STOCHASTIC, DETERMINISTIC AND NPR RESERVES

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Agenda

- VM-20 Net Premium Reserves by Tim Cardinal
  - Net Premium Reserve Example for Term
  - Considerations for Net Premium Reserve for UL

- VM-20 Deterministic Reserves by Stephen Krupa
  - Comparison of Deterministic Reserve Methods
  - Considerations for Deterministic Reserve Exclusion Test

- VM-20 Stochastic Reserve by David Neve
  - Considerations for Stochastic Reserve
  - Stochastic Reserve Exclusion Tests

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VM-20 RESERVES

Tim Cardinal, MAAA, FSA, CERA

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Reserves

VM-20 Minimum Reserve
- ☐ Greatest of NPR, DR+DPA, SR+DPA as applicable

Companywide Exemption
- ☐ **If** pass 3 criteria: Premium, RBC, non-material ULSG
- ☐ **Then** may elect to calculate reserves using pre-PBR formulas

Exclusion Tests
- ☐ Deterministic Exclusion Test
- ☐ Stochastic Exclusion Test

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Term NPR Example

Mechanically,

Term NPR ~ Current CRVM & Triple X & FAS60 - with a twist

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UL NPR

UL NPR
- ☐ Greater of UL Base NPR (3.B.5) and ULSG NPR (3.B.6)
- ☐ Floors: COI, Cash Value

Current UL CRVM	::	**UL Base NPR (without SGs)**
☐ Guaranteed Maturity Premium	::	Level Gross Premium
☐ Guaranteed Maturity Fund	::	f_{x+t}
☐ Account Value	::	e_{x+t}
☐ r-factor	::	e/f

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UL NPR

UL Secondary Guarantee (SG) NPR

☐ UL Base NPR chassis with differences

☐ Lapse rates

☐ Net Single Premium × min(1, ASG/FFSG) – Expense Allowance

ASG = Actual SG. FFSG = Fully Funded SG

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Modeled Reserve Assumptions

- Prescribed, stochastic, or prudent best estimate
  - Experience risk factors
  - Anticipated
  - Margins
  - Reviewed/updated

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Modeled Reserves: Asse**ts**

- ☐ Model segments

- ☐ Starting assets

  - ❑ Policy loans – implicit or explicit modeling

- ☐ Assumptions

- ☐ Investment strategy

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DETERMINISTIC RESERVE

Stephen Krupa, MAAA, FSA

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What Is the Deterministic Reserve (DR)?

- Method A less PIMR (pretax interest maintenance reserve)
  - Actuarial present value of benefits and expenses less actuarial present value of premiums
    - Cash flows projected over single scenario (#12 as per VM20 7.G.1)
    - PVs use Net Asset Earned Rate (NAER) path of discount rates
- Method B less PIMR
  - Starting assets along with premium and investment income to liquidate benefits and expenses by end of projection horizon
    - Cash flows projected over single scenario (#12)

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Why Method B (Direct Iteration)?

- Ensures precise asset level to runoff liabilities
  - Field test identified issues with gross premium reserve
    - Starting asset not always sufficient to runoff liabilities
    - Deviations arose for long duration products with significant cash flows in later durations
- Simpler because no need to:
  - Calculate NAER
  - Consider non-cash accounting entries
  - Discount liabilities
  - Meet 2% asset collar test
- Limit errors, particularly in calculating NAER
- Proof of reserve adequacy (by definition assets mature liabilities)

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What Are the General Steps for Calculating the DR?

- Determine margins and anticipated experience driving prudent estimate assumptions
  - Consistent with Stochastic Reserve (SR)
  - Exact SR assumption may differ when dependent on economic scenario
- Method A requires calculation of NAER
- Project asset and liability cash flows using scenario #12
- Calculate reserve
  - Method A – Gross Premium Reserve or
  - Method B – Asset that exhausts liability by end of coverage period

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What Outflows Are Included in DR?

- ☐ Future benefits (e.g., death, cash surrender…)
- ☐ Future expenses, excluding federal income tax
- ☐ Account value invested in separate account at valuation date
- ☐ Policy loan balance at valuation date (if loans are modeled explicitly)

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What Inflows Are Included in DR?

- Future gross premiums and other revenue
- Future net cash flows to/from general account or from/to separate account
- Future net policy loan cash flows (explicit modeling)
- Future net reinsurance cash flows
- Future derivative liability net cash flows

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What Impacts Investment Income for NAER?

