]When an employer is unable to obtain workers compensation insurance in the voluntary market, a policy is provided from the involuntary market pool. The servicing carrier collects the premium from the employer and remits it (minus an "expense allowance") to the pool. If the employer reports a claim, the servicing carrier pays the compensation benefits and bills them to the pool. For expected future payments on injuries that have already occurred, the servicing carrier sets up a "direct reserve" but cedes it to the pool. The original risk-based capital formula had a 10% credit risk charge on these recoverables from the pools.

Moreover, the credit risk charge guards against the risk of the primary company being unable to collect the reinsurance recoverables. But the involuntary pools impose joint and several liability on all member companies, and no state pool has defaulted on its obligations to servicing carriers.

In response to these criticisms, the NAIC Working Group eliminated the credit risk charge on reinsurance recoverable from involuntary pools, as well as from "public interest" voluntary pools. Public interest voluntary pools, such as the nuclear insurance pools, are pools designed to increase insurance availability for hard to service risks.[22]

Intercompany Pooling Agreements

The first (April 1991) draft of the risk-based capital formula imposed the 10% charge for reinsurance recoverables even on recoverables among affiliated insurers participating in intercompany pooling agreements. Some insurer groups objected, noting that:

- State rate regulations force them to use different legal entities to provide insurance to different classes of risks, such as "preferred" risks, "standard" risks, and "sub-standard" risks.

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[22]The term "public interest voluntary pool" is not used by the NAIC Working Group, since the term is too vague for objective measurement. Instead, these "voluntary market mechanism pools and associations" are defined by the NAIC Working Group (*NAIC Instructions*, p. 12) as "those which meet either of the two following sets of criteria:
Criteria #1

a. the members/reinsurers of the pool share pro rata in the experience of the pool; and
b. there are sufficient participants to provide a reasonably broad sharing of the risk, which shall be evidenced by a maximum 15% retention by any one participant.

Criteria #2

a. the purpose of the pool or association is to depopulate a residual market;
b. the pool or association must be specifically approved by the Commissioner of the domestic state;
c. liability of the reinsurers in the pool or association is joint and several;
d. at least five insurers participate in the pool; and
e. the premium volume of the pool or association exceeds $25 million."

- The intercompany pooling agreement reduces the risk to each individual legal entity. Furthermore, the risk to the *consolidated* enterprise is not increased by the intercompany pooling agreement, so why should its risk-based capital requirements increase?

The risk-based capital formula should encourage the use of such pooling agreements, not discourage their use. The NAIC Working Group agreed, and it eliminated the risk charge for reinsurance recoverable from affiliated U.S.-domiciled insurers.

Miscellaneous Receivables

There are two types of credit risks associated with various other receivables, such as "Receivables from Parents, Subsidiaries, and Affiliates" (Line 16 of Page 2 of the Annual Statement).

- The party owing the money may become insolvent and be unable to pay (or for other reasons may refuse to pay).
- The insurance company may have incorrectly estimated the receivable.

The risk-based capital charge for receivables was judgmentally chosen as 5% (see the *NAIC Instructions*, p. 12).

A lower charge is used for "Interest, Dividends, and Real Estate Income Due and Accrued." The risk here is primarily a default risk on the underlying securities. The charge chosen by the NAIC Working Group is the bond default charge for Class 2 bonds, or 1%.

5. UNDERWRITING RISKS

The charges for underwriting risks are the dominant portions of the risk-based capital formula. These charges have little similarity to the "C-2" charges in the life insurance formula. Most of the underwriting risk charges were developed by the staff of

the New York Insurance Department or by the AAA RBC Task Force. Much controversy continues, both within the NAIC research department and among outside analysts, as to whether these charges accurately quantify the risks faced by insurance enterprises. Casualty actuaries who wish to influence solvency monitoring issues must understand the rationale for the current charges, their strengths and weaknesses, and the alternatives that have been proposed.[23]

Reserving Risk

The reserving risk charge in the risk-based capital formula measures the susceptibility of loss reserves to adverse developments. The charge is quantified separately by line of business, using Schedule P data for the past ten years.

The reserving risk charge does *not* attempt to measure the adequacy of reported reserves. Measurement of a company's loss reserve adequacy is handled by state financial examinations and by analysis of Schedule P, not by the risk-based capital formula.[24]

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[23]The internal NAIC assessment of the effectiveness of the underwriting risk components may be found in Barth [6]. An example of an outside assessment is Cummins, Harrington, and Klein [16].

[24]The June 1993 "Statement of the Property/Casualty Risk-Based Capital Working Group," p. 3, states: "The formula will assist regulators, but it is not, and was never intended to be, a panacea of solvency regulation. The risk-based capital requirements will be based upon data contained in the insurer's financial statement. A formula cannot assess the correctness of this data … "

This perspective is surprising to some observers, since the (unintended) effect may be to increase insolvency risks, not to decrease them. Cummins, Harrington, and Niehaus [14, pp. 435–436] state this succinctly:

> In addition, risk-based capital requirements by themselves will do little or nothing to help regulators determine whether an insurer's reported net worth is overstated. The great difficulty in determining whether an insurer's reported losses and loss reserves are significantly understated, especially for long-tailed lines with highly volatile costs, limits the ability of risk-based capital to encourage weak insurers to hold more capital and to assist regulators. In fact, poorly designed risk-based capital requirements could increase incentives for some insurers to under-report loss reserves in order to show lower required risk-based capital, higher capital relative to required risk-based capital, or both.

See the discussion below in this paper on the "incentives" produced by the reserving risk charges.

For most companies, the reserving risk charge is the dominant part of the risk-based capital requirements. Because of the importance of this charge, numerous criticisms have been leveled against the quantification method, and alternatives have been proposed. The following sections set forth its development and its rationale.

Industry Adverse Development

The reserving risk charge begins with the calculation of adverse loss development ratios by Schedule P line of business. This calculation was done by the NAIC staff in 1993, and the resulting charges were "frozen." Individual ratios may be updated by the NAIC as the need arises; this component of the reserving risk charge is *not* recalculated each year.

We begin with adverse loss development ratios by company and by Schedule P line of business.

- The numerator of this ratio is the increase in estimated ultimate incurred losses between two statement dates. This increase is determined from the historical data in Schedule P, Part 2.[25]
- The denominator of the ratio is the held loss reserves at the earlier statement date. The held loss reserves are determined by subtracting paid losses (Schedule P, Part 3) from incurred losses (Schedule P, Part 2).[26]

For example, suppose that at December 31, 1985, a company reports $10 million of "other liability" incurred losses and $4

[25] In actuarial parlance, "incurred loss development" is generally used to mean the change in reported losses between two valuation dates, where reported losses are paid losses plus case basis loss reserves. The adverse loss development used here refers to the change in *estimated ultimate losses* as shown in Schedule P, where the estimated ultimate losses include bulk reserves.

[26] In most actuarial analysis, the denominator of an incurred loss development ratio would be the incurred losses at the earlier reserve date, not the held reserves at the earlier reserve date. The risk-based capital reserving risk charge, however, is applied to held reserves, not to incurred losses, so held reserves are used as the denominator of the adverse loss development ratio.

million of "other liability" paid losses for accident years 1985 and prior. At December 31, 1991, the company reports $12 million of "other liability" incurred losses for accident years 1985 and prior. To ensure consistency, all these figures would be drawn from the 1991 Annual Statement.[27]

The risk-based capital formula would consider the following figures:

- The loss reserves at December 31, 1985, were $6 million ($10 million – $4 million).
- The adverse development is $2 million ($12 million – $10 million).
- The adverse development as a percentage of reserves is 33.3% ($2 million ÷ $6 million).

These calculations are performed separately by

a. Individual company (not company group),

b. Schedule P line of business, and

c. Statement date (e.g., changes in incurred losses for accident years 1982 and prior between statement dates 1982 and 1991, changes in incurred losses for accident years 1983 and prior between statement dates 1983 and 1991, and so forth).

Individual company ratios are averaged to determine the base industry reserve charges which are promulgated by the NAIC. In-

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[27]The 1991 Statement actually shows incurred losses only for accident years 1982 through 1991. The "prior years" line does not include all incurred losses. Rather, for accident years prior to 1982, the "prior years" row shows the loss reserve at each statement date plus the paid losses in calendar years 1982 and subsequent. However, since the risk-based capital calculation needs loss reserves, not incurred losses, this is not a problem. Although Schedule P data are not sufficient to determine incurred losses for the "prior years," they are sufficient to determine loss reserves.

The 1991 Schedule Ps were used for determining the ratios used in the current risk-based capital formula. If the NAIC decides to update any of these ratios, subsequent Schedule Ps would be used.

dividual companies need not perform these calculations. A high or low adverse development ratio for a specific company affects the industry charge in this part of the formula. This additional effect on the particular company's reserving risk charge is discussed below.

"Worst Case Year"

For each line of business, the individual company development ratios are averaged over all companies for each statement date. In other words, the derivation of the reserving risk charge begins with a three-dimensional matrix of adverse loss development ratios, with several thousand companies, nine statement dates, and fifteen Schedule P lines of business. The averaging across companies leaves a two-dimensional matrix, with nine statement dates and fifteen lines of business.

Simple averages are used, not weighted averages, so the adverse loss development for an insurer with $100,000 of reserves is given the same weight as that for an insurer with $10 billion of reserves.

Some actuaries have argued that

- because small insurers have greater random fluctuation in their adverse development ratios,[28] and
- because simple averages (not weighted averages) are used in the formula,

the "average industry-wide ratios" used in the formula are greater than the "industry aggregate" ratios (as might be determined from the industry data in Best's *Aggregates and Averages*) for

[28] See Lowe [39] and the studies by Allan Kaufman supporting additional charges on small and on rapidly growing companies (published in the *Proceedings of the NAIC*). Barth [5, p. 23], in reviewing the risk-based capital results submitted with the 1994 Annual Statements, similarly notes that: "The R_4 RBC (reserving risk) charge for companies with large reserves may be higher than necessary, relative to smaller companies."

most lines of business. Thus, the NAIC formula has an unjustified upward bias.

In rebuttal, the NAIC Working Group has argued that

- the simple averages are *not* uniformly higher than the weighted averages (the relationship varies by line of business), so there is not necessarily an "upward bias;" and
- using weighted averages would give undue influence to the results of the largest carriers.

The simple averages were therefore retained in the risk-based capital formula.[29]

The greatest average value is selected from among all the statement dates. For instance, suppose the average values of adverse loss development from the statement date below to December 31, 1991, over all companies in the industry, for a given Schedule P line of business are as follows:

Statement date: December 31,	'82	'83	'84	'85	'86	'87	'88	'89	'90
Avg. adverse development:	25%	22%	28%	32%	22%	16%	15%	8%	5%

The most severe adverse loss development as a percentage of original reserves (32%) occurred between December 31, 1985, and December 31, 1991. The value of 32% would be the "industry-wide adverse development" for this line of business.[30] The risk-based capital standards imply: "This adverse development happened in the past, so it might happen again. Insurers

[29]In addition, the NAIC Working Group notes that A. M. Best uses a slightly different population of companies than the NAIC Working Group uses, so the average figures that each derives may not match exactly.

[30]The *NAIC Instructions* use the term "Industry loss and loss adjustment expense risk-based capital percentage"; see Page 20, Line 4.

need sufficient capital to withstand adverse loss reserve development of this magnitude."

Interest Discount Factor

Statutory accounting requires that loss reserves be reported at undiscounted values. The "implicit interest margin," or the difference between the discounted value of the reserves and the undiscounted value of the reserves, serves as an implicit "cushion" for solvency.[31] Not taking this implicit "cushion" into account would double-count the required capital: an explicit capital requirement held as surplus and an implicit capital cushion held as reserves.

The implicit interest margin differs by line of business, depending on the loss payout pattern of the reserves. To quantify the loss payout pattern for most lines of business, the risk-based capital formula uses the same method as employed by the IRS for its loss reserve discounting procedure. The payout pattern is determined by comparing paid losses to incurred losses by accident year and line of business, using Best's *Aggregate and Averages* Schedule P Part 1 data.[32]

The IRS and the risk-based capital formula use different discount rates. For determining taxable income of property/casualty insurance companies, the IRS uses a sixty-month moving average of the Federal Midterm Rate, which is the rate on outstanding Treasury securities with remaining terms between 3 and 9 years. The risk-based capital formula uses a flat 5% discount rate.

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[31]The risk-based capital formula uses the term "adjustment for investment income"; see the *NAIC Instructions*, p. 17. Some actuaries consider this phrase inappropriate, since the risk-based capital formula is measuring the assumed present value of the reserves, not the actual investment income earned by the insurer. Nevertheless, actuaries should be aware of the terms used by the NAIC in the risk-based capital formula.

[32]For a description of the IRS procedure, see Gleeson and Lenrow [27] or Almagro and Ghezzi [1].

The "Net" Industry Charge

The reserving risk charges for private passenger automobile liability insurance in the risk-based capital formula should clarify these factors. The factor reflecting "worst case year" industry adverse development, before any adjustment for the implicit interest margin, is 25.4%.[33] The implicit interest adjustment, using the IRS discounting procedure with a flat 5% annual rate, implies that discounted auto liability reserves are only 92.1% of the undiscounted values. The reserving risk charge in the risk-based capital formula, assuming that there is no company adjustment (see below), is therefore

$$1.254 * 0.921 = 1.155$$

or 15.5% of reserves held.[34]

Company Differences

The 1.254 factor in the illustration above is the base "industry aggregate" figure used in the risk-based capital calculations. But companies differ both in their reserve estimation procedures and in the types of risks that they write. Some companies consistently report adequate full value reserves, and they show little adverse development in subsequent years. Other companies report less adequate reserves, as a result of either conscious management decisions or poor actuarial work, and they show significant adverse loss development in subsequent years.

The NAIC risk-based capital formula therefore compares the company's own average loss development by line of business over the past nine years to that of the industry. The average loss development is derived from Schedule P, Part 2. It is computed

[33]This factor reflects *both* the worst case industry adverse development and the spreading of the reserving risk factors across lines of business (see below in the text).

[34]In the actual calculations, discussed below, the company adjustment is applied before the "adjustment for investment income." See the illustrations at the end of the paper for the exact sequence in which all factors are applied.

as

$$(\text{current incurred losses} - \text{initial incurred losses}) \div \text{initial incurred losses}$$

where

current incurred losses = the sum of incurred losses at the current statement date for the nine accident years prior to the current year, and

initial incurred losses = the sum of incurred losses at the initial statement dates for the nine accident years prior to the current year.

For instance, suppose the company shows the following figures in its 1997 Annual Statement for Schedule P, Part 2B ("private passenger auto liability/medical"):

	1997 Schedule P, Part 2B ($000)									
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1988	500	500	490	510	515	525	530	530	530	530
1989		540	520	510	520	525	530	535	540	540
1990			580	585	600	605	605	610	605	610
1991				620	630	630	650	690	680	680
1992					660	670	700	705	705	710
1993						700	700	716	725	720
1994							750	745	745	740
1995								800	810	840
1996									850	870
1997										900

The "current incurred losses" are

$$\$(870 + 840 + 740 + 720 + 710 + 680 + 610 + 540 + 530) = \$6,240.$$

The "initial incurred losses" are

$$\$(850 + 800 + 750 + 700 + 660 + 620 + 580 + 540 + 500)$$
$$= \$6,000.$$

The company's average adverse development is therefore (6,240 − 6,000) ÷ 6,000 = 4%, or a development factor of 1.040. Suppose that the corresponding industry average adverse development is 6.5%, or a development factor of 1.065. (See the *NAIC Instructions*, p. 20, line 1 for the actual industry average adverse development factors, which change from year to year.) The ratio of company to industry average adverse loss development is 1.040 ÷ 1.065, or 0.977.

This factor is applied to the industry "worst case year" adverse loss development to give a company-specific worst case year adverse development factor of 0.248 (0.254 * 0.977). A simple average is taken of the company-specific factor and the industry-wide factor to give the "company risk-based capital percentage" (*NAIC Instructions*, p. 17). This averaging may be conceived of as a credibility weighting of company adverse loss development and industry adverse loss development, with 50% credibility assigned to each component. In this illustration, the "company risk-based capital percentage" equals (0.254 + 0.248) ÷ 2, or 0.251.

This figure, plus unity, is multiplied by the "implicit interest margin" of 0.921 to give a final charge of 1.251 * 0.921 = 1.152, or 15.2% of carried reserves.

Note carefully where industry data are used and where company-specific data are used. The "worst case" year is an industry concept; there is no company-specific worst case year in the risk-based capital formula. The company adjustment, which uses company-specific data, compares the particular company's average historical adverse development to the industry average historical adverse development. However, it does *not* substitute the individual company's worse case year for the industry's worst case year.

However, the industry worst case year is *not* developed from aggregate industry data. Rather, individual company data are used to determine the adverse reserve developments from each statement date to December 31, 1992 (the date used for the initial determination of the reserving risk charges). Simple (unweighted) averages of the individual company adverse developments are used to determine the industry adverse developments, after exclusion of "outlying" results.

Company Adverse Development

Note the two differences between the adverse loss development in the company adjustment and the loss development used for the industry charge of 1.254 in the example above:

- Adverse loss development in the calculation for the company adjustment is compared with initial *incurred losses*. The adverse development used to determine the industry "worst case year" charge is compared with initial *reserves*.
- For the company adjustment, the weighted average of the nine historical loss development factors is used, not the "worse case year." (Nine factors are used, since Part 2 of Schedule P shows ten statement dates. The tenth statement date is the current statement date, so there are nine periods for potential adverse development.) The weights for the average are the incurred losses at the initial statement dates.[35]

The *NAIC Instructions* show the weighted average historical loss development factors for the industry by line of business. Each insurer calculates its own weighted average historical loss development factors from the Part 2 exhibits of its Sched-

[35]This "weighted average" is equivalent to the formula in the text, which compares the total adverse development to the sum of the incurred losses at the initial statement dates, where the "initial statement date" differs for each accident year.

ule P (termed "company development" in the *NAIC Instructions*).[36]

Spreading Across Lines

The description above explains the quantification of the reserving risk charge for a single line of business. The resulting charges vary widely: for some lines of business they are high, and for others they are low. Part of the variation truly relates to the riskiness of the line of business, but part of the variation may be caused by random fluctuations in the historical data.

The risk-based capital formula therefore retains part of the reserving risk charge in the specific line of business and judgmentally spreads the rest over all lines. The basis of the allocation is the relationship of aggregate industry reserves by line of business to the sum of aggregate industry reserves for all lines of business.[37]

Written Premium Risk

The reserving risk charge guards against the risk that the company's past business will turn out to be less profitable than expected—i.e., that reserves will develop adversely. Equally important is the risk that the company's future business will be

[36]The insurer must have experience for all ten accident years (for the ten year lines) in that line of business to use its own experience. Moreover, the insurer must not have initial negative incurred losses for any accident year, even if the current valuation of incurred losses is positive. See the *NAIC Instructions*, p. 16, for additional detail.

There is a slight mismatch in the dates of the adverse loss development. The company's average adverse loss development is based on the most recent Annual Statement. The industry average adverse loss development promulgated by the NAIC is based on data at least one year older. In general, this mismatch is not significant.

[37]Although there is a precise mathematical derivation of the individual line of business reserving risk factors, a strong dose of judgment was used in selecting the final risk factors for each line (that is, in "spreading" the total reserving risk capital requirement across lines of business). The NAIC Working Group has not disclosed the considerations affecting the spreading technique, other than to note the "basis of allocation." In general, it is not possible to exactly replicate the derivation of the final reserving risk factors, particularly for lines of business such as workers compensation, where significant adjustments were made to the standard procedure.

unprofitable, and that the company will have to cover underwriting losses with surplus funds.

