SOCIETY OF ACTUARIES

# Investment Symposium
# March 2010

# F7: Investment Implications of a Principal-Based Approach to Capital


**David Wicklund**
**Arnold Dicke**


## Moderator
**Ross Bowen**

# Investment Implications of a Principle-Based Approach to the C-3 Component of Risk-Based Capital

Concurrent Session F7

Society of Actuaries Investment Symposium, March 23, 2010

New York

Arnold A. Dicke

New World Actuaries
*A Division of New World Marketing, Inc.*

## C3P3:

**Considerations for the investment and/or ALM actuary**

**Swing Factors**

# C3P3: Considerations
## for the investment and/or ALM actuary

- Emphasis on Total Asset Requirement (TAR)
- TAR based on CTE 90 (TailVAR 90)
- GPVAD approach
- Starting assets/reinvestment
- Treatment of non-guaranteed elements
- Other considerations

## C3P3—Considerations:

### Emphasis on Total Asset Requirement (TAR) —required surplus = TAR - reserves

- Current RBC is calculated by formula and added onto reserves
- SoA testing showed that blocks with pre-PBA reserves often had zero C-3 RBC
- Likely this will not be true for blocks with principle-based reserves
- Alternative of setting C3 component equal to CTE(90) – CTE(70) was considered
- Some believe action levels in Model Law should be based on TAR instead of RBC
- Extreme example: Total Adjusted Capital = 10%*Stat Reserves; RBC Ratio = 400%

  RBC Ratio = TAC/RBC = .10*SR/RBC = 4; so: RBC = .025*SR

  C-3 component = .5% * Stat Reserves (assume no policy loans).

  Then, if stochastic C-3 component = min (TAR – SR, 0) = 0,

  RBC Ratio = TAC/RBC' = .10*SR/.02*SR = 500%

One proposed alternative to the current RBC ratio:
(Stat Reserves + Total Adjusted Capital)/TAR

## C3P3—Considerations:

### TAR based on CTE 90 (TailVAR 90)
### —only tail scenarios count

- CTE 90 is average over 10% of scenarios showing worst result
- The "true" scenario is likely to be outside the CTE average (i.e., in the "other" 90%)
- Actual profits will tend to reflect the true scenario
- Investment strategy must reflect both objectives:
  - as high as possible profits
  - impressive solvency metrics (or at least, no regulatory action)

## C3P3—Considerations:

### GPVAD approach
### —review

- "GPVAD" = Greatest Present Value of Accumulated Deficiencies
- Select starting assets for modeled policies in Business Segment
- For each scenario, project net cash flows to all future valuation dates
- "Accumulated deficiency" = "working reserve" – accumulated net cash flows
- "Working reserve" = Cash value (zero if no cash value)
- For each scenario, take present value of accumulated deficiency at each date
- Present value is taken at discount rates prescribed by formula (not at earned rates)
- Add greatest present value over all future valuation dates to starting assets
- This is the "Scenario Amount"
- "Stochastic Amount" for the Business Segment is the CTE 90 value (average over the highest 10% of the Scenario Amounts)

## C3P3—Considerations:

### GPVAD approach
### —interim accumulated deficiencies matter

- Because of GPVAD, CTE 90 calculation could include scenarios with interim mismatches
- Duration matching approaches usually are based on averages over all scenarios
- Average over all scenarios is CTE 0 – very different from CTE 90
- Some ALM strategies could lead to significant interim deficiencies—> high TAR & RBC
- Thus, GPVAD could impact ALM strategy

## C3P3—Considerations:

### GPVAD approach
### —non-zero "working reserve"

- Accumulated deficiency is a statutory concept
- To avoid interim AD's, assets must have book value >= reserve on all projection dates
- Cash value is a surrogate for reserve
- Setting WR = principle-based reserve would → need for stochastic within stochastic
- Not a liquidity test—does not require market value of assets equal to cash value

## C3P3—Considerations:

### GPVAD approach
### —formula Discount Rates used for present values

- Required to use 105% of one-year Treasury rates modeled in each scenario
- Discount Rate is adjusted for federal income tax
- DR = CTE 90 of AAA-scenario Treasury rates if only equities are modeled
- Original proposal set the Discount Rate = net asset earned rates
- Then Scenario Amount would have approximated the amount of starting assets needed to avoid all accumulated deficiencies
- Lower prescribed Discount Rates will set Scenario Amounts higher than this target
- Effect enhanced if large accumulated deficiencies occur at later durations in tail scenarios