- Projected net investment earnings from starting assets and reinvested assets

- Pattern of projected asset cash flows from starting assets and subsequent reinvested assets

- Pattern of projected net liability cash flows
  - If policy loan interest is same as NAER, then loan has zero net impact on NAER

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Deterministic Reserve – Method A

Year-End of Period ==>	0	1	2	3	4	5	6	7	8	9	10
A) Net Cash Flows		-40.00	-20.00	-10.00	-5.00	-1.00	-1.00	-2.00	-1.00	-2.00	-1.00
B) NAER (Assumed)		0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
C) Path of Discount Rates		0.96	0.92	0.89	0.85	0.82	0.79	0.76	0.73	0.70	0.68
D) Discounted Cash Flows [(-A) * (C)]		38.46	18.49	8.89	4.27	0.82	0.79	1.52	0.73	1.41	0.68
E) Gross Premium Valuation (Sum D from (t) to 10)	**76.06**	37.60	19.11	10.22	5.94	5.12	4.33	2.81	2.08	0.68	0.00

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Deterministic Reserve – Method B

Year-End of Period ==>	0	1	2	3	4	5	6	7	8	9	10
A) DR Scenario #12 projected investment rate		0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
B) Asset BOP		76.06	39.10	20.67	11.49	6.95	6.23	5.48	3.70	2.85	0.96
C) Investment Income on Asset BOP [(A) * (B)]		3.04	1.56	0.83	0.46	0.28	0.25	0.22	0.15	0.11	0.04
D) Net Cashflow EOP		-40.00	-20.00	-10.00	-5.00	-1.00	-1.00	-2.00	-1.00	-2.00	-1.00
E) Asset EOP [(B) + (C) + (D)]	76.06	39.10	20.67	11.49	6.95	6.23	5.48	3.70	2.85	0.96	0.00

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Common Variations in Calculating Net Asset Earned Rate (NAER)

- Level of starting assets

- Consistency of investment strategy for in-force and reinvested assets

- Assumed timing of cash flows (continuous, BOM, EOM, large ad hoc amounts)

- Rounding of monthly yield

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Examples of Calculation Variations for Net Asset Earned Rate

Assumptions					
(A) Assets BOM	1000				
(C) Cashflow	-10				
(I) Investment Income	5				
(B) Asset EOM	995				

Impact of Timing and Rounding on Computed Yield Rate

Cashflow Timing	Yield Rate Formula	Monthly	Monthly (Rounded to Nearest Basispoint)	Annualized (from Monthly Rounded to Nearest Basispoint)	Annualized (Rounded to Nearest Basispoint)
BOM	(I) /[(A) + (C)]	0.5051%	0.51%	6.2946%	6.29%
MOM	(I) /[(A) + .5 * (C)]	0.5025%	0.50%	6.1678%	6.17%
EOM	(I) /(A)	0.5000%	0.50%	6.1678%	6.17%

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Deterministic Reserve Exclusion Test (DRET)

- UL with secondary guarantee not meeting definition of non-material secondary guarantee or policies not excluded from SR, deemed not to pass DRET

- Recent proposal to deem term not to pass DRET

- Pass DRET, if sum of valuation net premiums for all future years < sum of guaranteed gross premiums

- Can't group together different risk profiles

- Closed block passes for 3 consecutive years, assume passes each year in the future (test every 5 years going forward)

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Valuation Net Premium for Deterministic Exclusion Test (Pre-Reinsurance)

- Applicable valuation premium from NPR
- Except, lapse rates are assumed 0% in all durations
- If gross premium subject to shock lapse, comparison of valuation net and gross premium only in initial premium period
- Substitute anticipated mortality for valuation mortality in net premium, if anticipated mortality > valuation mortality
- Premiums before reinsurance ceded and including assumed business

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Gross Premium for Deterministic Exclusion Test