One can develop capital charges to guard against potential underwriting losses over various time horizons, such as during the coming 12 months or during the coming five years. The risk-based capital formula uses a time horizon of one year: the potential underwriting losses to be considered are those that may occur during the next 12 months.[38]

Ideally, one would base the capital charge for future underwriting losses on the volume of business to be written during the coming year. As a proxy for the volume of business to be written during the coming year, the risk-based capital formula uses the volume of business written during the most recent calendar year. This future underwriting risk is termed "written premium risk."

The structure of the written premium risk charge is similar to that of the reserving risk charge. Average industry loss and loss adjustment expense ratios by accident year and by line of business are determined from Schedule P, Part 1, for the past ten years, by simple (unweighted) averages of individual company figures. The "worst case year," or the year with the highest average loss ratio, is selected.[39]

Interest Discount Factor

The Schedule P loss ratios are "ultimate" figures (also termed "nominal" figures, or "undiscounted" figures). Particularly for the long-tailed lines of business, the expected investment income resulting from the time lag between premium collection and loss payment is an important consideration in the profitability of a

[38]Contrast the 24-month time horizon used by the British Solvency Working Party, and the justification given for this by Daykin, Pentikäinen, and Pesonen [17], Chapter 14, Section 6.

[39]All references to "loss ratio" in this section refer to loss and loss adjustment expense ratios for net business, as shown in Schedule P, Part 1, Column 30.

book of business. The "worst case year" loss ratio is therefore multiplied by an investment income factor, which is derived from an IRS payment pattern and a 5% discount rate.

The "adjustment for investment income" used for the premium risk charge is not the same as the "adjustment for investment income" used for the reserving risk charge. The former reflects the expected investment income from policy inception to final loss payment for a newly issued block of business. The latter reflects the expected investment income on assets supporting the loss reserves currently held by the company for all accident years combined.

The relative magnitude of these two sets of figures depends on premium collection patterns and loss settlement patterns by line of business. The risk-based capital formula has greater premium risk "investment income adjustments" for workers compensation, medical malpractice, other liability, and products liability, but greater reserving risk "investment income adjustments" for homeowners, special liability, international, and reinsurance A and C.[40]

Company Experience

Just as is true for the reserving risk charge, the premium risk charge is adjusted for the company's own experience compared to that of the industry. Assume that for personal automobile insurance, the worst case year industry average loss ratio is 104.6%, and the average of all ten years' industry average loss ratios is 94.7%. Suppose also that a given company has a worst case year loss ratio of 110% and a ten year average loss ratio of 85%.

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[40] A "greater" adjustment means a smaller factor. For instance, the medical malpractice observed worst case adverse development used for the reserving risk charge is multiplied by an investment income adjustment factor of 80.8%, whereas the medical malpractice observed worst case loss ratio used for the premium risk charge is multiplied by an investment income adjustment factor of 77.8%. For a full discussion of this issue, see Woll [46].

The individual *company's* worst case year loss ratio is *not* used in the calculation; only the worst case year industry average loss ratio is used. However, the industry worst case year figure is adjusted for the individual company's average loss ratio compared with that of the industry, with equal weight given to industry and company experience. In this illustration, the ratio of company to industry average loss ratios is 0.898 ($0.850 \equiv 0.947$). To give equal weight to industry and company experience, the industry worst case year loss ratio is multiplied by a factor of

$$(1 + 0.898) \equiv 2, \quad \text{or} \quad 0.949,$$

giving an adjusted worst case year loss ratio of 99.3% (104.6% $*0.949$).[41]

For private passenger automobile liability, the "adjustment for investment income" factor is 0.924. The discounted worst case year loss ratio for this company's risk-based capital calculations is therefore

$$99.3\% * 0.924 = 91.8\%.$$

Combined Ratios

The company's (not the industry's) average expense ratio is added to this loss ratio to give a worst case year combined ratio. For instance, suppose that

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[41]Unless the company has relatively complete experience, the adjustment outlined in the text is not made. Specifically, if for a given line of business the earned premium in any accident year is zero or negative, or the loss ratio in any accident year is zero or negative, no company adjustment is used. Furthermore, the risk-based capital formula uses what it terms a *de minimus* test, which is intended to avoid outlying values resulting from years with low premium volume. The *de minimus* test specifies that accident years with premium volume less than 20% of the average premium volume for all ten years should be excluded when calculating the company average loss ratio. Furthermore, if three or more years have premium volumes less than 20% of the ten year average, then no company adjustment is used in the premium risk charge. (For lines of business using only 5 accident years of data, if two or more years have a premium volume less than 20% of the five year average, no company adjustment is used.) Finally, all company loss ratios are capped at 300%, to avoid excessive charges resulting from random large losses in a small volume line of business. See the *NAIC Instructions*, p. 18, for the complete specifications.

- the industry's worst case year loss ratio, after adjustments for the individual company's experience and for the interest discount (expected investment income), for a particular line of business, is 94%, and
- the company's average expense ratio (for all lines combined) is 23%,

then the combined ratio used in the formula is 117% (94% + 23%). The written premium risk charge is calculated as the worst case year combined ratio minus unity. If the company wrote $50 million of business in this line in the most recent calendar year, then the capital requirement (before the adjustment for the premium concentration factor; see below) is $50 million * 17% = $8.5 million.

The minimum written premium risk charge is 0%. For instance, if the industry worst case year discounted loss ratio is 84%, and the company's expense ratio is 13%, leading to a combined ratio of 97%, the written premium charge is 0%, not −3%.

In theory, one should add the expense ratio associated with the specific line of business to that line's loss ratio. However, expense ratios by line of business are not included in the Annual Statement, so an all lines combined expense ratio is used instead.[42]

The practical effect of using all-lines expense ratios is small: a lower expense ratio in one line of business is offset by a higher expense ratio in another line of business. The total risk-based capital requirement would differ only inasmuch as the premium risk charges for some lines are capped below at 0%. If the use of line-specific expense ratios would cause no line's written pre-

[42]Expense ratios by line of business are indeed found in the Insurance Expense Exhibit (IEE). However, the IEE is filed each year by April 1, one month after the Annual Statement and the risk-based capital calculations are due.

mium charge to fall below zero (and therefore be capped at zero), but the use of the all-lines expense ratio causes the written premium charge for one or more lines to be capped at zero, then the latter procedure will cause a higher all lines combined written premium charge than the former procedure does.

Note two differences between the loss portion and the expense portion of the combined ratio:

- The company average loss ratio and the industry average loss ratio are each given 50% weight in determining the loss portion of the combined ratio. For the expense portion, only company data are used, not industry data.
- The adjustment for investment income is applied only to the loss portion of the combined ratio, not to the expense portion. The adjustment for investment income is derived from a loss payout pattern, not a loss plus expense payout pattern. Although there is often a long lag between premium collection and loss settlement, most expenses are paid at about the same time as the premium is collected.

The offset for business written on loss-sensitive policy forms, the adjustment for business written on claims-made forms, the additional premium risk charge for rapidly growing companies, and the concentration adjustment to reflect diversification by line of business, are discussed below for both reserving risk and written premium risk.

Unearned Premium Reserves

The previous sections have dealt with reserving risk and with written premium risk. Reserving risk is the risk that underwriting results might turn out to be worse than expected on insurance coverage that has already been earned but for which claims payments are not yet fully settled. Written premium risk is the risk

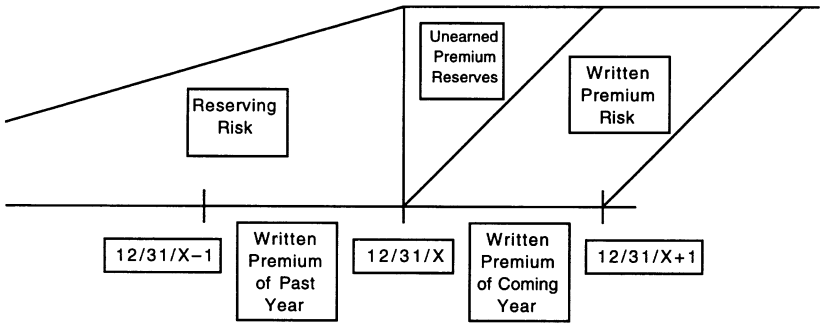
that underwriting results may turn out to be worse than expected on the coming year's underwriting activities.

There is a risk intermediate between these two: the risk that underwriting results may turn out to be worse than expected on coverage that has already been written but has not yet been earned. Just as the insurer holds loss reserves for coverage that has already been earned but for which claims are not yet fully settled, the insurer holds unearned premium reserves for coverage that has been written but has not yet been earned. Just as the reserving risk charge protects against unanticipated adverse development on the loss reserves, should there not be a similar charge to protect against the possibility that the unearned premium reserves may be insufficient to fund the claims that will arise on this coverage?

Figure 1 shows this graphically. Note that the most recent year's written premium is a proxy for the coming year's written premium.

FIGURE 1

THE UNDERWRITING RISKS TIME LINE



Valuation Date: 12/31/X
Reserving Risk: Coverage written and earned, but not all claims settled yet
Unearned Premium Reserve: Coverage written but not yet earned
Written Premium Risk: Coverage to be written in coming year
(Written premium of the past year is a proxy for written premium of the coming year.)

Equity in the Unearned Premium Reserves

This is the underlying structure of the risk-based capital formula, and the first (April 1991) draft of the formula indeed had a charge applied to the unearned premium reserves. In fact, if insurance companies held "net" unearned premium reserves—that is, "net" of prepaid expenses—the factors used to compute the unearned premium reserves charge would be about the same size as the factors used to compute the written premium risk charge.

But statutory accounting requires insurance companies to hold unearned premium reserves *gross* of all prepaid expenses. Unlike GAAP, statutory accounting does not allow a deferred policy acquisition expense asset.

The objective of statutory accounting for unearned premium reserves is conservatism. For most companies, the gross unearned premium reserve is about 20% to 25% greater than the amount actually needed to fund future claims. This statutory margin is referred to as the "equity" in the unearned premium reserves.

For almost all lines of business, this margin is more than sufficient to guard against unexpectedly poor underwriting results on the unexpired portions of policies that have already been written. Just as the reserving risk charge and the written premium risk charge contain offsets for expected investment income, the unearned premium reserves risk charge in the first (April 1991) draft of the risk-based capital formula contained an offset for prepaid acquisition expenses. With this offset, the charge was either zero or insignificant for almost all lines of business.

To simplify the formula, the unearned premium reserves risk charge was deleted, since it did not contribute significantly to the final capital requirements. In the final draft of the formula, no relic of this charge remains, because statutory accounting already contains a more than sufficient margin for this risk.

Occurrence Policies versus Claims-Made Policies

The first (April 1991) draft of the risk-based capital formula had the same reserving risk charge and written premium risk charge for business written on claims-made forms as for business written on occurrence forms. Some insurers argued that the reserving risk and written premium risk are smaller for business written on claims-made forms, and that this should be reflected in the risk-based capital standards.[43]

Two issues are paramount here. Adverse loss development results

- from the emergence of incurred but not reported (IBNR) claims, and
- from development on reported claims ("inadequate" case reserves).

Business written on claims-made forms has the second type of development. In fact, since claims-made business often includes the more "risky" business, reserve estimates are uncertain, and development on reported claims may be great. However, claims-made business has little (if any) IBNR claim emergence, which is the primary cause of adverse loss development in general liability and medical malpractice. Thus, claims-made business should show less adverse loss development than occurrence business.

Since industry-wide Schedule P exhibits for occurrence business and claims-made business were not available separately until 1993, data from several large writers of claims-made general liability business were used to analyze adverse loss development. The data indicated that adverse loss development was indeed a lesser problem for claims-made business than for occurrence business, at least for medical malpractice. For other liability and

[43]Most of the work on this subject was done by Paul Braithwaite, a member of the AAA RBC Task Force. His reports on claims-made business and the underwriting risk charges can be found in the *Proceedings of the NAIC*.

for products liability, however, the data either did not show a significant difference or the available experience was too sparse to yield meaningful conclusions.

Quantification and Data

The NAIC Working Group responded favorably to the claims-made recommendation, but it asked two questions:

- First, how significant is the difference in adverse loss development between business written on occurrence forms and business written on claims-made forms?
- Second, if different reserving risk charges are incorporated in the risk-based capital standards for occurrence and claims-made business, how should the NAIC collect the data needed to quantify the offset?

The two questions are intertwined. Since loss triangles were not reported for occurrence and claims-made business separately in the Annual Statement prior to 1993, there were no industry-wide data for quantifying the appropriate factors. (Other reserving risk factors are determined from Schedule P data.)

Implementation and Adoption

To implement the recommendation of the AAA RBC Task Force, the NAIC Blanks Task Force split the Schedule P exhibits for three lines of business—other liability, products liability, and medical malpractice—into occurrence and claims-made sections. In conjunction with this, the 1992 Part 4 of Schedule P, which showed "claims-made experience," was eliminated, and the information regarding extended loss and expense reserves was moved to a Schedule P interrogatory. No claims-made experience is now shown for commercial multi-peril business, since claims-made business is not a large portion of this line.[44]

[44]Braithwaite estimates that claims-made business forms less than 0.5% of commercial multi-peril experience.

The final risk-based capital formula adopted by the NAIC in December 1993 reduces the reserving risk charge and the written premium risk charge for medical malpractice business written on claims-made forms compared to business written on occurrence forms by 20%.[45]

Offset for Loss-Sensitive Contracts

The reserving risk charge in the risk-based capital formula quantifies the amount of capital needed to guard against unexpected adverse loss development. This unexpected adverse loss development must be paid for with surplus funds, so insurers should hold sufficient capital to withstand this risk.

Similarly, the written premium risk charge quantifies the amount of capital needed to guard against unexpectedly poor underwriting results during the coming year. Once again, the underwriting losses must be paid for with surplus funds, so insurers should hold sufficient capital to withstand this risk.

Risks in Retrospective Plans

For business written on loss-sensitive contracts, such as retrospectively rated workers compensation policies, part of the adverse loss development on previously written business or the poor underwriting results on new business will be funded by additional ("retrospective") premiums. That is, if actual losses are worse than forecast, the insured is billed for additional premiums at the retrospective adjustment date. Depending on the plan parameters, the aggregate additional premium for a company

[45] As noted above in the text, the data provided by Paul Braithwaite showed the disparity between occurrence and claims-made forms to be greatest for medical malpractice business. The NAIC Working Group initially intended to consider whether a similar reduction in the charge is appropriate for other liability and products liability as well (based upon the new Schedule P data), and whether the 20% figure used for medical malpractice is indeed correct. Since the new Schedule P data do not justify a claims-made offset for other liability and products liability, it is not expected that the NAIC Working Group will extend the medical malpractice offset to these lines.

may be 70 percent to 80 percent of the adverse loss development on previously written business or of the worse than expected loss experience on new business. Thus, one needs less surplus to withstand the risks of adverse loss development or poor underwriting results on loss-sensitive contracts than on prospectively rated contracts.

Similarly, reinsurance treaties may use sliding scale commission rates. Suppose the primary insurer and the reinsurer anticipate a 70% loss ratio on the ceded business, and they would normally use a 30% reinsurance commission rate. The sliding scale formula may set the commission rate as

$$30\% + 0.5 * (70\% - \text{actual loss ratio}),$$

subject to a maximum of 50% and a minimum of 10%.

If the actual loss ratio on the ceded business is indeed 70%, the reinsurance commission is 30%. If the loss ratio is 90%, making the ceded business unprofitable, the reinsurance commission is only $30\% + 0.5\ (70\% - 90\%) = 20\%$. In this formula, the reinsurance commission is capped at 10% and 50%.

The initial work on this subject done by private insurance companies found a receptive audience on the NAIC Working Group. The working group asked the AAA RBC Task Force (at that time, its "actuarial advisory committee") to develop a full proposal.

Two issues were paramount in the deliberations of the NAIC Working Group: the magnitude of the offset and the definition of a loss-sensitive contract.

Magnitude of the Offset

The proper size of the offset depends on the sensitivity of retrospective (or other loss-sensitive) premiums to adverse loss development or to worse than expected underwriting results. In other words, if incurred losses increase by $1,000, how much additional premium will be collected?

The premium sensitivity depends on the parameters of the loss-sensitive contract, such as loss limits and maximum premium limits in retrospectively rated plans. For "wide swing" plans sold to "jumbo" accounts, with high loss limits and high maximum premium limits, premium sensitivity is high. Since losses and retrospective premiums are rarely capped, each dollar of additional loss, on average, leads to nearly a dollar of additional premium. For "narrow swing" plans sold to small accounts, with low loss limits and retrospective premiums severely constrained by the maximum premium limits, premium sensitivity is low.[46]

Several regulators were concerned with the "credit" risk on accrued retrospective premiums. In other words, if losses develop adversely, the insurer must pay the claims, but it may not be able to collect the additional premiums if the insured becomes bankrupt or is otherwise unwilling to pay.[47]

Definition of a Loss-Sensitive Contract

Several regulators were concerned that if risk-based capital charges are lower for business written on loss-sensitive contracts, many under-capitalized companies may attempt to portray their policies as loss-sensitive, even if the "loss-sensitive" part of the contract is not significant. In consultation with the AAA RBC Task Force, the NAIC Working Group drew up a definition of a

[46]For a more complete treatment of the effects of loss-sensitive contracts on capital requirements, see Hodes, Feldblum, and Blumsohn [32]. For an analysis of the premium sensitivity for very small workers compensation retrospectively rated policies, see Bender [8].

In practice, numerous variables affect premium sensitivity. Hodes, Feldblum, and Blumsohn list "the plan parameters, the current loss ratio, and the maturity of the reserves." Bender [8, p. 36] lists "the retrospective rating formula, the aggregate loss ratio of the risks, and the distribution of the individual risks' loss ratios around the aggregate."

[47]On the credit risk for retrospectively rated policies, see Greene [28]. Industry-wide surveys of premium sensitivity were undertaken by the Tillinghast consulting firm, in a private study conducted by Stephen Lowe and Jon Michelson, and by the NAIC, in a study conducted by Robert Klein. Tillinghast's survey found that companies reported an average sensitivity of 65%. However, in consideration of the credit risk, and from a general desire to be "conservative," Tillinghast recommended an offset of only 45%, and this recommendation was adopted by the AAA RBC Task Force.

loss-sensitive contract to be used for risk-based capital purposes. The definition specifies six criteria that a contract must fulfill to be considered loss-sensitive:[48]

1. *An increase in losses can lead to an increase in net payment for that policy.* In other words, if the loss-sensitive item is not a monetary transaction, the contract is not loss-sensitive.
2. *The loss-sensitive payment must be at least 75% of the loss on primary business and at least 50% of the loss on reinsurance treaties, before the application of any limits.* In other words, if losses on a retrospectively rated workers compensation policy increase by $10,000, the retrospective premium must increase by at least $7,500, before the application of loss limits or maximum premium caps.
3. Maximum and minimum premiums, loss limits, and upper and lower bounds on the reinsurance commission may constrain an otherwise loss-sensitive contract. For a contract to be classified as loss-sensitive, *the "swing" of the plan must be at least 20% for primary business and 10% for reinsurance treaties.* In other words, the net amount payable when the loss experience is the worst possible must be at least 20% greater than the net amount payable when the loss experience is the best possible. For example, a retrospectively rated workers compensation policy with a minimum premium of $9,000 and a maximum premium of $10,000 would not qualify as loss-sensitive.
4. *The maximum net payment must be at least 15% greater than the expected net payment for primary business and at least 7.5% greater than the expected net payment for reinsurance treaties.* For example, a retrospectively rated workers compensation policy with a minimum premium

[48]These criteria are listed in the NAIC *Annual Statement Instructions* for Part 7 of Schedule P. For further discussion, see Feldblum [20].

of $5,000, an expected premium of $10,000, and a maximum premium of $11,000 would qualify as loss-sensitive under Criterion 3 but not under Criterion 4.

