Term NPR and DR Exploration in VM-20 reserves

1. Introduction
The life industry is undergoing a paradigm shift in the determination of U.S. statutory life reserves from a rules based reserves to a principle-based approach (PBA) as defined in the Valuation Manual for life insurance, including section VM-20. VM-20 is likely to be effective 1/1/2017 with a 3-year transitional period to implement. VM has potentially far reaching business implications. For example, VM-20 could impact the way company performance metrics such as earnings are measured and interpreted and hence how companies are managed.

At present, there isn’t a text book filled with examples, the industry does not have decades or years of experience in using VM-20 reserves – financial reporting, business planning, pricing or designing products. Concrete examples or case studies on many issues are virtually non-existent. Aside from strategic and operational considerations, there is much to ponder, explore, and understand practically from calculations to assumption setting to model methodologies. We aim to explore the different input parameters and product features and observe the resulting effects on Term NPR or Term DR.

2. Overview of Background
Historically, statutory reserving requirements for life insurance and annuities in the U.S. have been based on formulaic standards. Standards for health insurance already in corporate some elements of a principle-based method. The standards for life insurance are based on a prescribed formulaic method known as the Commissioners Reserve Valuation Method (CRVM). In its simplest terms, under CRVM, the reserve equals the excess of the Present Value of Future Guaranteed Benefits over the Present Value of Future Modified Net Premiums.

$$V = A_{x+t} - P\ddot{a}_{x+t}$$

The standards for annuities are based upon a prescribed formulaic method known as the Commissioners Annuity Reserve Valuation Method (CARVM). For CARVM, the present value of the excesses must be considered at all policy year ends at which the policyholder may elect to receive a benefit. The reserve is the greatest of the respective excesses.

$$iV = \max_{n \geq t} (B_n v^{n-t} - P\ddot{a}_{n-t})$$

For each of these methods, the Standard Valuation Law (SVL) prescribes assumptions to be used for mortality and interest. The reserving requirements in the SVL were developed in accordance with the concept of conservation embodied in statutory accounting principles. They establish a minimum for the reserve. Actuarial judgement may be used to increase, but not decrease the reserve. In addition, tax reserves for life insurance and annuities are generally based upon the reserve methods and assumptions adopted by states. The prescribed methods for tax purposes are CRVM
for life insurance and CARVM for annuities. Finally, minimum statutory standards for capital and surplus, referred to as Risk Based Capital (RBC) are also generally based on formulaic approach.

Formulaic standards served regulators well for many years. The formulaic methods prescribed by the SVL are based upon fundamental reserving concepts and worked well while companies were generally offering simple products with guarantees that were captured by the formulas and which were backed by well-matched, conservatively invested asset portfolios in a relatively stable economic environment. Formulaic methods and prescribed assumptions are also easy for regulators to monitor and examine. And the built in conservatism helps ensure the solvency of insurers. Over time, however, regulators began to identify limitations with the formulaic standards which motivated them to seek changes. In some instances, regulators turned to principles based methods to address these limitations. One of the first of these limitations related to the fact that the formulaic reserving standards focus on liabilities and do not incorporate specific risks related to assets supporting the liabilities. This limitation became apparent when interest rates spiked in the 1980s and insurers had to sell assets at a loss to provide cash values to policyholders who surrendered policies to take advantage of higher yields. This limitation was addressed by requiring companies to perform an analysis which evaluates liabilities in light of the assets held by the company to support the liabilities, also known as asset adequacy analysis. This evaluation is performed by a qualified actuary to support the actuarial opinion he/she issues which respect to the reserves. The analysis requires actuarial judgement and incorporates relevant credible company experience. So asset adequacy analysis incorporates elements of a principal-based method.

Another limitation came to light as the economic environment of the 1980’s led to an evolution of the life and annuity insurance marketplace as consumers began to demand insurance products that mirrored the results of investment products and companies began to look for ways to insulate themselves from newly identified risks. All of this led to new and more complex product designs such as universal life insurance, variable annuities and features such as market value adjustments and risks such as guaranteed living benefits which the formulaic methods were not designed to accommodate. The SVL contemplated that there may be products that would be of such a nature that the minimum reserves could not be determined by the prescribed methods and provided that minimum reserves for these products could be established via regulation.