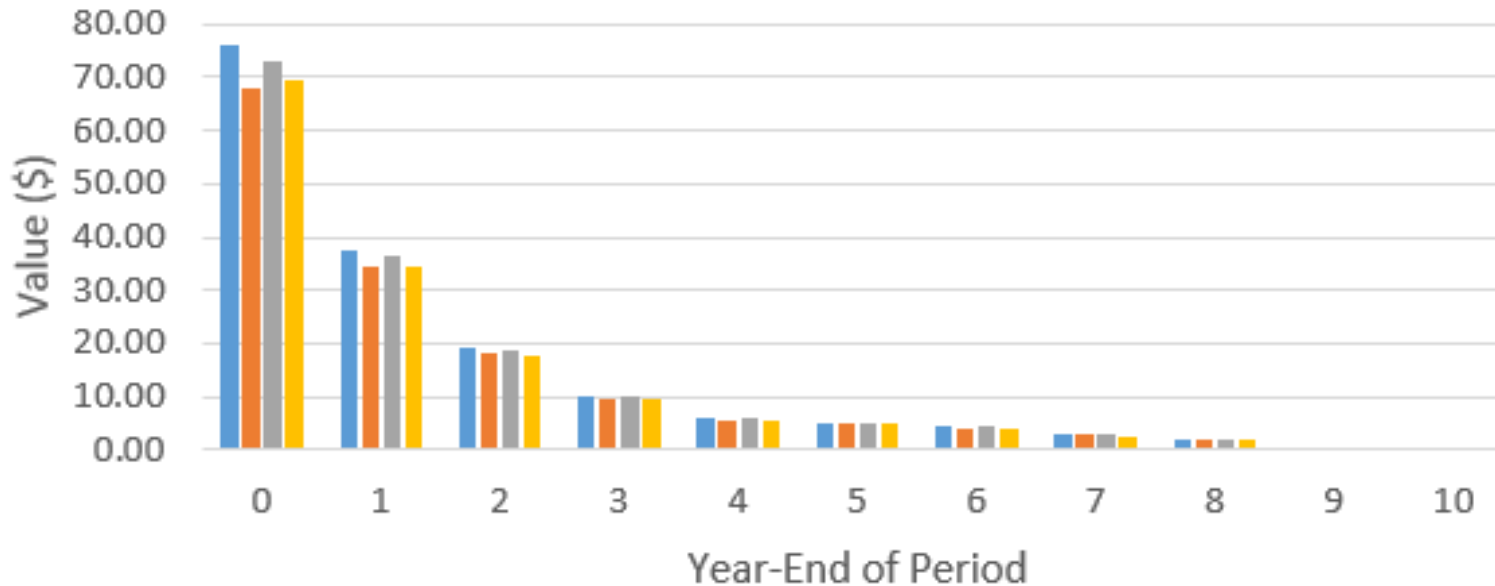| Universal Life	Other Than Universal Life (Permanent and Term Insurance)
- Premium specified in contract - If premium not specified, level annual gross premium at issue to keep policy inforce for entire coverage period using guaranteed mortality, interest, and expense	- Guaranteed gross premium specified in contract

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Deterministic Reserve – Illustrative Attribution Analysis for Individual and Aggregate Margins