5. *The loss-sensitive payments must be either premiums or commissions.* In other words, a policy with loss-sensitive policyholder dividends does not qualify as loss-sensitive.

6. *The losses and the corresponding loss-sensitive payments must flow through the income statement and the balance sheet.* In other words, suppose the workers compensation policy has a large dollar deductible of $100,000. For losses below $100,000, the insurance company still settles the claim and pays the benefits, but the insured reimburses the insurer for these payments. One might characterize this policy as loss-sensitive, since the greater the losses paid by the insurer, the greater the payments made by the insured. However, these amounts do not flow through the income statement as incurred losses and as premiums, so the contract does not qualify as loss-sensitive.

The final version of the risk-based capital formula adopted by the NAIC in December 1993 contains an offset for business written on loss-sensitive contracts. The parameters, however, differ from those recommended by Tillinghast or by the AAA. For instance, the offset for primary insurance carriers is only 30% of the otherwise applicable risk-based capital reserving risk charge and written premium risk charge, not the 65% in the Tillinghast survey or the 45% recommended by the Tillinghast actuaries.[49] The offset for reinsurance companies is 15% of the otherwise applicable risk-based capital reserving risk charge and written

[49]The reasons for the choice of a low offset factor include the lack of credible industry-wide data, the inconsistencies in the definition of loss-sensitive contracts, and the desire to be conservative.

premium risk charge, corresponding to the lower sensitivity discussed in the Tillinghast report for reinsurance company loss-sensitive contracts.

The lower sensitivity for reinsurance contracts relates to the nature of these policies. Many loss-sensitive reinsurance treaties have sliding scale reinsurance commissions, where the commission amount depends on the loss ratio of the book of reinsured business. The sensitivity of the contract is therefore limited by the magnitude of the commission allowance. Moreover, the effects of a poor loss ratio on the reinsured business is sometimes spread over several years, so the immediate effect is further reduced.

Diversification by Line

Is adverse loss development in one line of business correlated with adverse loss development in other lines of business? Similarly, are poor underwriting results in one line of business correlated with poor underwriting results in other lines of business?

Consider adverse development. If the adverse loss development is caused by random loss fluctuations, one would expect little interdependence among lines of business. If adverse loss development is related to conscious company actions to smooth calendar year earnings, one would expect greater interdependence among lines of business.

The risk-based capital formula assumes a partial interdependence among lines of business. The total reserving risk charge determined by the procedure outlined above, after adjustment for loss-sensitive business and for business written on claims-made contracts, is multiplied by

$$70\% + 30\% * (\text{reserves in largest line of business} \equiv \text{total reserves for all lines}).$$

The ratio of the reserves in the largest line of business to the total reserves for all lines is termed the "loss concentration factor" (*NAIC Instructions*, p. 23, note 2). The actuarial justification for this formula may be found in Butsic [12]. Butsic finds that, "For both reserves and premiums, the average correlation between lines is about 40%, a number too low to lump all lines into a single independent category without adjustment, and too high to require independent line categories" [12, p. 181].[50]

For instance, suppose a personal lines carrier writes automobile, homeowners, commercial fire, and CMP business. It holds total reserves of $800 million, of which $600 million are for automobile liability. The total risk-based capital reserving risk component (after the appropriate adjustments) is multiplied by

$$70\% + 30\% * (600 \equiv 800) = 92.5\%.$$

Similarly, the written premium risk charge is adjusted by a "premium concentration factor," which is analogous to the loss concentration factor used in the reserving risk charge. The premium concentration factor is defined as the written premium in the largest line of business in the most recent calendar year divided by the total written premium in all lines of business. The written premium risk charge determined by the procedure outlined

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[50]The NAIC research staff, upon reviewing 1994 risk-based capital results, found no significant correlations among lines of business. Thus, Wigger and Barth [44, p. 35], write:

> As the correlations show, there does not appear to be a strong relationship between the reserve development for any of the various lines of business. … This means that, for individual companies, reserve development tends to be independent between lines, although individual companies may have different experience. The correlations are, on average, close to zero, even for those lines where one would expect to see some relationship (medical malpractice-occurrence and medical malpractice-claims made, for example). One can infer from these results that adverse development in one line of business does not mean that the other lines a company writes are any more likely to develop adversely.

Similarly, Barth [6] writes:

> Related research on the correlation of reserve risk between lines of business suggests that the loss concentration factor calculation understates the benefits of diversification.

above, after adjustment for loss-sensitive business and for business written on claims-made contracts, is multiplied by

$$70\% + 30\% * (\text{premium concentration factor}).$$

Growth Charges

The "growth charge controversy" was one of the most hotly debated in the development of the risk-based capital formula. Several private studies, such as that performed by the A. M. Best Corporation and those undertaken by some academicians, suggested that rapid growth was a prime cause of insurance company insolvency.[51] Since it takes many years before the true profitability of a book of business is known, particularly in the commercial liability lines of business, rapid growth may conceal financial weakness. Moreover, a rapidly growing company, particularly one that is relatively new to certain lines of business, may not be aware of the risks that it faces or of the potential severity of adverse loss development or underwriting cycle fluctuations.

Similar concerns were voiced about small companies. A small company, particularly if it is not well diversified, may be subject to great risks from random large losses or natural catastrophes. For instance, a small homeowners writer with business only in Florida and without adequate excess-of-loss reinsurance protection is more vulnerable to financial ruin from a hurricane than is a large and diversified multi-line writer with the same amount of Florida business.

The first (April 1991) draft of the risk-based capital formula had no additional charges for rapidly growing or small companies. The NAIC Working Group asked its actuarial advisory committee to develop a recommendation for such additional charges, if they were justified. In 1992, the actuarial recommendations

[51] See *Best's Insolvency Study* [9]. For an example of one academic study, see Willenborg [45].

were adopted by the NAIC Working Group. In 1993, however, after strong opposition by small insurance carriers, the NAIC dropped the small company charge (but retained the growth charge). Instead, it recommended that single state carriers with less than $2 million of annual premium be exempt from the risk-based capital requirements, subject to the decision of the state's insurance commissioner.

Determination of the Growth Charge

If rapidly growing companies have worse than average adverse loss development on their held reserves and worse than average underwriting results, the magnitude of these phenomena should be apparent in the historical experience. Allan Kaufman, a member of the AAA RBC Task Force, fit the following two regression equations to Annual Statement data:

$$\text{Reserve development bias} = A_0 * \text{growth} + B_{\text{line}}, \qquad \text{and}$$

$$\text{Loss ratio bias} = A_0 * \text{growth} + B_{\text{line}}.$$

"Growth" is defined as the "arithmetic average of the year-to-year changes in written premium for direct and assumed business for the group for the latest three years." All other risk-based capital charges are based on the characteristics of the individual company. The amount of growth is based on the growth of the corporate group. The reasoning is as follows:

- Solvency is an attribute of each legal entity. If there are two "sister companies," one domiciled in New York and one domiciled in Illinois, and the New York company becomes insolvent, the Illinois company is under no legal obligation to bail out the New York company. The capital held by the New York company should be sufficient to protect it from the risks it faces, without support from the Illinois company.
- A corporate group may sometimes shift business from one member company to another member company. In the example above, the corporate group may decide to enter the substandard

automobile insurance market and to use the New York company for standard business and the Illinois company for substandard business. The existing standard business in the Illinois company is shifted to the New York company. This gives the appearance of rapid growth in the New York company, but this is not the type of growth that causes "reserve development bias" or "loss ratio bias." The growth rate is therefore determined from consolidated group figures.

Monetary inflation and the expansion of the economy cause a certain amount of "normal" growth, which is not expected to cause "reserve development bias" or "loss ratio bias." The risk-based capital formula looks at "excess growth," which is the growth rate minus 10%. In addition, after averaging the most recent three years' growth rates, the formula caps the growth rate at 40%.[52]

The "bias" is the difference between (i) the observed reserve development or loss ratio for a particular company and (ii) the average reserve development or loss ratio for all companies. For instance, suppose that the average reserve development in a par-

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[52]Kaufman ran the regression equations using both "total growth" and "excess growth" as the independent variable, with similar results. The figures shown in the text are his "total growth" results.

In theory, the amount of "normal growth" should depend on the inflation rate each year, as well as on real GNP growth and on the phase of the underwriting cycle. For instance, "normal growth" should be higher when monetary inflation is 15% per annum than when it is 5% per annum, all else being equal. However, a fixed normal growth rate of 10% per annum was chosen for simplicity, just as the flat 5% discount rate used to calculate the implicit interest margin was chosen for simplicity.

If a company has only three years of data, so only two annual growth rates can be calculated, the arithmetic average of these two growth rates is used, in lieu of the average of three growth rates that other companies use. If the company has only two years of data, a single growth rate is used.

The 40% cap on growth rates in the excess growth charge is applied to the average growth rate, not to the individual growth rates. For example, for a company with growth rates of 100%, 10%, and 10%, the average growth rate is 40%, which is not capped. Had we capped the individual growth rates, we would have 40%, 10%, and 10%, which gives an average of 20%.

The 40% capping is applied *before* the reduction by 10%. Thus, the maximum excess growth rate is 30%.

ticular line of business for all companies is 20%, and that the average reserve development in that line of business for companies with growth rates of +10% per annum is 25%. The reserve development "bias" is +5%, and the regression equation would indicate an A_0 value of +0.50 [since $0.50 * 10\% = 5\%$].

The reserve development bias regression equation produced an A_0 coefficient of 0.54, and Kaufman selected a value of 50% for the formula. The loss ratio bias regression equation produced an A_0 coefficient of 0.20, and Kaufman selected a value of 25% for the formula.[53]

Just as the reserving risk charges and the written premium risk charges are adjusted for the implicit interest margin in the reported reserves or in the underwriting results, the reserving risk "growth charge" and the written premium risk "growth charge" should be similarly adjusted. For simplicity, Kaufman [34, p. 3] chose a discount factor of 90% for all lines, which "approximates the average discount factor."

Adoption

The charge for rapidly growing companies was incorporated in the June 1993 version of the risk-based capital formula, which was adopted by the NAIC in December 1993. A company with an average three-year premium growth rate exceeding 10% per annum receives additional reserving risk and written premium risk charges.[54] The final formulas are

$$\text{Reserving risk growth charge} =$$

$$50\% * (\text{growth} - 10\%) * 90\%, \qquad \text{and}$$

[53]The full regression results, along with tests of significance and values for individual lines of business, may be found in Kaufman [34]. See particularly Appendix 1, Sheet 1, and Appendix 2, Sheet 2.

[54]The observant reader may note that since the underwriting risk charges are based on the experience of *all* companies, and the growth factors increase the charges for rapidly

$$\text{Written premium risk growth charge} = 25\% * (\text{growth} - 10\%) * 90\%.$$

6. THE COVARIANCE ADJUSTMENT

The first (April 1991) draft of the risk-based capital formula summed the individual charges to determine the company's capital requirements. Several actuaries, most notably Robert Butsic of the Fireman's Fund Insurance Companies, argued that the simple summation presumes that the various risks facing insurance enterprises might all occur simultaneously. In truth, these risks are at least partially independent. For instance, the risk of adverse loss development is independent of the risk of bond defaults or of stock market declines. Similarly, the risk of adverse development on personal automobile reserves is at least partially independent of the risk of adverse development on workers compensation reserves.

Even in 1991, of course, the NAIC Working Group recognized that a simple summation of charges was inappropriate for partially independent risks. However, good data quantifying the degree of independence were lacking, and there was no analysis of the proper method of combining the risk charges. Once Robert Butsic delivered his "Report on Covariance" to the NAIC Working Group, the risk-based capital formula was changed from a simple summation to Butsic's recommended formula.

In particular, Butsic [12, pp. 179, 180] notes the following relationships:

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growing companies, there should be an offsetting reduction in the factors for companies that are not rapidly growing. Indeed, Kaufman makes the same observation: "The otherwise applicable industry loss & lae reserve and premium charges by line should be reduced based on the amount of industry total RBC generated by the growth and size factors." No explicit reduction of this sort was made in the underwriting risk charges.

- Non-insurance asset risk (including credit risk) is independent of underwriting risk (reserves, premium, size, and growth risk).[55]
- Based on long-term historical data, the correlation between stock and bond returns is a rather weak 14%.
- Reserve and written premium risk are not very well correlated… From 1982 to 1991, the industry all-lines composite premium and reserve risk elements had only a 26% correlation.
- Based on judgment, reserve growth risk seems to be highly correlated with reserve risk.

Risk Categories

The various capital charges in the risk-based capital formula are first combined into six categories, termed R_0 through R_5, as follows:

R_0 :
- Investments in insurance affiliates
- Non-controlled assets
- Guarantees for affiliates
- Contingent liabilities

R_1 :
- Fixed income securities
  - Cash
  - Bonds
  - Bond size adjustment factor
  - Mortgage loans
- Short term investments
- Collateral loans
- Asset concentration adjustment for fixed income securities

[55] Butsic's report was written when there was a "size risk" component to the risk-based capital formula, so his formula has one term that is no longer present. Moreover, Butsic's paper does not have the adjustment for credit risk that is in the current formula.

R_2 :
- Equity investments
  - Common stocks
  - Preferred stocks
  - Real estate
- Other invested assets
- Aggregate write-ins for invested assets
- Asset concentration adjustment for equity investments

R_3 :
- Credit risk
  - Reinsurance recoverables
  - Other receivables

R_4 :
- Reserving risk
  - Basic reserving risk charge
  - Offset for loss-sensitive business
  - Adjustment for claims-made business
  - Loss concentration factor
  - Growth charge for reserving risk

R_5 :
- Written premium risk
  - Basic premium risk charge
  - Offset for loss-sensitive business
  - Adjustment for claims-made business
  - Premium concentration factor
  - Growth charge for premium risk

The proper categorization of the risk charges is essential for determining the overall capital requirements. Note particularly the following items.

1. After the credit risk charge has been calculated, one-half of this charge is removed from R_3 and added to R_4. This compensates for the inconsistency between (i) the interdependence of reserving risk and reinsurance collectibility risk and (ii) the lack of a covariance term in the square root rule (see the next two subsections).

2. The R_0 term appears *outside* the square root rule, whereas all the other terms appear *inside* the square root rule. This

makes it especially important to know which charges for affiliates appear in R_0. Charges for insurance subsidiaries, whether U.S.-based subsidiaries or alien subsidiaries, are included in R_0, so as to avoid a reduction of overall capital requirements by simple "layering" of the company's legal structure. Charges for non-insurance subsidiaries or affiliates appear in R_1 or R_2, depending on whether the insurer owns bonds or stock of the affiliate.

3. The determination of which investments are considered for the asset concentration factor is done for all assets combined, not separately for R_1 and R_2. The asset concentration factor charges are then separated into their R_1 and R_2 components for inclusion in the square root rule.

The Square Root Rule

Butsic recommended that the risk charges be combined by a square root rule. For instance, if there are two risk elements, with capital charges of $3 million and $4 million, then the total required capital would be $[(\$3 \text{ million})^2 + (\$4 \text{ million})^2]^{0.5} = \$5 \text{ million}$.

Of the six risk categories listed above, R_0 remains outside the square root rule and the remaining five risk categories are included inside the square root rule, or

$$\text{Total capital requirements} = R_0 + (R_1^2 + R_2^2 + R_3^2 + R_4^2 + R_5^2)^{0.5}.$$

In this statement of the formula, "R_3" means one-half of the credit risk charge, and "R_4" means the reserving risk charge plus the other half of the credit risk charge.

Three issues pertaining to this formula are particularly important:

- the lack of covariance terms in the square root rule;

- the exclusion of the R_0 charge from the square root rule; and
- the marginal capital effects of each risk element.

Covariance Terms

Let us return to the illustration above of two risk elements, "Risk A" and "Risk B," which have capital charges of $3 million and $4 million, respectively. A simple additive rule says that the total capital charge for the company should be $7 million. The square root rule says that the total capital charge for the company should be $5 million.

The true total capital requirement depends on:

- the meaning of the "capital requirement,"
- the probability distribution of each risk element, and
- the interdependence of the risk elements.

Suppose that the capital requirement for a given risk means that if the company had only that risk element and exactly that amount of capital, there is a 95% chance that the company would remain solvent over the coming year. For instance, if the company had only Risk A and exactly $3 million of capital, there is a 95% chance that it would remain solvent a year from now and a 5% chance that it would become insolvent.

If there are two risk elements that are perfectly correlated with each other, such that whenever the company lost money from risk element A it also lost money from risk element B, then the simple additive rule is correct. To have a 95% chance of remaining solvent over the coming year in the example above, the company needs $7 million of capital. If the two risk elements are at least partially independent of each other, then less than $7 million is needed. In this situation, the *complete* square root rule

would say that the total capital requirement is

$$[(\$3 \text{ million})^2 + 2 * \text{covariance (Risk A, Risk B)} * \$3 \text{ million} * \$4 \text{ million} + (\$4 \text{ million})^2]^{0.5}$$

When risks A and B are perfectly correlated, this expression reduces to

$$[(\$3 \text{ million})^2 + 2 * 1 * \$3 \text{ million} * \$4 \text{ million} + (\$4 \text{ million})^2]^{0.5}$$
$$= \$7 \text{ million}.$$

When risks A and B are perfectly independent, this expression reduces to

$$[(\$3 \text{ million})^2 + 2 * 0 * \$3 \text{ million} * \$4 \text{ million} + (\$4 \text{ million})^2]^{0.5}$$
$$= \$5 \text{ million}.$$

Butsic [11] says that, "Knowing the degree of correlation between risk elements can be as important as knowing the risk of individual items." In his published paper, Butsic includes the covariance terms among all the risk elements. In his covariance adjustment for the NAIC risk-based capital formula, however, there are no correlation terms or covariance terms, as though all the risks were perfectly independent.

In practice, there is some dependence among the risk factors. For instance, during recessions, when bond default rates are higher than average, stock market declines are more likely. If the dependence among the risk factors is strong, the square root rule may underestimate the capital requirements.

In response, Butsic argues that

- The square root rule, by itself, overestimates the amount of capital needed to achieve a given "expected policyholder deficit" ratio if the risk elements have normal or lognormal probability distributions.[56]

[56]In other words, if a company with only risk element A needs $3 million of capital to achieve a 1% expected policyholder deficit (EPD) ratio, and a company with only risk

- The correlation among the risk factors is very weak, so the underestimate of the needed capital is small.
- The one important interdependence, between the risk of adverse reserve development and the risk of reinsurance collectibility, is accounted for by the movement of one-half of the credit risk charge into the reserving risk category.[57]

The first two effects are largely offsetting, so the unadjusted square root rule gives a reasonably accurate result.

The Charge for Subsidiaries

The risk charge for insurance subsidiaries—the R_0 charge—is outside the square root formula. The rationale for this is that the risk-based capital requirement for an insurance company should not depend upon the organizational structure of the company. If an insurance company forms a subsidiary with half of its business and half of its assets, its capital requirements should not change. If the R_0 charge were within the square root section of the formula, the total risk-based capital requirement for the group would decrease as more layers of ownership were introduced.

For example, suppose the only risk-based capital charge was a bond risk default charge (R_1) of $10 million. If the company uses half the bonds to capitalize a subsidiary, the new charges would be R_0 of $5 million and R_1 of $5 million. If these two

element B needs $4 million of capital to achieve a 1% EPD ratio, and if risk elements A and B are normally or lognormally distributed, then the amount of capital needed to achieve a 1% EPD ratio for a company with risk elements A and B is somewhat less than the amount of capital prescribed by the complete square root rule. Butsic [12, p. 185] shows the approximate amount of overstatement, separately for the normal and for the lognormal case. It is difficult to illustrate this effect, since in the simplest discrete cases (e.g., with binomial distributions for the risk elements), the square root rule generally *understates* the required capital.