## C3P3—Considerations:

### Starting assets/reinvestment

- Starting assets chosen for each Business Segment from assets actually held
- Normally will be assets held to support policies in the Business Segment
- Valued at book (i.e., consistent with annual statement values); include
  1. Entire value of assets held in Separate Accounts that support policies in BS
  2. Balance of any policy loans outstanding
  3. Any "hedge assets" held for the benefit of policies
  4. Enough other General Account assets so that:
     total value (1+2+3+4) >= 98% of statutory reserves and other liabilities for BS
- No upper limit—could attempt to estimate TAR for BS
  GPVAD could be negative if starting assets are excessive
- Selection s/b consistent from one valuation to the next
- Reinvestment/disinvestment s/b consistent with company policy
- Should reflect "economic reality" (e.g., ability to borrow) at each point in scenario

## C3P3—Considerations:

### Starting assets/reinvestment

- Reinvestment must follow the investment policy actually used for the BS
- Actual assets in the BS presumably are the direct result of this investment policy
- Investment policy thus has major impact on RBC
  - •Inappropriate investment policy could lead to high C-3 component
  - •May have bigger impact than choice of starting assets
- Starting assets with high cash flow relative to book value could reduce TAR
- Would have similar effect on principle-based reserves—result: offset
- Choosing such assets could impact C-3 component for formula-based reserves
- Business segments may be aggregated at the option of the Qualified Actuary
  - Qualified Actuary must document basis for aggregation
  - Must use same Scenario Set
  - Exact method of aggregation not specified
  - Presumably combine Scenario Amounts prior to CTE calculation

## C3P3—Considerations:

### Starting assets/reinvestment —spreads/default costs

- "Appropriate asset default costs …shall be reflected…"
- What is meant by "appropriate"? Not specified in instructions.
- "Net spreads" over Treasuries must "reflect what a company expects to receive" on purchase or sale of security, as well as its asset management strategies
- Asset Subgroup of Academy's Life Reserve Work Group has detailed proposal
- Reflects significant regulator input
- May be useful to Qualified Actuaries looking for guidance
- Asset Subgroup's presentations to NAIC are on Academy website

## C3P3—Considerations:

### Treatment of Non-guaranteed Elements

- Changes in non-guaranteed elements can be reflected in the Cash Flow Model "based on experience assumed in each Scenario."
- The experience assumed in each Scenario is the Prudent Estimate assumption (which may be dynamic—i.e., a function of the Scenario variables)
- This leads to lower projected NGEs, but consistent with assumed experience
- Also, the Margin in the Prudent Estimate assumption has to make the Reported Amount (including the impact of any non-guaranteed elements) larger
- An additional Margin (that increases the Scenario Amounts) s/b added to provide for uncertainty
- Dividend liability is subtracted from TAR to get Reported Amount if the corresponding dividends are included in the Cash Flow Model

## C3P3—Considerations:

### Other considerations

- Equities are included in cash flow models, resulting in a C-1 offset for market risk
- Revenue sharing may be included, but actuary must assess likelihood of its receipt

## C3P3: Swing factors

- Stochastic Exclusion Test: What does it take to avoid stochastic modeling?
- Scenarios: How many? May you generate your own? If so, how?
- Derivative Programs: When are they reflected? Can they impact TAR?

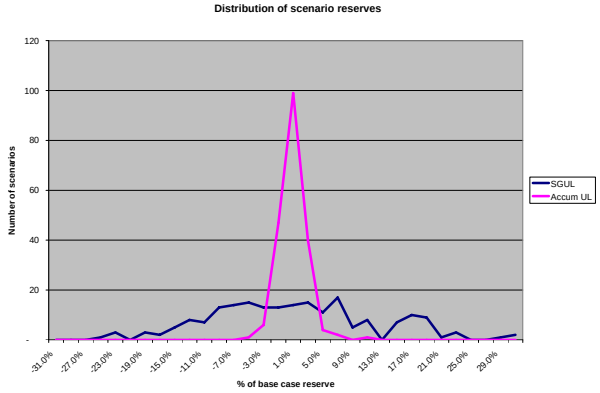
## C3P3—Swing Factors:

### Stochastic Exclusion Test

- Motivation: find a way to exclude less risky products from stochastic calculations (for both reserves and RBC)
  - "Product" means policies together with allocated assets/investment strategy
  - Ideally, test would be an extension of asset-adequacy testing
  - Test intended to detect material tail risk

**C3P3—Swing Factors: Stochastic Exclusion Test**

## Modeling: Accumulation UL vs. SGUL




- Conclusion – clear differences in degree of variability over scenarios

**C3P3—Swing Factors: Stochastic Exclusion Test**

## Academy Proposal: Stochastic Exclusion Test

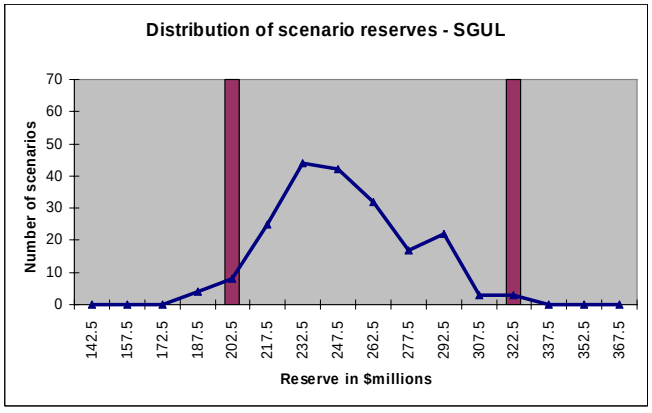
- Use asset-adequacy model, anticipated experience assumption
- 16 prescribed Test Scenarios
- Test Ratio: Numerator is greatest excess of gross premium reserve for each scenario over gross premium reserve for base scenario
- Test Ratio: Denominator is present value of benefits and expenses (used to normalize)
- Threshold Ratio: Block passes test if ratio is lower than threshold (proposed: 4%)
- C3P3: Block with Test Ratio less than 4% may use Factor-based Amount if it also passes a stand-alone asset-adequacy test (to be consistent with Total Asset Requirement approach)

# Test Scenarios

- Prescribed paths:
  - Pop-up
  - Pop-down
  - Up-down
  - Down-up
  - Delayed pop-up
  - Delayed pop-down
  - Deterministic reserve valuation scenario
  - Base scenario (shocks of zero)
  - Volatile short rates usually causing inverted yield curves
  - Volatile equity returns
- Interest paths on left are paired with both low and high equity return scenarios



# Range Covered by Test Scenarios




- Conclusion: The Test Scenarios adequately cover the range of stochastic results

## Setting the Threshold Ratio

- Modeled ratios:

| | Mature Block | New Block |
|---|---|---|
| **SGUL** | **6.8%** | **8.7%** |
| **20-yr term** | **1.7%** | **3.6%** |
| **Accumulation UL** | **0.8%** | **3.0%** |
| **Par WL** | **0.2%** | **0.9%** |

- Pragmatic judgment: Set threshold at 4%

C3P3—Swing Factors: Stochastic Exclusion Test

## Implications

- One smaller company put all products (mostly term and UL) into one Business Segment (single portfolio rate). The block failed the SET. When segmented into term and UL blocks (with appropriate assets), each block passed the SET—a risk management learning
- For policies with redundant reserves, Stochastic Amount less reserves may be less than Factor-based Amount—may be worth doing the calculation

## Treatment of Reinsurance in SET

- Reinsurance cash flows are included in numerator gross premium calculations
- Denominator must be "adjusted for reinsurance as appropriate to achieve consistency" with numerator
- Denominator is just PV(benefits and expenses) on the Base Scenario—could possibly be gamed by adjusting reinsurance premiums and allowances
- May need different treatments for coinsurance and other forms of reinsurance such as YRT or excess



## Are you sure you want to avoid stochastic modeling?

- Stochastic Amount could be less than Factor-based Amount
- Stand-alone cash flow testing is required
- Lose any benefit from aggregation