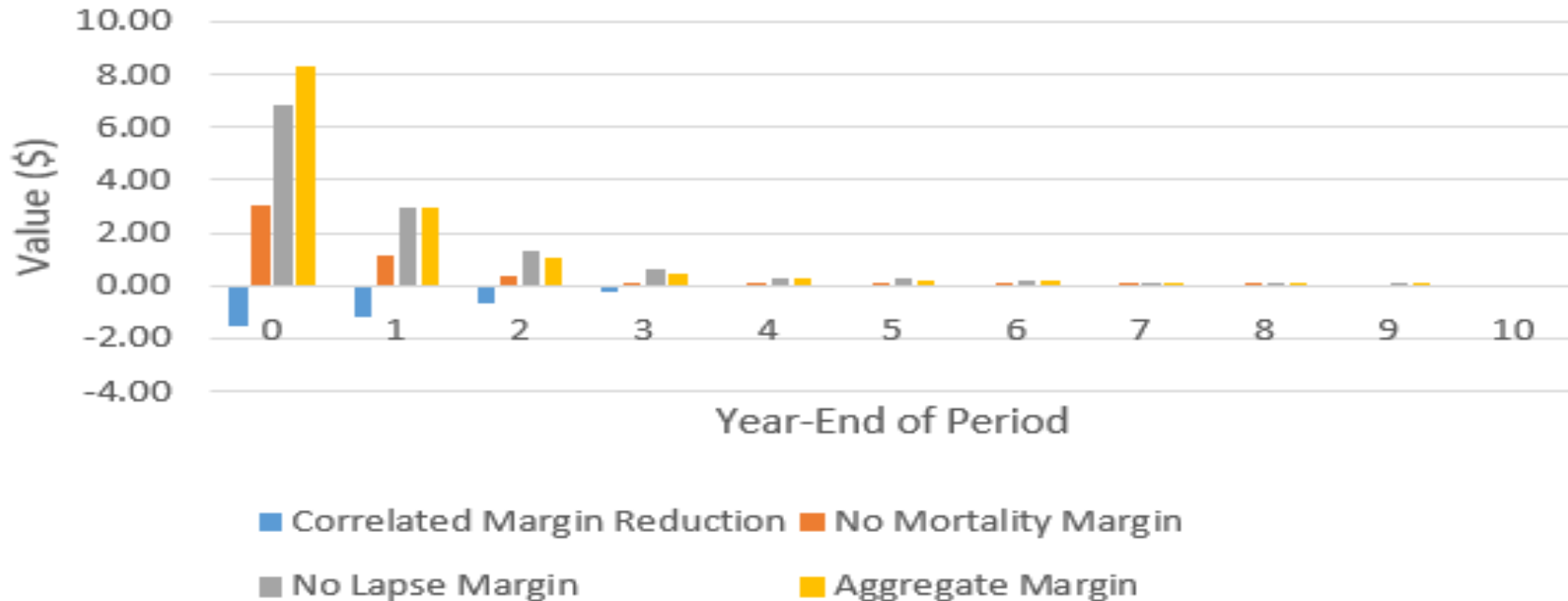| Year-End of Period ==>	0	1	2	3
1) Deterministic Reserve - Reported	76.06	37.60	19.11	10.22
2) Deterministic Reserve w/o Mortality Margin	72.99	36.45	18.70	10.08
3) Net Effect w/o Mortality Margin on Reported DR [(1) - (2)]	3.07	1.14	0.40	0.14
4) Deterministic Reserve w/o Lapse Margin	69.25	34.63	17.80	9.62
4) Net Effect w/o Lapse Margin on Reported DR [(1) - (4)]	6.81	2.97	1.30	0.59
5) Total Effect of Individual Margins [(3) + (4)]	9.88	4.11	1.71	0.73
6) Deterministic Reserve w/o All Margins	67.75	34.68	18.04	9.77
7) Net Effect of Aggregate Margins on Reported DR [(1) - (6)]	8.31	2.92	1.07	0.45
8) Net Difference of Aggregate Margin less Sum of Individual Margins [(7) - (5)]	-1.58	-1.19	-0.64	-0.28

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Illustrative Deterministic Reserve Amount – Attribution Analysis Graph

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Illustrative Deterministic Reserve Margin – Attribution Analysis Graph

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STOCHASTIC RESERVE OVERVIEW

David E. Neve, FSA, MAAA, CERA

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Stochastic Reserve

- **Similarities to the deterministic reserve**
  - ❑ Both project cash flows using cash flow models
  - ❑ Both project cash flows in compliance with later sections of VM-20 (Cash Flow, Reinsurance, and Assumptions Sections)
  - ❑ Both use prudent estimate assumptions
- **Differences with the deterministic reserve**
  - ❑ Based on multiple economic scenarios, not just one deterministic scenario
  - ❑ Focus is on tail risk (risks that have high impact but low probability)
  - ❑ Uses GPVAD method, not Gross Premium Reserve method
  - ❑ Discount rate is prescribed, not the company's projected portfolio rates
  - ❑ Must model prudent estimates dynamically with economic scenario

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Stochastic Reserve Calculation

- Determine margins and prudent estimate assumptions for all risk factors as described in Section 9
- Generate the prescribed stochastic economic scenarios using the Academy generator
- Determine the number of stochastic economic scenarios as described in section 7.G.2.c, d and e
- Determine the number of subgroups for aggregation purposes for the Stochastic Reserve calculation as described in Section 7.B.3. Currently being discussed by LATF
- For each aggregation subgroup, calculate the Scenario Reserve for each scenario
- Calculate the Stochastic Reserve by ranking the Scenario Reserves from lowest to highest and taking the average of the highest 30% (CTE 70) of these Scenario Reserves. Use the 30% worst scenarios that are unique for each aggregation subgroup
- Add together the Stochastic Reserve for all aggregation subgroups
- Adjust for starting value of PIMR (subtract positive PIMR or add negative PIMR)
- If necessary, add amounts to the Stochastic Reserve to capture any material risk included in the scope of VM-20 but not already reflected in the stochastic reserve

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Scenario Reserve

- The Scenario Reserve = starting assets plus the Greatest Present Value of Accumulated Deficiency (GPVAD) for each scenario

  - At the valuation date, start with the amount of starting assets and project the accumulated value of assets at the end of each projection year

  - Then determine the **negative** of the projected accumulated value of assets (may be positive or negative) for all model segments added together