[57]Reserving risk measures unanticipated adverse loss development. In some cases, when there is substantial unanticipated adverse loss development, as resulted from the passage of CERCLA (the "Superfund" legislation) in 1980, some reinsurers may become bankrupt or may be unwilling to pay claims, leading to high credit risk for reinsurance recoverables. In the absence of hard data showing the correlation between reserving risk and credit risk, the movement of one-half of the credit risk charge into the reserving risk category was a subjective method of accounting for this interdependence.

charges were now combined by the square root rule, the total risk-based capital requirement would be

$$[(\$5 \text{ million})^2 + (\$5 \text{ million})^2]^{0.5} = \$7.07 \text{ million}.$$

But the risks are not reduced simply by layering the insurance enterprise more finely. So the R_0 charge is kept outside the square root part of the formula. The risk-based capital requirement for the insurance enterprise remains \$5 million + \$5 million = \$10 million.[58]

Marginal Effects

An important implication of the square root rule for company strategy relates to the marginal effects of each risk charge on the total capital requirements. A preliminary illustration should clarify the meaning of marginal effects; the mathematical formula is derived afterwards.

> Suppose a company has two risk elements, A and B, with capital charges of \$10 million and \$2 million, respectively. The company can take on additional risk of either type A or type B, causing additional capital charges of \$1 million. That is, either risk A goes from \$10 million to \$11 million or risk B goes from \$2 million to \$3 million. What is the effect on the total capital requirements of the company?

If the risk charges are additive, such that the total capital requirements before the addition of the new risk elements is \$12 million, then it makes no difference whether Risk A is increased

[58]Butsic [12, p. 182] notes that consolidation of the risk-based capital categories for parents and affiliates and subsequent application of the square root rule is another means to deal with covariance among affiliates. Furthermore, Butsic points out that when the subsidiary is not a proportionate scaling of the parent company, the method described in the text (that is, keeping the R_0 charge outside the covariance formula) slightly overstates the theoretically correct risk-based capital requirements, whereas consolidation gives the correct figure.

from $10 million to $11 million or Risk B is increased from $2 million to $3 million. In either case, the new capital requirements are $13 million.

If the square root rule is used, then the total capital requirements before the addition of the new risk element is

$$[(\$10 \text{ million})^2 + (\$2 \text{ million})^2]^{0.5} = \$10.198 \text{ million}.$$

If risk A is increased from $10 million to $11 million, the new capital requirements are

$$[(\$11 \text{ million})^2 + (\$2 \text{ million})^2]^{0.5} = \$11.180 \text{ million}.$$

The marginal effect of each extra dollar of Risk A is

$$(\$11.180 \text{ million} - \$10.198 \text{ million}) \div (\$11 \text{ million} - \$10 \text{ million}) = \$0.98.$$

If Risk B is increased from $2 million to $3 million, the new capital requirements are

$$[(\$10 \text{ million})^2 + (\$3 \text{ million})^2]^{0.5} = \$10.440 \text{ million}.$$

The marginal effect of each extra dollar of Risk B is

$$(\$10.440 \text{ million} - \$10.198 \text{ million}) \div (\$3 \text{ million} - \$2 \text{ million}) = \$0.24.$$

Adding a dollar to risk charge A has a far greater effect on the total capital requirements than adding a dollar to risk charge B has. In this discrete example, the marginal effect of increasing risk charge A is about four times as great as the marginal effect of increasing risk charge B.

In the continuous case, the ratio of the marginal effects equals the ratio of the original capital charges. In other words, if the illustration above were revised to ask: *What is the marginal effect of adding a single dollar of additional risk charge either to Risk A*

or to Risk B? then the marginal effect of each extra dollar of risk charge for Risk A is five times as great as the marginal effect for Risk B, since the current risk charge for Risk A is five times as large as the risk charge for Risk B.

Mathematically, the covariance adjustment sets the total capital requirements as

$$\text{TCR} = \text{total capital requirements} = (\Sigma C_i^2)^{0.5},$$

where the C_i are the capital requirements for each individual risk. The *marginal* capital requirement for any risk j equals

$$\partial \text{TCR}/\partial C_j = 0.5(\Sigma C_i^2)^{-0.5} * 2C_j.$$

In other words, the marginal (post-covariance) charge for an additional dollar of any pre-covariance risk charge is proportional to the total dollars in that risk category. Risk categories with large pre-covariance charges, such as reserving risk, provide a high post-covariance contribution *for each dollar of risk charge.* Risk categories with low pre-covariance charges, such as default risk, provide a low post-covariance contribution *for each dollar of risk charge.*

There are several practical implications of this difference in marginal effects.

1. Before the covariance adjustment was included in the risk-based capital formula, financial analysts thought that changes in investment strategy could materially affect a company's capital requirements. For instance, some investment analysts envisioned high demand for bonds whose coupon payments were linked to a stock market index, thereby yielding returns similar to common stocks yet incurring the low capital charge afforded bonds. Once the covariance adjustment was incorporated into the formula, it became clear that the marginal effects of the asset risk charges were extremely small, thereby ren-

dering such investment ploys rather useless for reducing risk-based capital requirements.[59]

2. The risk-based capital requirements are dominated by the underwriting risk charges, and particularly by the reserving risk charge. Yet the reserving risk charges are perhaps the weakest link in the chain: it has been argued that the reserving risk charges are ad hoc extrapolations from historical happenstance, they do not adequately distinguish financially-troubled companies from sound companies, and they provide perverse incentives that may raise insolvency risks.

7. OTHER ISSUES

The previous sections of this paper describe the risk-based capital formula, along with the rationale for the various charges. Some charges, like the underwriting risk and the credit risk charges, were developed by the NAIC Working Group; some charges, like the asset risk charges, were developed by life insurance actuaries; and some charges, like the growth charges, the loss-sensitive contract offset, the claims-made business offset, and the covariance adjustment, were developed by members of the AAA RBC Task Force.

As noted previously, the reserving risk charge forms the dominant component of the risk-based capital requirements for most companies, and its pre-eminence is heightened by the square root rule. Many observers have criticized the magnitude and rationale of the reserving risk charges, as well as the unusual incentives provided by the formula.

[59]In addition, the reduction in the common stock charge for property/casualty companies from 30% (which is the charge in the life insurance risk-based capital formula) to 15% makes the final effect of moving from stocks to bonds almost negligible. For further analysis, see Salomon Brothers, "Property/Casualty Risk-Based Capital: The Surprise on the Asset Side."

Casualty actuaries have been in the forefront in attempts to quantify reserving risk (or "reserve uncertainty"), and numerous reports have been published in recent years on this topic. The growing dissatisfaction with the underwriting risk charges, the recognition by the NAIC research staff of the weaknesses of these charges, and the development of sounder statistical techniques by practicing actuaries should soon stimulate the reexamination of these risk charges.

The following sections discuss several aspects of the underwriting risk charges that are essential for understanding the controversies on this issue. Some of the proposed revisions are discussed in the footnotes, though the text of this paper is restricted to the actual NAIC formula.

Quantifying the Capital Charge for Underwriting Risk

The risk-based capital formula balances three major considerations:

- *Accuracy*: The capital charges must accurately reflect the risks faced by insurance companies.
- *Simplicity*: The rationale for the capital charges should be understood by company executives and state regulators, not just by highly trained actuaries and financial analysts.
- *Incentives*: The risk-based capital formula should provide incentives for companies to strengthen their capital structures.[60]

These goals conflict at times. Improving the accuracy of the charges often requires more complex statistical formulas. The tension between the actuarial accuracy motivating some of the AAA reports and the desire for simplicity often underlying the NAIC Working Group decisions is perhaps most evident in the

[60] See especially "Simplicity, Accuracy, and Incentives," a memorandum by Sholom Feldblum to the members of the actuarial advisory committee to the NAIC Working Group (January 29, 1992).

method of quantifying the capital charges for reserving risks and premium risks.

Worst Case Year

Some actuaries have criticized the NAIC's worst case year approach for measuring reserving risk and written premium risk for two reasons:

- *Theory*: The observed favorable or adverse development for a particular line of business over the past ten years may be due as much to historical happenstance as to true risk characteristics.[61]
- *Calibration*: Even if the observed adverse development is a good proxy for risk characteristics, the "optimal" or "required" capital may not be the same as the observed development.

Statistical Quantification

A subcommittee of the AAA RBC Task Force developed an alternative approach to quantifying the reserving and premium risk charges.[62] This approach considered the variances of reserve

[61]Lowe [39] summarizes this as follows:

"The current [risk-based capital] factors reflect the historical experience of the industry in the last underwriting down-cycle. In particular, they reflect the severe adverse reserve development that occurred in general liability, medical malpractice, and reinsurance, and the very severe loss ratios in malpractice and reinsurance....

"While the next down-cycle could easily be as severe, the specific forces that drive it will probably be different (as they are in each cycle), such that the incidence of adverse results by line will probably also be different....

"The methodology underlying the current factors, therefore, seems somewhat overly focused on the specifics of the recent past. While past experience is useful as a guide, it needs to be interpreted in terms of the current and future risks faced by the industry."

Compare, however, Vincent Laurenzano's implicit rejoinder to Lowe's argument [37, p. 102]: "The Working Group believes that it is more important for statutory capital standards to be based on past experience rather than on more subjective judgments as to the adequacy of current reserves, assumptions as to industry trends, or anticipated future business activities both as to the industry and individual companies."

[62]The subcommittee was chaired by Stephen Lowe, an actuary with Tillinghast. The final report of the subcommittee was discussed by the NAIC Working Group and subsequently published in the CAS *Forum* [39].

development and of loss ratios by line of business, as well as the effect of changing interest rates on statutory adverse development, and it combined these with an "expected policyholder deficit" concept to develop risk-based capital requirements.[63]

The NAIC reserving risk charges, despite their complexity, have shown surprisingly little predictive power. In a study of the NAIC risk-based capital formula, Cummins, Harrington, and Klein [16] assert that

> The loss reserve component of the NAIC risk-based capital formula, which accounts for half of industry risk-based capital, has virtually no predictive power in any of the tests we conducted.[64]

Michael Barth, the NAIC research associate currently responsible for monitoring the use of the risk-based capital formula, has expressed similar views [6, pp. 1, 2]:

> The current calculation does not track very well with the observed reserve risk for the individual lines of business, nor does the aggregate R_4 track very well with observed aggregate reserving risk.

Douglas M. Hodes, an actuary with the Liberty Mutual Insurance Company and a member of the life insurance risk-based capital actuarial advisory committee, issued a parallel report, using statistical methods similar to Lowe's but different assumptions. The resulting capital charges for reserving and written premium risk differed greatly from those arrived at by Lowe, particularly for the long-tailed lines of business.

Because of the complexity of these reports, and the lack of consensus among the actuarial community, the NAIC Working Group adhered to its original formula.

[63]For the use of expected policyholder deficit in devising capital requirements, see [11]. Robert Butsic, a member of the AAA RBC Task Force, developed the expected policyholder deficit component of Lowe's report as well.

Hodes, Feldblum, and Blumsohn [32] have combined the stochastic simulation techniques advocated by the British Solvency Working Party and the corresponding Finnish Working Party (and systematically laid out in Daykin, Pentikäinen, and Pesonen [17]) with Butsic's expected policyholder deficit procedures to develop capital requirements more in line with current actuarial thinking.

[64]See Cummins, Harrington, and Klein [16]. Robert Klein, a research economist with the NAIC, was in charge of assessing the effectiveness of the risk-based capital formula.

> Internal research supports these findings that the R_4 underwriting risk charge is not proportional to the observed reserving risk, on average.
>
> The graph compares total reserve error to total reserve RBC. The graph shows that there is no relationship between the observed reserve risk and the RBC requirement to support that risk.

Vincent Laurenzano points out that the underwriting risk charges were not designed to be predictive of reserve deficiencies. In fact, the RBC formula in general was not designed to be *predictive* of future insolvency, but rather to establish minimum capital requirements for insurers based on the risks contained in their balance sheets, including the risk that reserves may be understated.

Credibility

The development of the credibility component is instructive. The first (April 1991) draft of the risk-based capital formula used a "credibility weighting" of industry experience and the company's experience. The company's credibility varied from 0% to 50%, depending on the size of the company's reserves in the line of business. The largest companies received 50% credibility, while small companies received credibility factors close to 0%.

The full credibility standard (actually, the "50% credibility standard" here) was set by judgment, and the classical "square root" formula was used for partial credibility.[65] However, no analysis was done to justify the chosen full credibility standard or the partial credibility rule, so this element of the first draft formula was bereft of actuarial justification. Criticism of the formula, though, was strong, since small companies with good experience claimed that they were placed at a disadvantage

[65] See Longley-Cook [38] for further explanation of the classical full credibility standard and partial credibility rule.

compared with larger companies having the same experience. Since the risk-based capital formula was intended to set a company's capital requirements in accordance with the risks that it faced, this disparity was perceived as inequitable.[66]

Incentives

In theory, loss reserves are the result of a company's operations. Actuaries examine the premium and loss experience of the company and set reserves to cover the anticipated future obligations.

In practice, the adequacy of loss reserves may vary greatly from company to company, and even from year to year for a given company. These variations in reserve adequacy may affect the public's perception of the company's operations and its financial strength. A reduction in reserve adequacy—that is, a decrease in loss reserves (or in incurred losses)—shows up as an increase in statutory surplus. Conversely, an increase in reserve adequacy shows up as a decrease in statutory surplus.

Bulk reserve requirements cannot be estimated precisely, despite the reserve opinions written by actuaries or the financial audits performed by accountants. In fact, the bulk reserve is

[66] Actuarial advances in credibility theory over the past two decades have made empirical recommendations increasingly difficult to justify. Twenty years ago, the development of a new classical credibility formula generally used a full credibility standard based on claim frequency only, assumed a normal distribution of claim counts, and required simply that the actuary select a confidence interval.

Current approaches to credibility correctly consider the classical theory as little more than ad hoc standards. Bayesian credibility theory compares the *relative* predictive power of alternative sets of data, not the *absolute* predictive power of either one. For further elaboration of classical versus Bayesian credibility theory, see Philbrick [40], Herzog [29], and Venter [43].

This difference between classical and Bayesian credibility can be seen in the reserving risk charge. The AAA RBC Task Force developed a report showing that the past adverse loss development of a company was not well correlated with future adverse loss development. The authors of this report therefore recommended that the company credibility for the reserving risk charge be reduced or eliminated. Modern credibility theory, however, says that the absolute predictive power of the company's past adverse development for future adverse development is irrelevant. Rather, the proper credibility value depends on the *relative* predictive power of company versus industry past adverse development for the company's future adverse development.

often judgmentally chosen from a range of possible values. It has been argued that some troubled companies have given themselves the "benefit of the doubt" and have chosen unrealistically low reserve estimates, which have the effect of hiding financial weakness. Since minimum surplus requirements were low in the past, there was little temptation for financially sound companies to underestimate bulk reserve needs simply to ensure sufficient surplus, as opposed to the incentive for financially unsound companies to underestimate reserves.[67]

The advent of risk-based capital requirements may dramatically change company behavior. Now even large statutory surplus amounts may be deemed insufficient, and this insufficiency may lead to regulatory intervention in the company's affairs.

Insurers seeking to avoid such regulatory intervention may attempt to modify their operations or their accounting practices to improve their risk-based capital ratios. Because of the structure of the risk-based capital charges, and particularly because of the covariance adjustment, changes in the asset portfolio have an extremely small effect on the final capital requirements. Similarly, the costs of modifying the company's reinsurance arrangements or its business strategies will often outweigh any short term risk-based capital benefits.

Reserve Strengthening and Weakening

The opposite is true for reserving practices. The risk-based capital formula adds additional incentives for companies to report inadequate reserves. Stephen Lowe has termed this the "triple whammy" of the reserving risk charge:

- Reducing reserves increases statutory surplus. This was true both before and after the implementation of risk-based capital requirements. The effect of the new requirements is that now even financially strong companies will be examining their risk-

[67]Moreover, understatement of loss reserves raises federal income tax liabilities. Financially sound companies therefore had little motivation to underestimate their reserves.

based capital ratios (i.e., the ratio of adjusted surplus to the risk-based capital requirements) and seeking the least costly and most effective ways to raise them.

- Reducing reported reserves lowers the reserving risk charge. Moreover, since the reserving risk charge is dominant for most companies, the covariance adjustment in the risk-based capital formula further increases the marginal effect of the reserving risk charge relative to other charges. In other words, each dollar reduction in the reserving risk charge has a much greater effect on the overall capital requirements than does a similar dollar reduction in the other risk-based capital charges.
- Reducing reported reserves also reduces the reported adverse development, particularly if one also allocates a larger percentage of the reserves to the most recent accident year in the Schedule P exhibits. In the past, reserve strengthening not only reduced capital needs (since reserves contained a healthier margin) but sometimes even demonstrated greater management honesty in reporting practices, thereby lessening the perceived need for a "capital cushion." Now companies may be loath to strengthen reserves, since this action will increase the company's reported adverse loss development, further increasing its reserving risk charge.

One solution to this problem is to base the reserving risk charge on indicated reserves, not reported reserves, where the indicated reserves are determined from a base independent of the company's reserving system (such as earned premiums). In 1992, Stephen Lowe, an actuary with Tillinghast, recommended a reserving risk charge based on a paid loss Bornhuetter-Ferguson estimate of indicated reserves, though the complexity of the calculation was inconsistent with the generic simplicity required for the risk-based capital formula. Dale Nelson, an actuary with State Farm, developed a "percent of premium" reserving risk charge for the AAA RBC Task Force. This kept the formula simple and eliminated the untoward incentives in the risk-based capital formula. Nevertheless, questions about the accuracy of this method

persuaded the AAA RBC Task Force not to recommend it to the NAIC Working Group.

Moreover, the NAIC Working Group has argued that the alignment of reported reserves with indicated reserves is the task of the company's appointed actuary and the state insurance department's financial examiners, not that of the risk-based capital formula. The current requirements for a "Statement of Actuarial Opinion" regarding loss and loss adjustment expense reserve adequacy may help prevent deliberate reserve understatements, particularly if the actuarial community seeks to enforce the regulatory mandate. In addition, although reserve understatements may reduce the present company adjustment to the reserving risk charge, they increase future development and thereby the future reserving risk charge.

Workers Compensation and Tabular Discounts

The first draft of the risk-based capital formula led to an average (industry-wide) reserving risk charge for workers compensation of 0.4%, which seemed relatively low to some regulators and analysts.

Duration and Volatility

Some actuaries considered this factor appropriate, since the reserving risk charge reflects the *net* effect of unexpected adverse development and the implicit interest discount:

- Workers compensation indemnity payments are made over time as the injured workers' loss of income is realized, and medical payments are made when physicians' bills are submitted. Large awards are only occasionally paid as lump sums, in contrast to general liability or automobile liability claims. Rather, compensation claims are paid over long durations, as permanent disability payments or as lifetime pension awards. The resulting long reserve duration implies that the interest discount factor should be high for workers compensation.

- Payment patterns are statutorily mandated for workers compensation, so the volatility of adverse loss development is low. In lines of business subject to tort liability rules, an adverse court decision may dramatically change the insurer's liability, necessitating a revision of held reserves. In contrast, payments on workers compensation claims are set by statute and known to the insurer soon after the loss occurs. The expected future payments on reported cases may change if average durations of disability change. However, these changes are slow and incremental, unlike the sudden effects of court decisions.