**C3P3—Swing Factors:**

## Scenarios

- Options for obtaining scenario set:
  - Prescribed generator
  - Prescribed scenario set
  - Company generated scenarios that meet calibration criteria (current status: LHATF is discussing whether to permit—decision will apply to C3P3)
- Items that Qualified Actuary must provide in documentation:
  - Description of scenario generation
  - Rationale for number of scenarios
  - Correlation of equity and/or fund returns
  - Processes to ensure calibration criteria are met
  - Support for mapping variable accounts to proxy funds

**C3P3—Swing Factors: Scenarios**

## Calibration Criteria for Non-prescribed Generators

- Interest Rate Returns :
  - Compared to Academy benchmarks at 1, 5, 10 and 30 year horizons
  - Both left and right tails compared at each horizon
  - Cumulative statistics for spread compared for both tails at 30-year horizon
- Equity Returns:
  - Calibration requires comparison of gross accumulated wealth from a unit investment with a standard
  - Table given in the Instructions show wealth factors for 1, 5, 10 and 20 year accumulations for the 2.5, 5, 10, 90, 95 and 97.5 percentiles
  - E.g., value for 2.5$^{th}$ percentile for 5 years is 0.72—there is a 2.5% probability of the 5-year accumulated value of a unit investment being < 0.72
  - Calibrated model must not exceed this value (opposite for right tail)

## Number of Scenarios

- RBC Instructions :
  - "sufficient if any resulting understatement in the Reported Amount" is not material
  - How is materiality determined?
- Variance of CTE 90:
  - Is a function of the number of scenarios
  - Could use variance to state a criterion for number of scenarios



## Variance of CTE 90

CTE 90 may be defined as follows:

Find $a$ satisfying

$$\Pr(A|A > a) = 90\%$$

where $A$ represents the Scenario Amount.

⇒ $a$ is usually called VaR 90.

Then C-3, Phase 3 would set the Stochastic Amount equal to

$$\mathrm{E}[A|A > a)]$$

which is the average over all Scenario Amounts > VaR 90

The usual "sum over the worst 10%" is an estimator statistic, and has a variance that can be calculated.

**C3P3—Swing Factors: Scenarios**

## Variance of CTE 90

Here's the formula for the variance of the CTE 90, without derivation:

Define k = n*(1 – 90%) = 10%*n = number of scenarios averaged in CTE 90
and A(i) = the i-th Scenario Amount, ranked from smallest to largest

then CTE 90 = Sum{A(n-k+i), i = 1,…,k}/k [= average of k highest Amounts]

and VAR(CTE 90) ≈ {VAR[A(n-k+1),…,A(n)] + 90%*[CTE 90 - A(n-k+1)]}/k

where VAR[A(n-k+1),…,A(n)] = {Sum[A(i) – CTE 90]^2, i=(n-k+1),…,n}/(k-1)

Notice that the variance is a function of n. A condition such a VAR(CTE 90) < $\sigma^2$ would give a lower limit for n.

**C3P3—Swing Factors:**

## Derivative Programs

- "Derivative Program"—Program to buy or sell one or more Derivative Instruments or open or close hedging positions to achieve a specific objective
- "Liability-associated Derivative"—Derivative Program for which Derivative Instrument cash flows are combined with liability cash flows within the Cash Flow Model
- "Clearly Defined Hedging Strategy"—a strategy that identifies
  - The specific risks being hedged (e.g., delta, rho, vega)
  - The hedge objectives
  - The financial instruments to be used in hedging
  - The hedge trading rules, including tolerances
  - The criteria and metrics that measure hedge effectiveness

"Liability-side hedging" does not qualify as a CDHS

## C3P3—Swing Factors: Derivative Programs

### When/how are Derivative Programs reflected in modeling?

- Derivative Instruments currently held within Business Segment—
  - If part of a Derivative Program satisfying rules for CDHS: Include in model
  - If Derivative Instruments associated with "non-hedging" Derivative Programs:
    - Include in model if
      - normally modeled as part of company's risk assessment processes
      - appropriate to the business and not constructed to "game" the model
- Derivative Instruments projected to be purchased under CDHS: Include in model
- Cash flow model must show all costs and benefits, and must reflect all risks, including
  - basis risk, gap risk, price risk, parameter estimation risk
  - risks associated with variations in model assumptions (e.g., persistency)
- Hedge effectiveness must be introduced either directly or indirectly (via external model)