  - Discount the negative accumulated deficiencies at the end of each projection year to the valuation date

  - Path of discount rates = 105% of 1-year treasury rate in each future year

  - Scenario Reserve = the largest of discounted values plus starting assets

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Economic Scenarios for the Stochastic Reserve

- Prescribed Generator can be found on the SOA website

  www.soa.org/research/software-tools/research-scenario.aspx

- Additional description of economic scenarios can be found in Appendix 1 of VM-20

- Companies will have the choice to run either the full 10,000 stochastic scenarios or one of the pre-selected subsets (1,000, 500, 200, or 50 scenarios)

- Companies are encouraged to use the greatest number of scenarios their capacity allows

- Each scenario will provide the same 19 investment return categories, including Treasury interest rate yield curves at different tenors and various total investment equity return paths

- For general account equity investments and separate account funds, the company will need to determine "proxy funds" and then map each of the proxy funds to the prescribed fund returns

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Aggregation

- Aggregation refers to the number and composition of subgroups of policies that are used to combine cash flows

- Aggregating policies into a common subgroup allows the cash flows arising from the policies for a given stochastic scenario to be netted against each other (i.e., allows risk offsets between policies to be recognized)

- Current VM-20 requirements permit the aggregation of any groups of policies that are managed together under an integrated risk management process

- A proposal is currently being discussed by LATF that would prohibit the grouping of certain policies for the SR, namely term and ULSG (i.e., SR must be calculated separately)

  - Would limit the amount of risk offsets

  - Reflects a scenario that cannot occur since the 30% worst scenarios are almost certain to differ for each subgroup

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Stochastic Reserve Calculation Example

Starting Assets	1000
No. of Scenarios	10
Projection Period	5 years

Discount Rates

Year:	1	2	3	4	5
Scenario #1	4.0%	4.1%	4.2%	4.3%	4.4%
Scenario #2	4.0%	3.9%	3.8%	3.7%	3.6%
Scenario #3	4.0%	3.9%	3.8%	3.9%	4.0%

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Stochastic Reserve Calculation Example

Accumulated Assets

Year:	Start	1	2	3	4	5
Scenario #1	1000	950	900	850	800	750
Scenario #2	1000	950	700	450	200	-50
Scenario #3	1000	1200	700	-50	-100	200

Present Value of Accumulated Assets

Year:	Start	1	2	3	4	5
Scenario #1	1000	896	800	712	630	555
Scenario #2	1000	896	624	379	159	-38
Scenario #3	1000	1132	624	-42	-80	150

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Stochastic Reserve Calculation Example

Present Value of Accumulated Deficiency (Negative of Accumulated Assets)

Year:	Start	1	2	3	4	5
Scenario #1	-1000	-896	-800	-712	-630	**-555**
Scenario #2	-1000	-896	-624	-379	-159	**38**
Scenario #3	-1000	-1132	-624	42	**80**	-150

Greatest Present Value of Accumulated Deficiency

Scenario #1	-555
Scenario #2	38
Scenario #3	80

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Stochastic Reserve Calculation Example

GPVAD over all 10 Scenarios

Scenario #1	-555	Scenario #10	-1234
Scenario #2	38	Scenario #1	-555
Scenario #3	80	Scenario #4	-416
Scenario #4	-416	Scenario #7	-208
Scenario #5	19	Scenario #5	19
Scenario #6	40	Scenario #2	38
Scenario #7	-208	Scenario #6	40
Scenario #8	47	**Scenario #8**	**47**
Scenario #9	99	**Scenario #3**	**80**
Scenario #10	-1234	**Scenario #9**	**99**

CTE(70)   75

Average of the largest
30% (3 scenarios)

Stochastic Reserve = Starting Assets Plus GPVAD at CTE(70) = 1,000 + 75 = 1,075

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Stochastic Reserve Exclusion Test

- The company may elect to exclude one or more groups of policies from the SR (but optionality is currently under study by LATF)

- Policies that have clearly defined hedging strategies are not eligible

- Rationale for an stochastic exclusion:

  - ❑ Not needed for products that are insensitive to the interest rate and equity return risk
  - ❑ Burdensome for companies
  - ❑ Burdensome for regulators to review and audit

- Avoiding the stochastic calculation may be appealing to some companies (i.e., small companies with simple products) but they could lose the full benefit of risk diversification that arises under the stochastic calculation

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Stochastic Reserve Exclusion Test

Three alternatives:

1. Calculating an exclusion ratio and passing a benchmark.

2. Providing a demonstration in the PBR Actuarial Report.

3. Providing a certification to the commissioner (upon request) that the group of policies is not subject to material interest rate risk or asset return volatility risk.