The combined effect of these two characteristics—the long reserve duration and the statutorily mandated loss payments—produces a low reserving risk charge.

Aggregate industry experience is even more indicative of the stability of workers compensation reserves. The +0.4% reserving risk factor was derived from unweighted (simple) averages of individual company adverse developments. Using aggregate industry data, or weighted averages of individual company data, produced a large *negative* reserving risk charge for workers compensation.

In other lines of business, external factors may affect the entire industry's liabilities, such as the enactment of retroactive liability for environmental impairment exposures, which may raise the industry's products liability reserves, or a natural disaster, which may raise the industry's homeowners reserves. There are few such cataclysmic events that might raise the industry's workers compensation reserves.[68]

Criticisms

Other actuaries, as well as several regulators, considered the workers compensation reserving risk factor to be too low. Several

[68]For a more complete analysis of the factors affecting workers compensation reserve uncertainty, see Hodes, Feldblum, and Blumsohn [32].

arguments were given to support this view, such as

- The observed loss development in the 1980s does not reflect the riskiness of workers compensation in the 1990s.[69]
- Industry-wide workers compensation reserves are deficient, more so than in other lines of business. This argument was sometimes worded to say that compensation carriers hold discounted reserves, but do not disclose this fact in their financial statements.[70]
- Many insurance companies use tabular loss reserve discounts for their workers compensation lifetime pension claims. The reserving risk charge in the risk-based capital formula should reflect the use of tabular discounts.

Tabular Discounts

The last of the arguments listed above, the tabular discount argument, became the official reason for changing the workers compensation reserving risk charge, from 0.4% in 1992 to 11% in 1993. Some actuaries believe, however, that the first two reasons were the underlying impetus for the revision in the factor.

How does the valuation basis for loss reserves affect the appropriate reserving risk charge? Adverse loss development in statutory statements may result from two causes:

- reserve inadequacies, resulting either from unexpected developments or from poorly estimated (or consciously underestimated) initial reserves, or
- the "unwinding" of the interest discount on discounted reserves. Although the unwinding of an interest discount is expected, it appears as adverse development in Schedule P.

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[69] See, for example, Lowe [39, p. 112]. Other actuaries argue that this criticism is reversed, as the adverse economic results for workers compensation in the latter half of the 1980s have dissipated in the 1990s.

[70] See, for example, the August 1992 report of the NAIC Working Group regarding the workers compensation reserving risk charge.

For instance, suppose full value reserves are set up for a block of business in December 1993 for $10 million. In December 1994 the losses are paid, but because of an adverse court decision, the total settlement is $11 million. This is "true" adverse development.

Alternatively, discounted reserves of $10 million, at a 10% interest rate per annum, may be set up for a block of business in December 1993. In December 1994, the losses are paid for $11 million. If the discount is not "grossed up" in Schedule P, then the latter situation also shows the same adverse loss development: 10% of reserves.[71]

The rationale for the effect of tabular discounts on the appropriate reserving risk charge is as follows:

- For other lines of business, current reserves are assumed to be adequate, so no future development is expected. All reserve figures are at full (undiscounted) value, since the charges are determined from Part 2 of Schedule P, which has always been gross of non-tabular discounts.
- For workers compensation, to the extent that companies use tabular discounts, current reserves are reported on a discounted basis. Future development equal to the unwinding of the tabular discount is expected. To get the full "gross-of-discount" adverse loss development, one must add the expected future unwinding of the interest discount to the observed adverse loss development in the experience period.

[71] When the workers compensation reserving risk charge was developed in early 1992, all the Schedule P exhibits were net of tabular discount, though they were gross of non-tabular discount. Since 1994, Part 2 of Schedule P, from which the reserving risk charges were determined, has been changed to a gross-of-tabular-discount basis, though Part 1 of Schedule P remains net of tabular discount. For a complete analysis of the Schedule P reporting requirements and of the change in the treatment of tabular discounts, contrast Feldblum [20] which documents the 1996 Schedule P, with Feldblum [25], which documents the 1992 Schedule P.

To account for the expected future unwinding of the tabular interest discount, the workers compensation reserving risk charge was changed from 0.4% to 11.1%.[72]

Two aspects of the tabular discounts issue provoked heated debate within the actuarial community: the adjustments to surplus in the risk-based capital formula, and the definition of tabular discounts.

Surplus Adjustments

The risk-based capital formula removes non-tabular discounts from policyholders' surplus, but retains the tabular discounts. (See Section 9 below.) Non-tabular discounts are removed from surplus to place all companies on a "level playing field."[73] Tabular discounts are retained in surplus to place property/casualty insurers providing long-term disability benefits on a "level playing field" with life insurers providing similar benefits.

For instance, suppose a commercial lines insurer writing workers compensation and other liability business has $1 billion of surplus, $1.5 billion of other liability reserves, and $2 billion of workers compensation reserves. The compensation reserves are net of $100 million of tabular discounts on lifetime pen-

[72]It is not clear how one should adjust the reserving risk charge for tabular discounts. Some actuaries have argued that the use of tabular discounts in workers compensation reserving should *lower* the reserving risk charge, not raise it, for the following reason.

Tabular loss reserve discounts are used for lifetime pension cases. The discounts are most frequently calculated at a 3.5% interest rate, which is the required rate for the unit statistical plan of the National Council on Compensation Insurance. Pension cases, which are permanent total disability and fatality claims, are extremely long-tailed, with average lifetimes of 30 to 40 years. The implicit interest margin in the risk-based capital formula uses the IRS loss reserve discounting procedures, which assumes that all claims are fully paid within 16 years. Extending the payment pattern from 16 years to the actual payment pattern of pension cases generates enough additional interest margin, because of the low tabular discount rate (3.5%) as compared to the risk-based capital discount rate (5.0%) or the actual portfolio yields received by insurance companies (about 7% in the 1990s), to compensate for the expected future unwinding of the interest discount.

For a complete analysis of the treatment of tabular discounts in the risk-based capital reserving risk charge, see Appendix A of Hodes, Feldblum, and Blumsohn [32].

[73]Compare the AAA "Conceptual Framework" white paper, from which several other studies of risk-based capital have borrowed the "level playing field" concept.

sion cases. In addition, this carrier has received permission from the insurance department in its domiciliary state to discount its other liability reserves and its remaining workers compensation reserves at a 4% discount rate. The amount of this "non-tabular" discount is $400 million.

The "adjusted policyholders' surplus" for the insurer's risk-based capital ratio calculation is $600 million, or $1 billion minus $400 million. In other words, the non-tabular discounts are subtracted from surplus, though the tabular discounts are not removed from surplus.

This adjustment to surplus for non-tabular discounts is phased-in over a five-year period. In the example above, $80 million is subtracted from surplus each year for five years, to get the risk-based capital "adjusted surplus." The reserving risk charge, however, is applied to reserves gross of any non-tabular discount, with no five-year phase-in.

Definition of Tabular Discounts

A company desirous of a higher risk-based capital ratio would prefer to label its interest discounts as "tabular" instead of as "non-tabular." Two questions arose:

- Do tabular discounts apply only to known cases (i.e., reported cases which are identified as lifetime pension), or to "unidentified pension cases" as well (i.e., claims that have not yet been coded as lifetime pension)?
- Do tabular discounts apply to indemnity (e.g., weekly disability) payments only, or to medical benefits as well (e.g., home nursing care for a quadriplegic)?

The NAIC Working Group stated that tabular discounts may be applied to all lifetime pension cases, whether already identified or not, but only to the indemnity benefits. The tabular dis-

count on unidentified lifetime pension cases is determined by standard actuarial bulk reserving procedures.[74]

8. IMPLEMENTATION OF RISK-BASED CAPITAL REQUIREMENTS

The risk-based capital formula produces a number: a "risk-based capital requirement." Three questions arose repeatedly during the development of the risk-based capital standards:

- What exactly does the "risk-based capital requirement" or the "risk-based capital ratio" mean?
- What effect should these figures have on regulatory action?
- How will regulatory action be implemented?

Minimum, Target, and Triple-A Standards

Existing state statutes define the minimum amount of surplus that an insurance company must hold to obtain a license. The amount varies by state, and it depends on the lines of business which the insurer writes. It is generally quite low, ranging from about $1 million to about $5 million. It does not vary with the size of the company or with the particular risks which it faces.

These state statutes define minimum capital requirements. They make no attempt to define the "optimal" or "target" amount of capital which the company should hold.

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[74]The same definition has been adopted by the NAIC Blanks (EX4) Task Force for Schedule P reporting. A clear definition of tabular discounts is needed since Part 1 of Schedule P is net of tabular discounts but gross of non-tabular discounts; see Feldblum [20].

Note 19 to the Financial Statements requires disclosure of all loss reserve discounts, separately for tabular discounts and non-tabular discounts. The definition of tabular discounts follows that introduced by the risk-based capital formula; see Feldblum [26].

The Actuarial Committee's "White Paper"

One of the first projects undertaken by the actuarial advisory committee to the NAIC Working Group (now the AAA RBC Task Force) was to develop a "white paper" on risk-based capital requirements.

The actuarial advisory committee was being asked to study the parameters used in the risk-based capital formula that had been developed by the NAIC Working Group. The committee responded that the proper size of the parameters depended on the meaning of the risk-based capital standards:

- If the risk-based capital formula defined a minimum amount of capital that must be held by all companies to be allowed to operate, then low parameters were appropriate.
- If the risk-based capital formula defined a target amount of capital that represented the "optimal" capital position for an insurer, then higher parameters would be appropriate.
- If the risk-based capital formula represented a "Triple-A" standard, or an amount of capital that only the financially strongest companies would hold, then even higher parameters would be appropriate.

The NAIC Working Group did not initially address this issue. Rather, it implicitly responded by spelling out the regulatory and company actions necessitated by the ratio of actual surplus held to the risk-based capital standard. (See Section 9 below.) The June 1993 statement of the NAIC Working Group, however, says:[75]

> The Working Group believes the proposed formula provides a minimum threshold measure of capital adequacy and is not overly complex… Since the formula is intended to identify insurers that require regulatory

[75] *Proceedings of the NAIC*, 1993, Second Quarter, p. 565.

> attention and does not purport to compute a target level of capital…

In other words, the risk-based capital formula is setting a minimum threshold for capital requirements, not a target level or a "Triple-A" level.[76]

9. REGULATORY ACTION

What effect do the risk-based capital standards have on regulatory and company actions?

Regulatory Hesitancy

Suppose you were the insurance commissioner in your state, and you have been informed that a medium-sized personal automobile writer domiciled there was in financial difficulty. You ponder how strenuously you should investigate this company:

- The company has over 1,000 employees in the state. If the company is liquidated, these individuals will be unemployed, increasing the discontent of the citizenry and reducing the state tax revenues.
- If the company does become bankrupt, outstanding claims will be paid by the state guaranty fund. The guaranty fund assesses all insurance companies doing business in the state, most of which are domiciled in other states.

The hesitancy of many state insurance departments to take action against financially troubled companies was a major impetus for the development of risk-based capital standards and requirements.

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[76]Cummins, Harrington, and Niehaus [14], forcefully argue for a minimum threshold standard. See, for instance, [14, p. 443]. "The arguments in favor of a minimum threshold approach are compelling… Fewer undesirable distortions in the decisions of sound insurers would result with a minimum threshold approach…"

Levels of Action

Some regulators argue that insurance departments must be afforded great discretion in their dealings with domestic insurance companies. Other regulators have argued that certain actions must be required of regulators, particularly when the needed action is unpleasant.

The risk-based capital requirements are a compromise between these two viewpoints. There are four levels of regulatory action, depending on the relationship between the "adjusted surplus" held by the company and the "risk-based capital surplus." This ratio is termed the "risk-based capital ratio."

The ACL Level

The levels of regulatory action actually depend not on the risk-based capital ratio but on the relationship of the company's adjusted surplus to the risk-based capital "authorized control level" (ACL) benchmark. At first glance, this seems a superficial distinction, since the authorized control level is a percentage of the risk-based capital standard. In practice, it is easier to change the authorized control level than the risk-based capital formula itself, and thereby implicitly change all the regulatory action levels.

For example, during the first half of 1993, the ACL benchmark was expected to be 50% of the risk-based capital standards. This would have forced many companies into rehabilitation or liquidation, and may have led to substantial opposition to the new risk-based capital standards.

However, the June 1993 draft of the risk-based capital formula defined the ACL benchmark as 40% of the risk-based capital standards. At this level, only about half as many companies would have been forced into rehabilitation or liquidation; as a result, opposition to the new standards was muted.

In October 1993, the NAIC shifted back to a 50% ACL benchmark, with a two-year phase-in from 40% to 50%, thereby giving

time to companies to strengthen their capital positions. By this time, the industry waters were placid, and in December 1993 the risk-based capital formula was adopted without significant opposition.

Four Action Levels

The NAIC envisions four levels of regulatory or company action, depending on the relationship of the company's actual (adjusted) surplus to its risk-based capital surplus. A property/casualty insurance company's actual surplus is adjusted for risk-based capital purposes by removing the amount of non-tabular loss reserve discounts from surplus (and adding them to reserves). Tabular loss reserve discounts do not affect the company's reported surplus for risk-based capital purposes.[77]

Company Action Level

The company action level is 75% to 100% of the risk-based capital standard, or 150% to 200% of the authorized control level benchmark. (The figures here assume an ACL benchmark equal to 50% of the risk-based capital surplus, as will be true at the end of the phase-in period.) If the company's adjusted surplus is within the company action range, no action is required of the state insurance department. Rather, the company must submit a plan of action to the insurance commissioner of the domiciliary state, explaining how the company intends to obtain the needed capital or to reduce its operations or risks to meet the risk-based capital standards.

Regulatory Action Level

The regulatory action level is 50% to 75% of the risk-based capital standard, or 100% to 150% of the ACL benchmark. The

[77] In addition, a property/casualty insurance company which owns a life insurance subsidiary may make the same adjustments to its surplus that the life insurance subsidiary makes to its surplus. These adjustments are to add back the asset valuation reserve and one-half of the policyholder dividends liability.

company's action is the same as at the "company action level": it must submit a plan to the insurance commissioner explaining how it intends to raise its risk-based capital ratio. If the company's adjusted surplus is within the regulatory action level range, then the commissioner has the right to take corrective action against the company, such as by restricting new business. However, all action by the state insurance department is discretionary; nothing is mandated by the risk-based capital formula or associated statutes.

Authorized Control Level

The authorized control level is 35% to 50% of the risk-based capital standard, or 70% to 100% of the ACL benchmark. If the company's adjusted surplus is within the ACL range, regulatory action is still discretionary, but the insurance commissioner is "authorized" to take control of the company.

Mandatory Control Level

The extreme level of regulatory action, the mandatory control level, is below 35% of the risk-based capital requirements, or below 70% of the ACL benchmark. If the company's (adjusted) actual surplus is below 70% of the authorized control level, then the insurance commissioner of the domiciliary state *must* rehabilitate or liquidate the company.[78]

Implementation

Past NAIC practice has been to propose "model laws" that are enacted by each state's legislature. This procedure allows full state discretion in reformulating the statute, but it also leads to long delays and inconsistencies between states.

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[78]The actual wording of the NAIC Risk-Based Capital Model Act is quite complicated. See Sections 3 through 6, which contain detailed instructions for these four "event levels": company action level event, regulatory action level event, authorized control level event, and mandatory control level event (pp. 312-5 through 312-9 of the January 1995 version of the NAIC Model Regulation Service notebook).

Two changes have therefore been made for risk-based capital.

- The proposed model law will not specify the risk-based capital formula, since then each state legislature might make changes and pass a different formula. In addition, as changes are made to the risk-based capital formula, each state would have to modify its statutes. Rather, the model law will make the NAIC risk-based capital requirements the statutory capital requirements in that state.

  To ensure uniform adoption of the risk-based capital standards among the states, the statutory Annual Statement instructions were revised to require disclosure of the NAIC "authorized control level risk-based capital" and the "adjusted surplus" on lines 25 and 26 of the Five Year Historical Data exhibits on pages 22 and 23 of the Annual Statement. Each state already has legislation making the NAIC statutory blank the official insurance company accounting requirement. Thus, each state already has legislation requiring insurers to compute and disclose their risk-based capital figures.[79]

- In late 1990, the NAIC adopted a "Solvency Policing Agenda." One part of this agenda says that a state's insurance department will be accredited by the NAIC only if it passes the required model laws. In December 1993, the NAIC amended its life insurance risk-based capital model law to make it applicable to non-life insurers, and this new model law became part of the NAIC accreditation standard in June 1994. Since the states desire accreditation, passage of the risk-based capital model law should be swift.

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[79] A parallel procedure was used to force the adoption by all states of the Statement of Actuarial Opinion. In the 1970s and 1980s, many states independently passed legislation requiring an opinion regarding loss reserve adequacy from an actuary or a loss reserve specialist, leading to a motley set of requirements in these states. In 1991, the NAIC revised the Annual Statement Instructions to require a Statement of Actuarial Opinion, leading immediately to uniform requirements in all states.

Purposes of the Risk-Based Capital Standards

There are five potential uses of the risk-based capital standards. They are ranked below from the intended purposes to those uses that are expressly prohibited by the NAIC.

1. *Minimum Capital Requirements*: The risk-based capital requirements replace (or supplement) the existing ad hoc minimum capital and surplus requirements with standards that reflect the operations of each company and the risks that it faces.
2. *Solvency Monitoring*: The risk-based capital standards serve as an additional tool in the insurance commissioner's solvency monitoring repertoire, to be used in conjunction with more comprehensive financial examinations.
3. *Legal Authority*: The risk-based capital model act provides the insurance commissioner with legal authority to intervene in a company's operations if it appears to be financially troubled.
4. *Rate-Making*: The risk-based capital formula might be used to determine the needed capital for a "return on equity" rate filing.
5. *Marketing*: The risk-based capital ratio might be used as a marketing tool to identify "stronger" or "weaker" companies, either by the companies themselves or by independent agents and financial analysts.

The last two uses have been expressly prohibited by the NAIC, as illustrated by the June 1993 statement of the NAIC Working Group:

> Since the formula is intended to identify insurers that require regulatory attention and does not purport to compute a target level of capital, the Working Group

> does not believe the results of this formula should be used in setting or reviewing premium rates or in determining an appropriate rate of return for an insurer. Furthermore, this formula should not be used to rate insurers, as many other factors must be taken into consideration in such an evaluation.[80]

The first three purposes listed above are summarized by Vincent Laurenzano [37, p. 100] as follows:

> The primary objective of the NAIC's risk-based capital project is to raise the safety net that statutory surplus provides for policyholder obligations. This enhancement of statutory surplus is to be accomplished by replacing the current fixed minimum capital requirements with a flexible capital standard that is related to the size and the risk profile of an insurer's balance sheet and underwriting activities. For property and casualty insurers the intent is to set a threshold level of capital, based upon industry performance and individual insurer characteristics, which will raise the statutory capital level from its current generally low and arbitrary amounts to a realistic base. The proposed capital standard will enable regulators to more effectively use statutory remedies and, in conjunction with

[80]See also Sections 8B and 8C of the NAIC Risk-Based Capital Model Act:

- Section 8B: It is the judgment of the legislature that the comparison of an insurer's Total Adjusted Capital to any of its RBC levels is a regulatory tool which may indicate the need for possible corrective action with respect to the insurer, and is not intended as a means to rank insurers generally. Therefore … the making, publishing … of any advertisement, announcement, or statement … with regard to RBC levels of any insurer … is prohibited.
- It is the further judgment of the legislature that the RBC Instructions, RBC Reports, Adjusted RBC Reports, RBC Plans, and Revised RBC Plans are intended solely for use by the commissioner in monitoring the solvency of insurers and the need for possible corrective action with respect to insurers and shall not be used by the commissioner for ratemaking nor considered or introduced as evidence in any rate proceeding nor used by the commissioner to calculate or derive any elements of an appropriate premium level or rate of return for any line of insurance which an insurer or any affiliate is authorized to write.

the array of other solvency tools, hasten intervention into troubled situations.