## C3P3—Swing Factors: Derivative Programs

### Specific Considerations—things to worry about

- Interaction of hedging assumptions (assumptions regarding future trading) and other model assumptions
- "Discontinuous" hedging strategies: relationship of sensitivities to market and interest rates of (1) policyholder options/guarantees and (2) hedging assets is discontinuous
- Model "strategies" that make money in some scenarios without losing a "reasonable" amount in other scenarios
- Historical validation of the pricing of financial instruments traded in the model

# References


- American Academy of Actuaries' C3 Work Group, Draft C3 RBC Instructions and Appendices, http://www.naic.org/documents/committees_e_capad_lrbc_C3_RBC_instructions_package.pdf
- "Variance of the CTE Estimator", by Manistre and Hancock, North American Actuarial Journal, vol. 9, no. 2
- Academy's LRWG Asset Subgroup, Update to LHATF on VM-20: Prescribed Default Costs for Existing Investments http://www.actuary.org/pdf/life/lhatf_sept09.pdf


# Questions?

New World Actuaries
*A Division of New World Marketing, Inc.*

# RBC C3 Phase 3 — calculation methodology

David Wicklund, FSA, CFA, MAAA
23 March 2010

Ernst & Young
Quality In Everything We Do

## Agenda

- RBC C3 Phase 3 overview
- Stochastic Amount calculation
- Stochastic Exclusion Test
- Status

## Overview

- RBC C3 Phase 3 introduces a principle-based approach to the determination of capital requirements to cover interest rate risk and market risk for life insurance products.
- Products in scope
  - Universal life
  - Variable life and variable universal life
  - Term life
  - Whole life
  - Indexed life and universal indexed life
  - Group life
  - Combination policies (includes life plus other benefits) that are filed as life insurance policies
- Current target implementation date is year end 2010




## C3 requirement

- The total C3 requirement is equal to the excess of the Total Asset Requirement over the statutory reserve.
- Total Asset Requirement is equal to the sum of the following components:
  - Stochastic Amount
  - Alternative Amount
  - Factor-based Amount
  - Non-modeled Amount

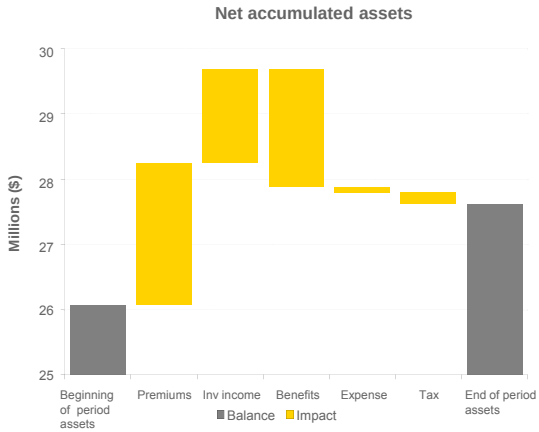
# Stochastic Amount calculation: summary of steps

- The Stochastic Amount under RBC C3 Phase 3 is calculated with five steps:
  1. Project cash flows using stochastic scenarios
  2. Calculate the accumulated deficiency at the end of each projection year
  3. Determine the Greatest Present Value of Accumulated Deficiencies (GPVAD) for each scenario
  4. Determine Scenario Amounts
  5. Determine the Stochastic Amount
- Key definitions
  - Accumulated deficiency = working reserve – net accumulated assets
  - Working reserve = cash surrender value
  - Scenario Amount = starting assets + GPVAD
  - Stochastic Amount = CTE 90 of Scenario Amounts





# Net accumulated assets value rollforward




**Typical general account cash flow items**

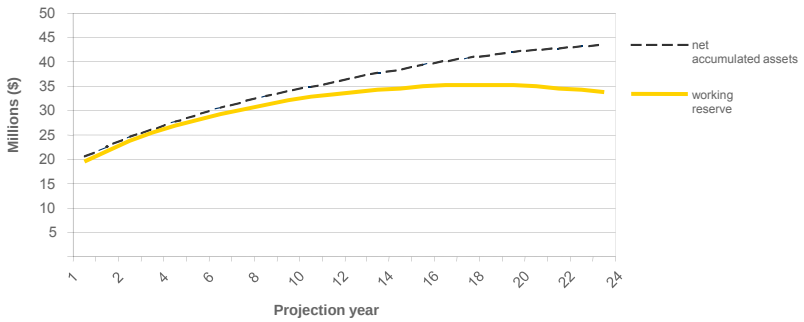
- Gross premiums
- Investment income
- Policyholder benefits
- Expenses
- Tax