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Concept for the Ratio Test

- Concept is similar to the New York 7 used in asset adequacy testing

- Define a limited number of scenarios: 16 was chosen

- Determine variability of reserve for each scenario

- Invent a measure of variability. If low enough, no need for stochastic valuation

- Process to generate scenarios:

  - ❑ Start with yield curve on valuation date

  - ❑ Use Academy generator to create scenarios using predefined sets of random shocks

- Details of shocks and the development of the 16 scenarios are found in Appendix 1 of VM-20

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Ratio Test

- Calculate an "Adjusted Deterministic Reserve" for each of the 16 Scenarios
  - ❑ a = Reserve for baseline scenario
  - ❑ b = Largest reserve determined over the other 15 scenarios
  - ❑ c = Baseline scenario present value of benefit cash flows only (no premium or other revenue items)
- The company may exclude a group of policies from the Stochastic Modeling Requirement if **(b – a) / c < 0.06**
- Must pass on both pre-reinsurance and post-reinsurance basis
- If the ratio is less than 6% on the pre-YRT reinsurance basis, but greater than 6% on the post-YRT reinsurance basis, the company can still pass the test if a demonstration can be made that the sensitivity of the Adjusted Deterministic Reserve is comparable pre- and post- YRT reinsurance

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Ratio Test – Adjusted Deterministic Reserve

The company can elect one of two options to calculate the adjusted deterministic reserve:

1. The deterministic reserve defined in VM-20, but with the following differences:
   - Using anticipated experience assumptions with no margins
   - Using the interest rates and equity return assumptions specific to each scenario

2. A gross premium reserve developed from the cash flows from the company's asset adequacy analysis models, using the experience assumptions of the company's cash flow analysis, but with the following differences:
   - Using the interest rates and equity return assumptions specific to each scenario
   - Using the methodology to determine net asset earned rates and discount rates defined in VM-20 specific to each scenario to discount the cash flows, but using the company's cash flow testing assumptions for default costs and reinvestment earnings

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Ratio Test

Other Requirements:

- For purpose of calculating this ratio, the company may not group together with other policies:

    - Term policies that are subject to NPR

    - Universal life insurance with secondary guarantee policies that are subject to NPR

    - Contract types with significantly different risk profiles

- Mortality improvement beyond the projection start date may not be reflected in the mortality assumption

- The company must use assumptions within each scenario that are dynamically adjusted as appropriate for consistency with each tested scenario

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Demonstration Test

- The demonstration must provide a reasonable assurance that if the stochastic reserve was calculated on a standalone basis for the group of policies subject to the stochastic reserve exclusion, the minimum reserve for those groups of policies would not increase.

- The company must provide a demonstration in the PBR Actuarial Report in the first year and at least once every three calendar years

- The demonstration must take into account whether changing conditions over the current and two subsequent calendar years would be likely to change the conclusion to exclude the group of policies from the stochastic reserve requirements

- The demonstration may be based on analysis from a date that precedes the initial or subsequent exclusion period

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Demonstration Test

- Acceptable demonstrations include but are not limited to:

  - Standalone SR is < max [DR, NPR – DPA]

  - SR is < max [DR, NPR – DPA] for a representative sample of policies

  - Scenario Reserve is < max [DR, NPR – DPA] for a limited, but sufficient, number of adverse deterministic scenarios

  - Risks that would cause the SR to be > max [DR, NPR – DPA] have been substantially eliminated through hedging, investments strategies, reinsurance, or other means

  - Any method acceptable to the commissioner

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Certification

- The company is required to provide a certification by a qualified actuary that the group of policies is not subject to material interest rate risk or asset return volatility risk (i.e., the risk of non-fixed-income investments having substantial volatility of returns such as common stocks and real estate investments)

- Certification must be given in the first year and at least every third calendar year thereafter

- The company is required to provide the certification and documentation supporting the certification to the commissioner upon request

- Not available for variable life or universal life with a secondary guarantee

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Certification

Examples of methods to support actuarial certification

▪ For policies reserved using old CRVM, a demonstration that the reserves held are greater than each of the 16 ratio test scenarios or each of the NY7 scenarios

▪ The ratio test was passed within the last 36 months and the company has not had a material change in its interest rate risk

▪ A qualitative risk assessment of the group of policies was completed that concludes the group of policies does not have material interest rate risk or asset return volatility

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