Therefore the goals of the NAIC's risk-based capital project are to:

- relate capital and surplus requirements of an insurer to the risks inherent in its particular operations;
- establish a universally recognized capital standard; and
- provide regulators with the authority to enforce compliance with more appropriate capital requirements.[81]

10. CONCLUSION

The risk-based capital requirements are the product of the combined efforts of regulators and actuaries. Regulators had the authority to set capital requirements for insurance companies, and actuaries had the expertise to determine appropriate parameters for each charge.

Many parts of the risk-based capital formula reflect the contributions of casualty actuaries, from the six-category structure of the covariance adjustment to individual charges (such as the growth charge) or components of charges (such as the loss concentration factor, the claims-made business offset, or the loss-sensitive contract offset).

The present risk-based capital formula is but the first step in the actuarial analysis of financial strength. Numerous other for-

[81] A similar perspective is reflected in Barth [7, p. 3]: "The NAIC RBC system operates in two basic fashions. First, it acts as a tripwire system that gives regulators clear legal authority to intervene in the business affairs of an insurer that triggers one of the warning levels. As a tripwire system, RBC alerts regulators to undercapitalized companies while there is still time for the regulators to react quickly and effectively to minimize the overall costs associated with an insolvency. Secondly, the RBC results may be used to intervene in the management of a company that is found to be in hazardous condition during the course of an examination."

mulas and models are now being developed by actuaries under the rubric of "dynamic financial analysis." The development of the NAIC risk-based capital system shows the theoretical potential and practical limitations of one type of solvency monitoring system. Readers of this paper should now have a better grasp of what has been accomplished, as well as a determined but realistic view of what may yet be achieved.

11. AN ILLUSTRATION

The risk-based capital formula has many interlocking pieces. This section provides a fully documented illustration, showing the capital requirements for a hypothetical insurance company, to help the reader understand the components of the formula.

The NAIC provides a risk-based capital diskette to each domestic insurance company. The exhibits in this illustration are based directly on the NAIC diskette for the 1995 risk-based capital submission, which was due in early 1996.

Most of the NAIC diskette is automated: the company copies entries from the financial statements to the diskette, and the spreadsheet calculates the risk-based capital charges. For a few cells, such as the number of issuers for the bond size adjustment factor, there is no corresponding entry in the financial statements, and the company must provide the required figures.

The *NAIC Instructions* contain all the cross-references between the risk-based capital diskette and the Fire and Casualty Annual Statement. These cross-references are not repeated here.

Certain factors, such as the reserving risk industry-wide adverse development factors and the interest discount factors, are promulgated by the NAIC. The method of deriving these factors is covered in the text of this paper. Since many of these factors involved judgment, they cannot be replicated by others, and their derivation is not illustrated here. These factors are hard-coded into the NAIC diskette.

This illustration follows the rounding and presentation formats used in the NAIC diskette. In general, although intermediate values are shown in rounded format, actual values are kept with full precision and the final risk-based capital requirements are calculated to the dollar. Thus, there are numerous rounding discrepancies in the exhibits and the documentation. To replicate the final risk-based capital requirements, the reader should recalculate the intermediate values with greater precision.

Simplifications

There are several minor differences between the entries required of the company and the illustration shown here.

- For the reserving risk and written premium risk components, the company enters the historical information from Schedule P. The risk-based capital spreadsheet determines the "company average development" and the "company average loss ratio" by line of business. (The "industry average development" and the "industry average loss ratio" by line of business are promulgated by the NAIC, and they are hard-coded in the spreadsheet.) This illustration does not show the calculation of these factors, since the text of this paper provides an example. Instead, the illustration assumes that these figures are given.

  In addition, certain logical values are calculated by the spreadsheet. For instance, for the written premium charge, the spreadsheet seems to ask, "Does the company pass the *de minimus* test?" This is *not* an input cell. Rather, the user enters the Annual Statement premium figures for each accident year, and the spreadsheet determines if the company passes the *de minimus* test.[82]

- Certain exhibits are abbreviated in this illustration. For instance, the reserving risk and written premium risk charges

[82]The reader should consult the *NAIC Instructions* to see which cells must be entered directly and which are calculated by the spreadsheet. This paper is not intended as a "how-to manual" for completing the risk-based capital submission.

consider all the Schedule P lines of business. This illustration uses only the first six lines of business, and the documentation discusses only three of these. Showing more lines of business simply complicates the illustration and adds no more educational information.

- The risk-based capital charges for investments in affiliates can be exceedingly complex, particularly for large, multi-layered insurance groups. This illustration makes no attempt to cover the various potential situations. Rather, it assumes that the insurance company is the sole owner of several subsidiaries, whose book value and risk-based capital requirements are given. The intention is to illustrate how the risk-based capital formula deals with investments in affiliates, not to illustrate all the possible variations.

Order

This illustration follows the format of the NAIC exhibit. It covers

- asset risk charges for unaffiliated investments;
- investments in affiliates;
- credit risk charges: reinsurance recoverable and other receivables;
- reserving risk charges;
- written premium charges;
- off balance sheet risks and growth charges;
- the covariance adjustment; and
- summary.

The format of the NAIC exhibits is sometimes confusing. For instance, the "asset risk charges" exhibits have entries for both the R_1 and the R_2 risk components, and the exhibits do not always clearly separate them.

Investments

Calculation of the investment risk charges may be divided (conceptually) into three steps:

1. investments in unaffiliated enterprises;
2. adjustments to the RBC charges for these investments: the asset concentration factor and the bond size factor; and
3. investments in affiliated enterprises.

Unaffiliated Investments

The basic risk-based capital charge for investments in unaffiliated enterprises is the statement value of the investment times the RBC factor. The RBC factors differs (a) by type of investment and (b) by quality classification of the investment. Two additional charges are then included: a bond size factor charge and an asset concentration charge.

Bond Investments

Exhibit 1 shows the risk-based capital requirements for investments in bonds of unaffiliated enterprises.

- The company enters the statement values in the first numeric column.
- The RBC factors in the second numeric column are hard-coded into the spreadsheet.
- The risk-based capital charge in the third numeric column is the product of the entries in the first two columns.

The exhibits throughout this illustration are intended to highlight the major sources of risk, not necessarily to reflect prevalent industry practice. For instance, the bond risk charges are high only for bonds below investment grade quality. In this illustration, the company owns $35,000,000 of bonds that are "in or near

default" (Class 06).[83] This set of bonds gives a risk-based capital charge of $10,500,000, which is almost half of the total bond charge (before the bond size adjustment factor) of $21,800,000 ($3,300,000 + $18,500,000).

Class 01 bonds are not subject to the bond size factor. For the remaining bonds, there are 227 issuers in this example. (The company must enter this number. It is not readily available from other Annual Statement exhibits, except by counting individual issuers.)

The bond size adjustment factor is calculated as

$$[(50 * 250\%) + (50 * 130\%) + (127 * 100\%)] \equiv 227 = 139.65\%.$$

In other words, the risk-based capital charge for bonds subject to the bond size factor, or $18,500,000, must be multiplied by 1.3965. The NAIC exhibit shows this as an additive factor, not a multiplicative factor. That is, the $18,500,000 is multiplied by 0.3965 to give $7,334,802, and this product is added to the other bond charges to give a total of $29,134,802. This figure, along with mortgages, other loans, and part of the asset concentration charge, becomes the R_1 component for the square root rule.

Unaffiliated Stock

The investments in unaffiliated stocks are divided between preferred stock and common stock, as shown in Exhibit 2. The risk-based capital charges for preferred stock are similar to those for corporate bonds with an additional 2% charge in each quality class (except for Class 06, which already has the maximum charge of 30%).

Investments in unaffiliated common stocks have a risk-based capital charge of 15%. Investments in non-government money market funds have a charge of 0.3%.

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[83]This illustration is heuristic only, with large amounts of Class 06 and Class 04 bonds (so that there are significant charges) and few other corporate bonds (so that there is a significant bond size factor).

The charges for preferred stock and common stock, along with the charges for other equities (such as real estate) and part of the asset concentration charge, becomes the R_2 component for the square root rule.

Other Investments

Exhibit 3 shows investments in several other types of securities, divided between long-term assets and short-term assets:

- real estate;
- mortgages;
- other long-term (Schedule BA) assets;
- collateral loans;
- cash; and
- other short-term investments.

As is true for investments in bonds and stocks, the RBC factors are hard-coded, the statement values are entered by the company, and the RBC charges are the products of these two figures. Some of these charges are included in the R_1 risk component and some are included in the R_2 risk component.

Asset Concentration Charges

The asset concentration worksheet doubles the risk-based capital charges for investments from the ten largest issuers. Investments that have less than a 1% risk-based capital charge, such as government bonds, are not included. Similarly, investments that already carry the maximum risk-based capital asset risk charge of 30%, such as Class 06 corporate bonds, are not included. In addition, affiliated common stock, preferred stock, affiliated bonds, and home office properties are excluded.

The remaining assets are grouped by issuer to determine the ten largest groups. The insurance company may hold both stocks

and bonds from the same issuer, as in the first several examples in Exhibit 5. The stocks and bonds are combined to determine the ten largest issuers.

The asset concentration factors are shown in Exhibit 4. These are the same factors as for the original investments. Thus, the asset concentration procedure doubles the charge for these investments.

The "additional RBC" charges shown in Column 4 of Exhibit 5 are subtotaled into fixed income charges and equity charges, and they are included in the R_1 risk component and the R_2 risk component, respectively.

Investments in Subsidiaries

To illustrate the treatment of the risk-based capital charges for investments in affiliates, this illustration shows several subsidiaries: two directly-owned U.S. property/casualty insurance subsidiaries, one indirectly-owned U.S. property/casualty insurance subsidiary, the holding company that owns this property/casualty insurer and that has a value in excess of the indirectly-owned subsidiary, one alien insurer, and one investment subsidiary.

The risk-based capital charges are shown in Exhibit 6, and additional detail is shown in Exhibit 7. The charges for the insurance subsidiaries are included in the R_0 risk component, which is outside the square root procedure in the covariance adjustment. The charge for the holding company's value in excess of the indirectly-owned subsidiary is an equity charge, so it is included in the R_2 risk component. One "looks through" the investment subsidiary to the stocks (or bonds) that it owns. In other words, the equity risk charge for the stocks owned by this investment subsidiary is passed up to the parent company's R_2 risk category.

Because the R_2 risk component is relatively small in this illustration (as is true for most U.S. insurance companies) relative

to the reserving risk charge and the written premium risk charge, the marginal effect of each dollar of R_2 risk charge after covariance is weak.

Thus, the relative effect of the risk charge for each affiliate is more extreme than it appears in Exhibit 6. The charges included in the R_0 risk component are powerful. The charges included in the R_2 risk component are diluted by the square root rule.

Credit Risk

The credit risk Exhibit 8 has two sections. The bottom section lists five miscellaneous receivables from page 2 of the Annual Statement:

- federal income tax recoverable (page 2, line 13);
- interest, dividends, and real estate income due and accrued (page 2, line 15);
- amounts recoverable from parents, subsidiaries, and affiliates (page 2, line 16);
- amounts receivable related to uninsured accident and health plans (page 2, line 18); and
- aggregate write-ins for other than invested assets (page 2, line 20).

The statement values in Column 4 are entered by the company from its Annual Statement balance sheet. The RBC factors in Column 5 are hard-coded in the spreadsheet. The risk-based capital requirements in Column 6 are the products of the entries in the preceding two columns.

Ceded Reinsurance

The top section of Exhibit 8 displays the charge for reinsurance recoverables, which is ten percent of the outstanding bal-

ance. As discussed in the text of this paper, there are several modifications to this charge.

- There is no charge for reinsurance recoverable from U.S. affiliates. As the first and fifth rows of this section indicate, recoverables from *non-U.S.* affiliates only are listed.
- There is no charge for reinsurance recoverables from involuntary (residual market) pools. As the third and seventh rows of this section of the exhibit indicate, recoverables from *voluntary* pools only are listed.
- There is no charge for reinsurance recoverables from certain voluntary pools and associations. The NAIC Working Group explains that

> Not all voluntary pools receive the reinsurance RBC charge. List those pools for which an exemption is claimed in the table below. The sum of the ceded balances in the table below and the sum of the ceded balances in the RBC table above should equal the total in lines 0799999 and 1699999 of Schedule F Part 3.

The Provision for Reinsurance

- The statutory provision for reinsurance (that is, the "Schedule F penalty") is deducted from the reinsurance recoverables before application of the risk-based capital charge.[84] To do otherwise would double-count the liability or the capital requirement.

  In the illustration, the unadjusted recoverable is shown in Column 1 in the upper half of the exhibit, the provision for reinsurance is shown in Column 3, and the difference, which is the "amount subject to RBC," is shown in Column 4.

[84]For the computation of the "provision for reinsurance," see Feldblum [21].

For the unaffiliated reinsurers, there are various Schedule F penalties shown in the exhibit.

- The largest authorized unaffiliated reinsurer has been classified as "slow-paying" for this ceding company, and its balances are not secured. Thus, there is a large Schedule F penalty on line 2, and the ceded balances subject to RBC are $18,500,000.
- For the recoverables from domestic unaffiliated unauthorized reinsurers in line 6, or $10,000,000, 80% is secured by funds withheld or letters of credit. The Schedule F penalty is $2,000,000, and the ceded balances subject to risk-based capital charges equal $8,000,000.
- Very little of the recoverables from non-domestic unaffiliated unauthorized reinsurers in line 8, or $7,500,000, is secured by funds withheld or letters of credit. The Schedule F penalty is large ($6,500,000) and the ceded balances subject to risk-based capital charges are small ($1,000,000).

The figures in Column 4, the "amounts subject to RBC," are multiplied by the credit risk factor of 10% to give the figures in Column 5, the "RBC requirements." These amounts are summed to give the risk-based capital charge of $4,750,000 for reinsurance recoverables. To this is added the charge for miscellaneous recoverables to give the total credit risk RBC of $4,885,000.

Reserving Risk Charge

The risk-based capital underwriting risk charges use all the Schedule P lines of business. For simplicity, the first six of these lines are shown on Exhibit 9. In order to illustrate the various adjustments that must be considered, the computation of the charges for three of these lines is described below.

- *Private Passenger Automobile Liability* is the company's largest line in premium volume and second largest line in reserve

volume. The underwriting risk charges for this line use the standard formula, with no adjustments (in this illustration) for loss-sensitive contracts or for claims-made business.

- *Workers Compensation*, one-fifth of whose business is written on retrospectively rated plans, receives the loss-sensitive contract offset on this portion.

- *Medical Malpractice* is partly written on occurrence forms, to which the full capital charges apply, and partly written on claims-made forms, to which the 20% claims-made reduction applies.

All dollar amount entries are in thousands, since the figures are from Schedule P, whose entries are in thousands of dollars. The final risk-based capital charges, however, are converted back to whole dollars.

The sixth row of figures on the exhibit shows "Loss + LAE Unpaid Sch P Part 1 (in 000s)." In the tenth and eleventh rows of figures, the company enters the percentage of reserves for accidents relating to loss-sensitive business, such as retrospectively rated workers compensation policies or reinsurance treaties with sliding scale commission rates. In 1994, this information was not found elsewhere in the Annual Statement. In 1995, a new Part 7 was added to Schedule P to provide this information (Part 7, Section 1, Column 4).[85] The illustration assumes that one-fifth of the workers compensation business is written on retrospectively rated plans, and one-fifth of the reserves are for accidents relating to such business.

The thirteenth row of figures shows the reserves relating to business written on claims-made forms. The claims-made risk charge reduction applies to medical malpractice business only.

[85] See Feldblum [20] for further discussion of this statutory exhibit.

The illustration assumes that slightly more than half the company's medical malpractice business is written on claims-made forms, but claim reserves for these policies constitute only 25% of the line's reserves.

The figures appearing on the spreadsheet are rounded, though the actual entries and the computations use unrounded numbers. The use of the unrounded numbers in the spreadsheet cells enables us to obtain the "net loss + LAE RBC" of $320,157,630 in the Total column of Row 17.

Private Passenger Auto Liability

If there were no company adjustment, then the reserving risk charge would equal

$$\text{Reported Reserves} * [(1 + \text{RBC Charge})(\text{Discount Factor}) - 1].$$

As long as the company has the required historical experience, the RBC charge is modified by the company's own experience. The adjusted RBC charge is the average of the industry RBC charge and the company RBC charge. The company RBC charge is the industry RBC charge times the ratio of the company average development factor to the industry average development factor.

Exhibit 9 shows these computations. The "Industry RBC Percentage" of 0.254, which is based on 1982–1991 experience, is hardcoded into the spreadsheet; it does not change from year to year. The industry average development factor is based on Schedule P experience from the previous year's Annual Statements. Thus, for the 1995 risk-based capital spreadsheet, this figure is based on data from the 1994 Annual Statements. It is hard-coded into the spreadsheet, but it changes from year to year. For personal auto, the figure was 1.032 for the 1995 risk-based capital submission.

The "Company Average Development" is based on data from the current year's Annual Statement. It is not hard-coded into the spreadsheet, since it varies from company to company. In this illustration, the figure for personal auto is 1.150.

The ratio of the company average development to the industry average development is $1.150 \div 1.032 = 1.114$, as shown on Row 3. The adjusted RBC percentage (which is not shown on the spreadsheet) is $0.254 * 1.114 = 0.283$. The "Company RBC Percentage," which is the average of the adjusted RBC percentage and the industry RBC percentage, is $(0.254 + 0.283) \div 2 = 0.2685$. This figure is shown on Row 5.

The adjustment factor used to convert the "Industry RBC Percentage" to the "company RBC percentage" can also be computed in a single step as

$$[(\text{industry average development factor} + \text{company average development factor}) \div 2] \div \text{industry average development factor.}$$

In this illustration, the figures are

$$[(1.032 + 1.150) \div 2] \div 1.032 = 1.05717.$$

The "company RBC percentage" equals

$$0.254 * 1.05717 = 0.268.$$

The reserving risk charge equals

$$\text{Reported Reserves} * [(1 + \text{Company RBC Charge})(\text{Discount Factor}) - 1].$$

For this illustration, the figures are

$$\$600{,}000{,}000 * \{[1 + (0.268)](0.921) - 1\} = \$100{,}984{,}880.$$

Workers Compensation

Of the company's $1,250,000,000 in workers compensation reserves, 20%, or $250,000,000, is for accidents related to business written on retrospectively rated plans. This business gets the 30% reduction for loss-sensitive contracts,[86] so the final risk-based capital charge is multiplied by

$$1 - (30\%) * (20\%) = 94\%.$$

For workers compensation, the adjustment for the company's experience is

$$[(1.066 + 1.050) \div 2] \div 1.066 = 0.9925.$$

The reserving risk charge, before the offset for loss-sensitive contracts, equals

Reported Reserves

$$* [(1 + \text{Company RBC Charge})(\text{Discount Factor}) - 1].$$

For this illustration, the figures are

$$\$1,250,000,000 * \{[1 + (0.9925)(0.273)](0.872) - 1\}$$

$$= \$135,336,829.$$

Multiplying this figure by 94% yields the final risk-based capital charge of $127,216,620. The spreadsheet shows this computation in two steps. The loss-sensitive discount on Row 12 equals the percentage of loss-sensitive business times the loss-sensitive business offset factor times the "Base Loss + LAE Reserve RBC" (Row 9), or

$$20\% * 30\% * \$135,336,829 = \$8,120,210.$$

The final reserving risk charge is $135,336,829 – $8,120,210 = $127,216,620.