**Other cash flow items**

- Asset management fees
- Revenue sharing
- General/separate account transfers
- Liability associated derivatives

# Accumulated deficiencies

Development of accumulated deficiencies for a single scenario



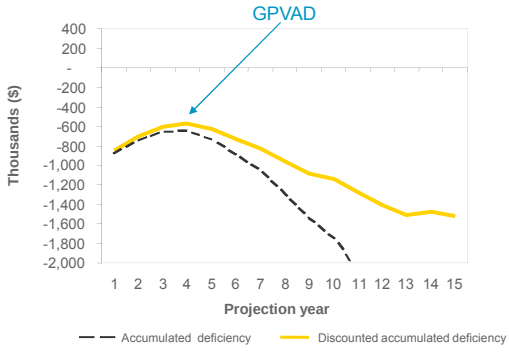

- Accumulated deficiencies = working reserve - net accumulated assets
- Accumulated deficiencies determined at the Business Segment level
- Net accumulated assets > working reserve for all years in this example
- No positive accumulated deficiencies for scenario in this example



ERNST & YOUNG
Quality In Everything We Do

# Development of Scenario Amount

Greatest Present Value of Accumulated Deficiencies




Scenario Amount

| | |
|---|---|
| Starting assets | US$14,609 |
| Scenario GPVAD | US$(568) |
| Scenario Amount | US$14,041 |

- Discounting at 105% of after-tax one-year US Treasury rates from specific scenario
- GPVAD = US$(568) and occurs in forth projection year in example
- In example, Scenario Amount < starting assets



ERNST & YOUNG
Quality In Everything We Do

## Stochastic Amount

**Stochastic Amount = CTE 90 of Scenario Amounts = US$14,079**

| | |
|---|---|
| Statutory reserve | US$14,609 |
| Stochastic Amount | US$14,079 |
| C3 requirement | US$0 |

- In this example, Stochastic Amount < statutory reserve
- No C3 requirement in this example





## Scenarios

- Stochastic interest rate and equity scenarios

1. Scenarios based on prescribed NAIC generators
2. Prepackaged scenarios from prescribed NAIC generators
3. Proprietary scenario sets
4. Stochastic models developed by company

- Number of scenarios at company discretion

## Prudent Estimate assumptions

- Prudent Estimate assumptions for assumptions that are not stochastic or prescribed
- Prudent Estimate assumption = Anticipated Experience + margin
- Higher margin for more uncertain risk
- Higher margin if limited experience
- Candidates for Prudent Estimate assumptions
  - Mortality
  - Lapse
  - Maintenance expense
  - Premium persistency
  - Asset default
  - Revenue sharing




## Asset modeling

- Starting assets ≥ 98% of statutory reserve
- Explicit asset modeling required
- Reinvestment and disinvestment reflect company strategy
- Future hedge positions to be modeled only if part of a Clearly Defined Hedge Strategy
- Currently held derivatives may be included in starting assets

## Stochastic Exclusion Test

- Determines if the Factor-based Amount may be used
- Steps in test
  - Calculate present value of net cash flows for base scenario (A)
  - Calculate present value of net cash flows for 15 deterministic shock scenarios and determine maximum Test Scenario Amount (B)
  - Calculate the present value of benefits and expenses for base scenario (C)
  - Stochastic Exclusion Test ratio = (B – A)/C
  - If Stochastic Exclusion Test ratio < 4%, the Business Segment passes and the Factor-based Amount may be used




## Stochastic Exclusion test

- Stochastic Exclusion Test assumptions
  - Anticipated Experience assumptions
  - Starting assets ≥ 98% of statutory reserve
  - Taxes excluded from cash flows and discount rate
  - Discount rates set at the net asset earned rate in each period
- Not required to use Factor-based Amount

## Status

- NAIC to decide at spring meeting (25-28 March 2010) if it will adopt the current RBC C3 Phase 3 report
- After meeting, we will know if RBC C3 Phase 3 will be in effect in 2010
- Possible limited initial scope
  - ACLI developed limited scope recommendation
  - Initially limited to fixed universal life with secondary guarantee