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[86]There are separate lines for the *direct* loss-sensitive business (Row 10) and the *assumed* loss-sensitive business (Row 11), since the loss-sensitive contract offset is 30% for direct business and 15% for assumed business. See the text of this paper for the justification of this differentiation.

Medical Malpractice

The medical malpractice charge has an offset of 20% for claims-made policies. Since 25% of the $400,000,000 of reserves (or $100,000,000) is for claims relating to business written on claims-made forms, as shown on Row 13, the final risk-based capital charge is multiplied by

$$1 - (20\%) * (25\%) = 95\%.$$

For medical malpractice, the adjustment for the company's experience is

$$[(1.028 + 1.200) \div 2] \div 1.028 = 1.084.$$

The reserving risk charge, before the offset for claims-made business, equals

Reported Reserves

$$* [(1 + \text{Company RBC Charge})(\text{Discount Factor}) - 1].$$

For this illustration, the figures are

$$\$400,000,000 * \{[1 + (1.084)(0.565)](0.808) - 1\}$$

$$= \$121,084,545.$$

Multiplying this figure by 95% yields the final risk-based capital charge of $115,030,318.

The spreadsheet shows the computation in two steps. The "Claims-Made Discount" on Row 14 equals the percentage of claims-made business times the claims-made offset factor times the "Base Loss + LAE Reserve RBC," or

$$25\% * 20\% * \$121,084,545 = \$6,054,227.$$

The final risk-based capital charge is $121,084,545 – $6,054,227 = $115,030,318.

The computations for the other lines shown on the exhibit, homeowners/farmowners, commercial auto liability, and commercial multi-peril, have no additional features beyond those already discussed.

Loss Concentration Factor

The sum of the reserving risk charges for the six lines of business is $374,611,461, shown on Row 15. The loss concentration percentage is the ratio of unpaid losses and LAE for the largest line, or $1,250,000,000 for workers compensation, to unpaid losses and LAE for all lines combined, or $2,425,000,000. This ratio is 0.515464. This figure is *not* shown on the exhibit.

The adjustment for diversification by line, or the loss concentration factor, is

$$70\% + 30\% * (\text{Loss Concentration Percentage}).$$

In this illustration, the adjustment is

$$70\% + 30\% * 51.5464\% = 85.464\%.$$

Multiplying this factor by the unadjusted charge of $374,611,461 gives the "Net Loss + LAE Risk-Based Capital Charge" of $320,157,630 in the Total column of Row 17.

Written Premium Charge

Exhibit 10 shows the same lines of business as Exhibit 9. We discuss the same three lines as for the reserving risk charge.

The format of the written premium risk charge exhibit is similar to that of the reserving risk charge exhibit. The "Industry Loss & LAE Ratio" on Row 4 is based on 1982–1991 historical experience. It is hard-coded into the spreadsheet, and it is not updated each year.

The "Industry Average Loss and LAE Ratio" on Row 1 is based on Schedule P experience from the year prior to the current valuation date. It is hard-coded into the spreadsheet, but it is updated from year to year. For the 1995 risk-based capital computations, the entries are based on 1994 Schedule Ps.

The "Company Average Loss and LAE Ratio" on Row 2 is based on the company's current Schedule P experience. The "Company Underwriting Expense Ratio" on Row 6 is an all lines combined average (25% in this illustration), and it is based on information in the current Annual Statement.

Row 8 of the exhibit shows the net written premium by line of business in the most recent calendar year. (In the theory of the risk-based capital formula, this figure serves as a proxy for the net written premium in the coming twelve months.) Rows 10 and 11 show the percentage of premium written on loss-sensitive contracts. The figures are shown separately for direct business, which has an offset factor of 30%, and for assumed business, which has an offset factor of 15%.

Row 13 shows the percentage of claims-made written premium. This entry is relevant only for medical malpractice.

Private Passenger Auto Liability

If there were no company adjustment to the written premium risk charge factor, and no offsets for loss-sensitive contracts or for claims-made business, the written premium charge would be

$$\text{Written Premium} * \{[(\text{Industry Loss \& LAE Ratio} * \text{Discount Factor}) + \text{Expense Ratio}] - 1\}$$

The industry loss & LAE ratio is the "worst case year," not the average industry loss and LAE ratio. The discount factor is applied to the loss and LAE ratio, since loss and loss adjustment

expenses are paid out over time. It is not applied to the expense ratio, since most expenses are paid out up front. Note the difference in the structure of the charge between the reserving risk charge and the written premium risk charge. The reserving risk RBC factor measures just the adverse development, so the discount factor is applied to "unity plus the RBC factor." In the written premium risk charge, there is no "unity plus" that needs to be added.

As long as the company has the required years of experience and it passes the *de minimus* test, the RBC charge factor is modified by the company's own experience. Specifically, the adjustment is

$$[(\text{Industry Average Loss Ratio} + \text{Company Average Loss Ratio}) \div 2] \div \text{Industry Average Loss Ratio.}$$

In this illustration, the figures are

$$[(0.931 + 0.982) \div 2] \div 0.931 = 1.027.$$

The adjusted loss and LAE ratio is $1.046 * 1.027 = 1.075$. This is shown on Row 5 as the "Company RBC Loss & LAE Ratio."

The capital charge is

$$\text{Written Premium} * \{[(\text{Adjusted RBC Charge Factor} * \text{Discount Factor}) + \text{Expense Ratio}] - 1\}$$

In this illustration, the figures are

$$\$800{,}000{,}000 * \{[(1.075 * 0.924) + 0.250] - 1\} = \$194{,}381{,}161.$$

Workers Compensation

Of the company's $500,000,000 in workers compensation written premium, 20%, or $100,000,000, is written on retrospectively rated plans. This business gets the 30% reduction for loss-sensitive contracts, so the final risk-based capital charge is multiplied by

$$1 - (30\%) * (20\%) = 94\%.$$

The adjustment to the RBC Charge Factor is

$$[(0.901 + 0.850) \div 2] \div 0.901 = 0.9717.$$

The adjusted loss & LAE ratio is $0.9717 * 1.008 = 0.9795$.

The capital charge before the loss-sensitive contract offset is

Written Premium

$$* \{[(\text{Adjusted RBC Charge Factor} * \text{Discount Factor}) + \text{Expense Ratio}] - 1\}$$

In this illustration, the figures are

$$\$500,000,000 * \{[(0.9795 * 0.836) + 0.250] - 1\}$$
$$= \$34,419,170.$$

Multiplying by 94% gives the final charge of $32,354,020. The spreadsheet shows this in two steps. The loss-sensitive discount is 6% of $34,419,170, or $2,065,150. The final written premium charge is $34,419,170 – $2,065,150 = $32,354,020.

Medical Malpractice

The medical malpractice charge has an offset of 20% for claims-made business. Since 53.3%, or $80,000,000, of the $150,000,000 premium is written on claims-made forms, the final risk-based capital charge is multiplied by

$$1 - (20\%) * (53.3\%) = 89.33\%.$$

The company adjustment to the RBC Charge Factor is

$$[(0.955 + 0.984) \div 2] \div 0.955 = 1.0152.$$

The adjusted loss & LAE ratio is $1.0152 * 1.472 = 1.494$.

The capital charge before the claims-made business offset is

Written Premium

$$* \{[(\text{Adjusted RBC Charge Factor} * \text{Discount Factor}) + \text{Expense Ratio}] - 1\}.$$

In this illustration, the figures are

$$\$150{,}000{,}000 * \{[(1.494 * 0.778) + 0.250] - 1\}$$

$$= \$61{,}890{,}615.$$

Multiplying by 89.33% gives the final charge of $55,294,075. As for workers compensation, the spreadsheet shows the two-step format.

Premium Concentration Factor

The sum of the written premium risk-based capital charges for the six lines of business is $339,258,714. The premium concentration percentage is the ratio of written premium for the largest line, or $800,000,000 for private passenger auto liability, to written premium for all lines combined, or $1,800,000,000. This ratio is $8 \div 18 = 0.444$.

The adjustment for diversification by line, or the "premium concentration factor," is

$$70\% + 30\% * (\text{Premium Concentration Percentage}).$$

In this illustration, the adjustment is

$$70\% + 30\% * 44.4\% = 83.3\%.$$

Multiplying this factor by the unadjusted charge of $339,258,714 gives the net written premium risk-based capital charge of

$282,715,595 at the bottom of the exhibit (Row 17, Total column).

Off Balance Sheet Risks

The "miscellaneous off balance sheet items" in Exhibit 11 show three charges:

- noncontrolled assets, from General Interrogatory #20;
- guarantees for affiliates, from Note 4 to the financial statements; and
- contingent liabilities, from Note 8 to the financial statements.[87]

The risk-based capital factor is 1% for each of these, which is hard-coded into the second numeric column of the exhibit. The figures in the first numeric column, "Statement Value," are entered by the company. The RBC charges in the third numeric column are the products of the entries in the first two columns. These charges are included in the R_0 risk category.

The only miscellaneous off balance sheet item in this illustration stems from a suit against the company, unrelated to its insurance operations, seeking $15,000,000 in damages. The company believes that it has no liability; no entry is made to the balance sheet, though a disclosure is made in the notes to the financial statements. The risk-based capital charge is 1% of this amount, or $150,000.

Excessive Growth

The excessive growth RBC charge depends upon the rate of premium growth during the past three years for the group of which the company is a member. This is the only place where consolidated group figures are used in the risk-based capital calculation. Insurance company fleets sometimes shift an entire

[87]The interrogatory numbers and financial statement note numbers are for the 1995 Annual Statement. The numbers may be different in subsequent years.

block of business from one member to another member. If individual company premium were used to determine excessive growth, this shift of business would show up as a surge in growth, when in fact there is no additional risk.

The excessive growth charge depends upon *gross* written premiums, not net written premiums. New insurers will often use much pro-rata reinsurance to lessen their risks and to gain underwriting assistance from the reinsurers. As these new insurers mature, they will eliminate much of the reinsurance coverage, in order to retain more of the profits from their book of business.

The excessive growth charge relates to the presumed unfamiliarity of the insurance company with the underwriting or reserving characteristics of a new book of business. This unfamiliarity is reflected in the growth of gross written premium, regardless of whether the insurer is reinsuring part of the risk. Of course, the growth charge is applied to net written premium and net loss reserves, so if the reinsurer has indeed transferred the underwriting and reserving risks to reinsurers, it will have no additional capital requirements.

Conversely, when the primary insurer takes down its reinsurance coverage, its net business has indeed increased. But this is not growth that reflects unfamiliarity with the characteristics of the book of business, so it does not affect the calculation of the growth charge factor. Of course, since the primary company is retaining more of the business, its risks have increased, so any growth charge factor that it does have (from increases in gross written premium), as well as the standard written premium and reserving risk factors, are applied to a larger volume of net written premium or net loss reserves.

The company enters the gross written premium figures for the consolidated group in the first four rows of Exhibit 12. The spreadsheet calculates:

- three individual year group growth rates (for the three most recent years);
- three average group growth rates (latest year, latest two years, and latest three years); and
- the selected group growth rate.

Each individual year's group growth rate is that year's gross written premium divided by the previous year's gross written premium. In the illustration, these rates are 18%, 17%, and 14%.

The average growth rates are arithmetic averages. For instance, the two year average is the average of the current year's group growth rate and the previous year's group growth rate.

The selected growth rate is the three-year average if it exists (i.e., if the group has been in business for more than three years). Otherwise, it is the two-year average, if it exists; otherwise it is the one-year rate, if it exists. In the illustration, the three-year average growth rate of +16.3% exists, so it is selected.

The excess growth rate is the selected growth rate minus 10%. The excess growth rate is capped below at 0% and above at 30%. (This is equivalent to capping the selected growth rate at 40%, as discussed in the text of this paper.) For a company that has been in business less than one year, the excess growth rate is 0%. In the illustration, +16.3% − 10.0% = +6.3%, which is the excess growth rate.

The company enters the current year's net loss and LAE unpaid and net written premium.

For the reserving risk portion, the Excessive Growth RBC Charge equals

$$\text{Excessive Growth Rate} * 45\% * \text{Unpaid Losses and LAE}$$

$$= 6.3\% * 45\% * \$2{,}425{,}000{,}000 = \$70{,}325{,}000.$$

In the illustration, the factor of "0.029" is derived as

$$\{[(18\% + 17\% + 14\%) \div 3] - 10\%\} * 0.45 = 2.85\%.$$

For the written premium risk portion, the Excessive Growth RBC Charge equals

$$\text{Excessive Growth Rate} * 22.5\% * \text{Net Written Premium}$$

$$= 6.3\% * 22.5\% * \$1{,}800{,}000{,}000 = \$25{,}200{,}000.$$

In the illustration, the factor of "0.014" is derived as

$$\{[(18\% + 17\% + 14\%) \div 3] - 10\%\} * 0.225 = 1.425\%.$$

For the covariance adjustment, the loss reserves excess growth RBC will be included in the R_4 risk category, and the written premium excess growth RBC will be included in the R_5 risk category.

Covariance Adjustment

In Exhibit 13, the individual risk-based capital charges are grouped into the six risk categories (total R_0, total R_1, etc.). Line 54, "Total RBC After Covariance," uses these subtotals in the square root rule, as

$$\text{Total RBC After Covariance}$$

$$= R_0 + (R_1^2 + R_2^2 + R_3^2 + R_4^2 + R_5^2)^{0.5}.$$

In the illustration, the total RBC after covariance is $948,037,136. In 1995, the "authorized control level RBC" is 45% of this amount, or $426,616,711, as shown on Line 55. In 1996 and subsequent years, the authorized control level RBC will be 50% of the total RBC after covariance.

Risk-Based Capital Ratio

The company's adjusted capital in this illustration is $1,335,000,000, as shown in Exhibit 14. This figure is derived from the company's policyholders' surplus as recorded in the Annual Statement, along with the adjustments noted in the text of this paper, such as the adjustments for loss reserve discounts.

Since the company's adjusted capital exceeds the company action level, no level of action is indicated. The company's risk-based capital ratio is $1,335,000,000 ≡ $426,616,711, or 3.13. In other words, the company is in reasonable financial condition, though it is not particularly strong.

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EXHIBIT 1

UNAFFILIATED BONDS

		(1) Statement Value		(2) Factor		(3) RBC Requirement
(1)	Class 01—U.S. Government—Direct and Guaranteed	1,200,000,000	×	0.000	=	0
(2)	Class 01—U.S. Government Agency (not backed by full faith and credit of the U.S. government)	1,100,000,000	×	0.003	=	3,300,000
(3)	Other Class 01 Unaffiliated Bonds	0	×	0.003	=	0
(4)	Class 02 Unaffiliated Bonds	350,000,000	×	0.010	=	3,500,000
(5)	Class 03 Unaffiliated Bonds	0	×	0.020	=	0
(6)	Class 04 Unaffiliated Bonds	100,000,000	×	0.045	=	4,500,000
(7)	Class 05 Unaffiliated Bonds	0	×	0.100	=	0
(8)	Class 06 Unaffiliated Bonds	35,000,000	×	0.300	=	10,500,000
(9)	Subtotal—Bonds Subject to Bond Size Factor	485,000,000				18,500,000
(10)	Number of Issuers	227				
(11)	Bond Size Factor					0.40
(12)	Bond Size Factor RBC					7,334,802
(13)	Total Unaffiliated Bonds RBC					29,134,802

EXHIBIT 2

UNAFFILIATED PREFERRED AND COMMON STOCK

	(1) Statement Value		(2) Factor	(3) RBC Requirement
Unaffiliated Preferred Stock				
(1) Class 01 Unaffiliated Preferred Stock	10,000,000	×	0.023 =	230,000
(2) Class 02 Unaffiliated Preferred Stock	5,000,000	×	0.030 =	150,000
(3) Class 03 Unaffiliated Preferred Stock	0	×	0.040 =	0
(4) Class 04 Unaffiliated Preferred Stock	0	×	0.065 =	0
(5) Class 05 Unaffiliated Preferred Stock	0	×	0.120 =	0
(6) Class 06 Unaffiliated Preferred Stock	0	×	0.300 =	0
(7) Total Unaffiliated Preferred Stock	15,000,000			380,000
Unaffiliated Common Stock				
(8) Non-government Money Market funds	20,000,000	×	0.003 =	60,000
(9) Other Unaffiliated Common Stock	350,000,000	×	0.150 =	52,500,000
(10) Total Unaffiliated Common Stock	370,000,000			52,560,000

EXHIBIT 3

OTHER LONG TERM ASSETS AND MISCELLANEOUS ASSETS

LONG TERM ASSETS	(1) Statement Value		(2) Factor	(3) RBC Requirement
(1) Company Occupied Real Estate	50,000,000	×	0.100 =	5,000,000
(2) Encumbrances	0	×	0.100 =	0
(3) Investment Real Estate	125,000,000	×	0.100 =	12,500,000
(4) Encumbrances	0	×	0.100 =	0
(5) Total Real Estate	175,000,000			17,500,000
(6) Mortgage Loans	10,000,000	×	0.050 =	500,000
(7) Schedule BA Assets	10,000,000	×	0.200 =	2,000,000
(8) Total Long-Term Assets	195,000,000			20,000,000

MISCELLANEOUS ASSETS	(1) Statement Value		(2) Factor	(3) RBC Requirement
(1) Collateral Loans	2,500,000	×	0.050 =	125,000
(2) Cash	5,000,000	×	0.003 =	15,000
(3) Aggregate Write-ins for Invested Assets	7,500,000	×	0.050 =	375,000
(4) Short-Term Investments	0	×	0.003 =	0
(5) Total Miscellaneous Assets	15,000,000			515,000

EXHIBIT 4

ASSET CONCENTRATION FACTORS

Type Asset	Factor
Class 02 Unaffiliated Bonds	0.010
Class 03 Unaffiliated Bonds	0.020
Class 04 Unaffiliated Bonds	0.045
Class 05 Unaffiliated Bonds	0.100
Unaffiliated Preferred Stock—Class 01	0.023
Unaffiliated Preferred Stock—Class 02	0.030
Unaffiliated Preferred Stock—Class 03	0.040
Unaffiliated Preferred Stock—Class 04	0.065
Unaffiliated Preferred Stock—Class 05	0.120
Real Estate Excluding Home Office	0.100
Real Estate Encumbrance Excluding Home Office	0.100
Schedule BA Assets	0.200
Aggregate Write-Ins for Invested Assets	0.050
Collateral Loans	0.050
Mortgages	0.050
Unaffiliated Common Stock	0.150

EXHIBIT 5

ASSET CONCENTRATION

(1)	(2) Statement Value	(3) Factor	(4) Additional RBC
ISSUER #1 Transient Industries			
Fixed Income-Type Assets			
1.01 Class 02 Unaffiliated Bonds	5,078,597	× 0.010 =	50,786
1.03 Class 04 Unaffiliated Bonds	4,278,072	× 0.045 =	192,513
1.07 SUBTOTAL—FIXED INCOME	9,356,669		243,299
Equity-Type Assets			
1.08 Unaffiliated Preferred Stock—Class 02	131,493	× 0.030 =	3,945
1.17 Unaffiliated Common Stock	2,806,391	× 0.150 =	420,959
1.18 SUBTOTAL—EQUITY	2,937,884		424,903
1.99 TOTAL—ISSUER #1	12,294,553		668,203
ISSUER #2 Insolvent Savings and Loan			
Fixed Income-Type Assets			
2.01 Class 02 Unaffiliated Bonds	1,344,445	× 0.010 =	13,444
2.03 Class 04 Unaffiliated Bonds	5,399,430	× 0.045 =	242,974
2.07 SUBTOTAL—FIXED INCOME	6,743,875		256,419
Equity-Type Assets			
2.08 Unaffiliated Preferred Stock—Class 01	1,866,501	× 0.023 =	42,930
2.09 Unaffiliated Preferred Stock—Class 02	499,999	× 0.030 =	15,000
2.18 SUBTOTAL—EQUITY	2,366,500		57,929
2.99 TOTAL—ISSUER #2	9,110,375		314,348

EXHIBIT 5

PART 2

(1)	(2) Statement Value	(3) Factor	(4) Additional RBC
ISSUER #3 Rapacious Development Corporation			
Fixed Income-Type Assets			
3.01 Class 02 Unaffiliated Bonds	2,968,829	× 0.010 =	29,688
3.07 SUBTOTAL—FIXED INCOME	2,968,829		29,688
Equity-Type Assets			
3.08 Unaffiliated Preferred Stock—Class 01	1,575,280	× 0.023 =	36,231
3.18 SUBTOTAL—EQUITY	1,575,280		36,231
3.99 TOTAL—ISSUER #3	4,544,109		65,920
ISSUER #4 Imperceptible Products			
Fixed Income-Type Assets			
4.01 Class 02 Unaffiliated Bonds	1,888,606	× 0.010 =	18,886
4.07 SUBTOTAL—FIXED INCOME	1,888,606		18,886
Equity-Type Assets			
4.08 Unaffiliated Preferred Stock—Class 01	745,152	× 0.023 =	17,138
4.18 SUBTOTAL—EQUITY	745,152		17,138
4.99 TOTAL—ISSUER #4	2,633,758		36,025
ISSUER #5 Brassbound Insurance Company			
Fixed Income-Type Assets			
5.01 Class 02 Unaffiliated Bonds	730,825	× 0.010 =	7,308
5.07 SUBTOTAL—FIXED INCOME	730,825		7,308
Equity-Type Assets			
5.08 Unaffiliated Preferred Stock—Class 01	407,194	× 0.023 =	9,365
5.18 SUBTOTAL—EQUITY	407,194		9,365
5.99 TOTAL—ISSUER #5	1,138,019		16,674

EXHIBIT 5

PART 3

ISSUER #6 Massachusetts Pork Authority				
Equity-Type Assets				
6.01 Class 02 Unaffiliated Bonds	923,456	×	0.010 =	9,235
6.07 SUBTOTAL—FIXED INCOME	923,456			9,235
6.99 TOTAL—ISSUER #6	923,456			9,235
ISSUER #7 Ingestme Food Corp.				
Equity-Type Assets				
7.17 Unaffiliated Common Stock	564,321	×	0.150 =	84,648
7.18 SUBTOTAL—EQUITY	564,321			84,648
7.99 TOTAL—ISSUER #7	564,321			84,648
ISSUER #8 DIS Information Processing				
Equity-Type Assets				
8.17 Unaffiliated Common Stock	249,666	×	0.150 =	37,450
8.18 SUBTOTAL—EQUITY	249,666			37,450
8.99 TOTAL—ISSUER #8	249,666			37,450
ISSUER #9 Gulf Bag				
9.17 Unaffiliated Common Stock	194,778	×	0.150 =	29,217
9.18 SUBTOTAL—EQUITY	194,778			29,217
9.99 TOTAL—ISSUER #9	194,778			29,217
ISSUER #10 Ennui Entertainment Industries				
10.17 Unaffiliated Common Stock	157,528	×	0.150 =	23,629
10.18 SUBTOTAL—EQUITY	157,528			23,629
10.99 TOTAL—ISSUER #10	157,528			23,629
11.07 SUBTOTAL—FIXED INCOME	22,612,260			564,835
11.18 SUBTOTAL—EQUITY	9,198,303			720,512
11.99 GRAND TOTAL—COMBINED ISSUERS	31,810,563			1,285,347

EXHIBIT 6

SUMMARY FOR SUBSIDIARY, CONTROLLED, AND AFFILIATED INVESTMENTS

	Affiliate Type	Affiliate Code	RBC Required for Affiliated Common Stock	RBC Required for Affiliated Preferred Stock	RBC Required for Affiliated Bonds	Total RBC Required
(01)	Direct P/C Subsidiaries—U.S.	1	203,919,032	5,100,000	10,024,303	219,043,335
(02)	Direct Life Subsidiaries—U.S.	2	0	0	0	0
(03)	Indirect P/C Subsidiaries—U.S.	3	189,973,343	0	0	189,973,343
(04)	Indirect Life Subsidiaries—U.S.	4	0	0	0	0
(05)	Investment Subsidiaries	5	17,500,000	0	0	17,500,000
(06)	Holding Company in Excess of Indirect Subsidiaries	6	9,485,912	0	0	9,485,912
(07)	Alien Insurers	7	28,875,134	0	0	28,875,134
(08)	N/A	8	—	—	—	—
(09)	Investment in Parent	9	0	0	0	0
(10)	Other Affiliate—P/C Insurance not subject to RBC	10	0	0	0	0
(11)	Other Affiliate—Life Insurance not subject to RBC	11	0	0	0	0
(12)	Other Affiliate—Non-insurer	12	0	0	0	0
(99)	Total	—	449,753,421	5,100,000	10,024,303	464,877,724

EXHIBIT 7

DETAILS FOR AFFILIATED BONDS AND STOCKS

(1) Name of Affiliate	(2) Affiliate Code	(3) NAIC Company Code or Alien ID Number	(4) Affiliate's RBC After Covariance	(5) Statement Value of Affiliate's Common Stock	(6) Total Value of Affiliate's Outstanding Common Stock	(7) Percent Owned	(8) Statement Value of Affiliate's Preferred Stock
Fenway Insurance Company	1	10000	131,450,121	157,869,234	157,869,234	100.0	0
Writeit Re	1	10001	87,593,214	72,468,911	72,468,911	100.0	5,100,000
Minuteman Insurance Company	3	10002	245,126,894	437,791,578	564,892,359	77.5	0
Goldfinger Inc.	5		17,500,000	125,000,000	125,000,000	100.0	0
ZZZ Holding Corp.	6		0	42,159,610	0	100.0	0
Norton Casualty of Calcutta	7	AA-10000	0	57,750,268	0	100.0	0
Total	—	—	481,670,229	893,039,601	—	—	5,100,000

(9) Total Value of Affiliate's Outstanding Preferred Stock	(10) Percent Owned	(11) Statement Value of Affiliate's Bonds	(12) Total Value of Affiliate's Outstanding Bonds	(13) Percent Owned	(14) RBC Required for Common Stock	(15) RBC Required for Preferred Stock	(16) RBC Required for Bonds	(17) RBC Required
0	100.0	0	0	100.0	131,450,121	0	0	131,450,121
5,100,000	100.0	15,275,625	15,275,625	100.0	72,468,911	5,100,000	10,024,303	87,593,214
0	100.0	0	0	100.0	189,973,343	0	0	189,973,343
0	100.0	0	0	100.0	17,500,000	0	0	17,500,000
0	100.0	0	0	100.0	9,485,912	0	0	9,485,912
0	100.0	0	0	100.0	28,875,134	0	0	28,875,134
—	—	15,275,625	—	—	449,753,421	5,100,000	10,024,303	464,877,724

EXHIBIT 8

CREDIT RISK FOR RECEIVABLES

	Reinsurance Recoverables	(1) Sched F Part 3 Statement Value	(2) Adjusted for Voluntary Pools	(3) Applicable Penalty	(4) Amount Subject to RBC		(5) Factor	(6) RBC Requirement
Annual Statement Source								
(1)	L0399999—Alien Affiliated	5,000,000		0	5,000,000	×	0.100 =	500,000
(2)	L0599999—Unaffiliated U.S.	20,000,000		1,500,000	18,500,000	×	0.100 =	1,850,000
(3)	L0799999—Voluntary Pools	15,000,000	0	0	15,000,000	×	0.100 =	1,500,000
(4)	L0899999—Alien Unaffiliated	0		0	0	×	0.100 =	0
(5)	L1299999—Alien Affiliated	0		0	0	×	0.100 =	0
(6)	L1499999—Unaffiliated U.S.	10,000,000		2,000,000	8,000,000	×	0.100 =	800,000
(7)	L1699999—Voluntary Pools	0	0	0	0	×	0.100 =	0
(8)	L1799999—Alien Unaffiliated	7,500,000		6,500,000	1,000,000	×	0.100 =	100,000
(9)	Total Reinsurance Recoverables	57,500,000	0	10,000,000	47,500,000			4,750,000
(10)	Federal Income Tax Recoverable				0	×	0.050 =	0
(11)	Interest, Dividends, Real Estate Income Due & Accrued				1,000,000	×	0.010 =	10,000
(12)	Recoverables from Parent, Subsidiaries, Affiliations				2,000,000	×	0.050 =	100,000
(13)	Amounts Recoverable Relating to Uninsured A&H				0	×	0.050 =	0
(14)	Aggregate Write-Ins for Other Than Invested Assets				500,000	×	0.050 =	25,000
(15)	Total Credit Risk RBC Charge				51,000,000			4,885,000

EXHIBIT 9

UNDERWRITING RISK—RESERVES

	Schedule P Line of Business	(1) H/F	(2) PPA	(3) CA	(4) WC	(5) CMP	(6) Med Mal	(15) Total
(1)	Industry Average Development	0.994	1.032	1.075	1.066	1.038	1.028	—
(2)	Company Average Development	1.011	1.150	1.100	1.050	1.065	1.200	—
(3)	(2)/(1)	1.017	1.114	1.023	0.985	1.026	1.167	—
(4)	Industry Loss & LAE RBC Percentage	0.275	0.254	0.287	0.273	0.374	0.565	—
(5)	Company RBC Percentage	0.277	0.268	0.290	0.271	0.379	0.612	—
(6)	Loss + LAE Unpaid Schedule P Part 1 (000s)	50,000	600,000	100,000	1,250,000	25,000	400,000	2,425,000
(7)	Other Discount Amount Not Included in Loss + LAE Unpaid in Schedule P Part 1 (000s)	0	0	0	0	0	0	0
(8)	Adjustment for Investment Income	0.928	0.921	0.905	0.872	0.880	0.808	—
(9)	Base Loss + LAE Reserve RBC (000s)	9,269	100,985	16,776	135,337	5,335	121,085	388,786
(10)	Percentage Direct Loss-Sensitive	0.00	0.00	0.00	0.20	0.00	0.00	—
(11)	Percentage Assumed Loss-Sensitive	0.00	0.00	0.00	0.00	0.00	0.00	—
(12)	Loss-Sensitive Discount (000s)	0	0	0	8,120	0	0	8,120
(13)	Percentage Claims Made—Medical Malpractice	—	—	—	—	—	0.25	—
(14)	Claims Made Discount—Medical Malpractice (000s)	—	—	—	—	—	6,054	6,054
(15)	Loss + LAE RBC After Discount (000s)	9,269	100,985	16,776	127,217	5,335	115,030	374,611
(16)	Loss Concentration Factor							0.855
(17)	Net Loss + LAE RBC Charge							320,157,630

EXHIBIT 10

UNDERWRITING RISK—NET WRITTEN PREMIUMS

	Schedule P Line of Business	(1) H/F	(2) PPA	(3) CA	(4) WC	(5) CMP	(6) Med Mal	(15) Total
(1)	Industry Average Loss & LAE Ratio	0.808	0.931	0.818	0.901	0.689	0.955	—
(2)	Company Average Loss & LAE Ratio	0.805	0.982	0.980	0.850	0.912	0.984	—
(3)	(2)/(1)	0.996	1.055	1.198	0.943	1.324	1.030	—
(4)	Industry Loss & LAE Ratio	0.917	1.046	1.013	1.008	0.917	1.472	—
(5)	Company RBC Loss & LAE Ratio	0.915	1.075	1.113	0.979	1.066	1.494	—
(6)	Company Underwriting Expense Ratio	0.250	0.250	0.250	0.250	0.250	0.250	—
(7)	Adjustment for Investment Income	0.942	0.924	0.900	0.836	0.884	0.778	—
(8)	C/Y Net Written Premium (000s)	200,000	800,000	100,000	500,000	50,000	150,000	1,800,000
(9)	Base Written Premium RBC (000s)	22,442	194,381	25,198	34,419	9,591	61,891	347,921
(10)	Percentage Direct Loss-Sensitive WP	0.00	0.00	0.00	0.20	0.00	0.00	—
(11)	Percentage Assumed Loss-Sensitive WP	0.00	0.00	0.00	0.00	0.00	0.00	—
(12)	Loss-Sensitive Discount—WP (000s)	0	0	0	2,065	0	0	2,065
(13)	Percentage Claims Made WP—Medical Malpractice	—	—	—	—	—	0.53	—
(14)	Claims Made Discount—Medical Malpractice (000s)	—	—	—	—	—	6,598	6,598
(15)	NWP RBC after Discount (000s)	22,442	194,381	25,198	32,354	9,591	55,293	339,259
(16)	Premium Concentration Factor							0.833
(17)	Net Written Premium RBC Charge							282,715,595

EXHIBIT 11

MISCELLANEOUS OFF BALANCE SHEET ITEMS

		(1) Statement Value		(2) Factor	(3) RBC Requirement
(1)	Non-controlled Assets	0	×	0.010 =	0
(2)	Guarantees for Affiliates	0	×	0.010 =	0
(3)	Contingent Liabilities	15,000,000	×	0.010 =	150,000
(4)	Total Miscellaneous Off Balance Sheet Items	15,000,000			150,000

EXHIBIT 12

EXCESSIVE PREMIUM GROWTH

		(1) Company Gross Written Premiums	(2) Company Adjustments	(3) Group Gross Written Premiums	(4) Group Adjustments	(5) Selected Adjusted Gross Premiums	(6) Statement Value	(7) Factor	(8) RBC Requirement
(1)	1995	2,000,000,000	0	5,059,643,589	0	5,059,643,589			
(2)	1994	1,900,000,000	0	4,287,833,550	0	4,287,833,550			
(3)	1993	1,805,000,000	0	3,664,815,000	0	3,664,815,000			
(4)	1992	1,714,750,000	0	3,214,750,000	0	3,214,750,000			
(5)	1995 Growth Rate							0.180	
(6)	1994 Growth Rate							0.170	
(7)	1993 Growth Rate							0.140	
(8)	Three Year Average Growth Rate							0.163	
(9)	Two Year Average Growth Rate							0.175	
(10)	One Year Average Growth Rate							0.180	
(11)	Selected Average Growth Rate							0.163	
(12)	RBC Average Growth Rate = Line 11 – 10%, capped to fall between 0% and 30%							0.063	
(13)	Excessive Growth Charge Applied to Loss/LAE Reserve from Schedule P Part 1 Column 23 Line 12						2,425,000,000	0.029	70,325,000
(14)	Excessive Growth Charge Applied to Net Written Premiums from Underwriting & Investment Exhibit Part 2B Column 4 Line 32						1,800,000,000	0.014	25,200,000

EXHIBIT 13

PART 1

CALCULATION OF TOTAL RISK-BASED CAPITAL AFTER COVARIANCE

		RBC Amount
R_0—Asset Risk—Subsidiary Insurance Companies		
(1)	Affiliated U.S. P/C Insurers—Directly Owned	219,043,335
(2)	Affiliated U.S. P/C Insurers—Indirectly Owned	189,973,343
(3)	Affiliated U.S. Life Insurers—Directly Owned	0
(4)	Affiliated U.S. Life Insurers—Indirectly Owned	0
(5)	Affiliated Alien Insurers	28,875,134
(6)	Non-controlled Assets	0
(7)	Guarantees for Affiliates	0
(8)	Contingent Liabilities	150,000
(9)	Total R_0	438,041,812
R_1—Asset Risk—Fixed Income		
(10)	Class 01 U.S. Government Agency Bonds	3,300,000
(11)	Unaffiliated Bonds Subject to Size Factor	18,500,000
(12)	Bond Size Factor RBC Charge	7,334,802
(13)	Bonds—Affiliated Investment Subsidiary	0
(14)	Bonds—Affiliated Holding Company in excess of Insurance Subsidiaries	0
(15)	Bonds—Investment in Parent	0
(16)	Bonds—Affiliated U.S. P/C Not Subject To RBC	0
(17)	Bonds—Affiliated U.S. Life Not Subject To RBC	0
(18)	Bonds—Affiliated Non-insurer	0
(19)	Mortgage Loans	500,000
(20)	Collateral Loans	125,000
(21)	Cash	15,000
(22)	Short-Term Investments	0
(23)	Asset Concentration RBC—Fixed Income	564,835
(24)	Total R_1	30,339,637

EXHIBIT 13

PART 2

CALCULATION OF TOTAL RISK-BASED CAPITAL AFTER COVARIANCE

		RBC Amount
R_2—Asset Risk—Equity		
(25)	Common—Affiliated Investment Subsidiaries	17,500,000
(26)	Common—Affiliated Holding Company in excess of Insurance Subsidiaries	9,485,912
(27)	Common—Investment in Parent	0
(28)	Common—Affiliated U.S. P/C Not Subject To RBC	0
(29)	Common—Affiliated U.S. Life Not Subject To RBC	0
(30)	Common—Affiliated Non-insurer	0
(31)	Preferred—Affiliated Investment Subsidiaries	0
(32)	Preferred—Affiliated Holding Companies in excess of Insurance Subsidiaries	0
(33)	Preferred—Investment in Parent	0
(34)	Preferred—Affiliated U.S. P/C Not Subject To RBC	0
(35)	Preferred—Affiliated U.S. Life Not Subject To RBC	0
(36)	Preferred—Affiliated Non-insurer	0
(37)	Unaffiliated Common Stock	52,560,000
(38)	Unaffiliated Preferred Stock	380,000
(39)	Real Estate	17,500,000
(40)	Schedule BA Assets	2,000,000
(41)	Aggregate Write-ins for Invested Assets	375,000
(42)	Asset Concentration RBC—Equity	720,512
(43)	Total R_2	100,521,425
R_3—Asset Risk—Credit		
(44)	One half of Credit RBC Charge	2,442,500
R_4—Underwriting Risk—Reserves		
(45)	One half of Credit RBC Charge	2,442,500
(46)	Total Adjusted Unpaid LLAE Reserve RBC Charge	319,982,040
(47)	Excessive Growth Charge—Loss/LAE Reserve	70,325,000
(48)	A&H Claims Reserves Adjusted for LCF	0
(49)	Total R_4	392,749,540
R_5—Underwriting Risk—Net Written Premium		
(50)	Total Adjusted NWP RBC Charge	282,715,595
(51)	Excessive Growth Charge—Written Premiums	25,200,000
(52)	A&H Earned Premium Adjusted for PCF	0
(53)	Total R_5	307,915,595
(54)	Total RBC After Covariance	948,037,136
(55)	Authorized Control Level RBC	426,616,711

EXHIBIT 14

COMPARISON OF TOTAL ADJUSTED CAPITAL TO RISK-BASED CAPITAL

		Abbreviation	(1) Amount
(1)	Total Adjusted Capital		1,335,000,000
(2)	Company Action Level = 200% of Authorized Control Level	CAL	853,233,423
(3)	Regulatory Action Level = 150% of Authorized Control Level	RAL	639,925,067
(4)	Authorized Control Level = 100% of Authorized Control Level	ACL	426,616,711
(5)	Mandatory Control Level = 70% of Authorized Control Level	MCL	298,631,698
(6)	Level of Action, if Any		NONE
	The following numbers must be reported in the Five Year History Exhibit on the indicated line		
	Total Adjusted Surplus to Policyholders		1,335,000,000
	Authorized Control Level Risk-Based Capital		426,616,711