As discussed above, the mortality table and the interest rates prescribed for valuation purposes are intended to be conservative. They are also locked in at issue. Although mortality experience has improved dramatically through the years, the mortality tables have been slow to change to reflect this improved experience. Further, the same assumptions and margins are applied regardless of the actual experience or risk profile of the company. This limitation was perhaps the most important driver of the
development of a comprehensive Principle-Based approach to valuing life insurance and annuities. This limitation drove some companies with better than average risk experience or risk profiles to seek ways to interpret regulatory requirements so that their experience could be more appropriately reflected in reserves and to avoid regulatory requirements altogether. This issue was particularly acute for companies with sophisticated underwriting techniques issuing level term insurance and universal life insurance with secondary guarantees in a highly competitive environment as it resulted in significant disconnects between the assumptions being used to price products and those required for reserves. This disconnect also motivated some companies to seek methods to finance reserves perceived to be excessive. This led to competitive issues among companies as varying interpretations of the regulations evolved. It also raised solvency concerns for the regulators.

3. Research Focus
A principle-based valuation is a reserve valuation that uses one or more methods or one or more assumption determined by the insurer and which (1) quantifies the benefits, guarantees and funding, associated with the contracts and their risks at the level of conservatism that reflects conditions that include unfavorable events that have a reasonable probability of occurring during the lifetime of the contracts. For polices or contracts with significant tail risk, the valuation reflects conditions appropriately adverse to quantify the tail risk; (2) incorporate assumptions, risk analysis methods and financial models and management techniques that are consistent with, but not necessarily identical to, those utilized within the company’s overall risk assessment process, while recognizing potential differences in financial reporting structures and any prescribed assumptions or methods; (3) incorporates assumptions that are prescribed or derived utilizing the company’s available experience, to the extent it is relevant and statistically credible or to the extent that company data is not available, relevant, or statistically credible, that are established utilizing other relevant, statistically credible experience. It is important to note that assumptions will be prescribed for risks over which the company does not have significant control or influence. And finally, a principle-based reserve valuation must provide margins for uncertainty including adverse deviation and estimation error, such that the greater the uncertainty the larger the margin and resulting reserve.

Revisions to the Standard Valuation Law, adopted by the NAIC in 2009, establish the framework for the principle-based valuation standards by establishing principles upon which reserves are to be based rather than specific formulas. Additional detail and constraints regarding the principle-based methods will be included in a separate document referenced in the law called the “Valuation Manual.” The framework will apply to all life, annuity and health insurance coverage. However, the initial principle-based standards will only apply to life insurance, with certain exceptions, exemptions and exclusions and will be applied prospectively with an optional 3-year transition period. Existing standards will continue to apply to coverage which is not subject to a principle-based standard. The valuation manual will be updated to incorporate
principle-based standards for other coverage as they are developed. The Valuation Manual is intended to be a living document that includes the details of the valuation standards.

The VM-20 minimum reserve is the greatest of three reserves – the Aggregate Net Premium Reserve, NPR, which is a formulaic reserve, and two modeled reserves – the Deterministic Reserve, DR, and the Stochastic Reserve, SR. You also need to calculate a Due and Deferred Premium Asset, DPA.

Assumptions are either prescribed, stochastically modeled or use prudent estimate assumptions applying a margin to provide for adverse deviations and estimation error. Assumptions must be periodically reviewed and updated as appropriate. Sensitivity testing of assumptions is required to understand the materiality of prudent estimate assumptions on the minimum reserve. A margin must increase reserves. Assumption and margin setting is one of the more challenging pieces to VM-20.

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\text{Prudent} = \text{Anticipated} + \text{Margin}
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VM-20 modeled reserves introduce assets as part of the statutory reserve calculation. Projected asset cash flows affect investment income and portfolio earned rates. Dynamic liability assumptions often use a crediting rate strategy based on portfolio earned rates and lapse rates that are a function of credited rates.

4. Deterministic Reserve Exploration

If a product is designed to be remotely profitable, the DR in the first few years should be negative. This is because only cash transactions enter into the reserve calculation, furthermore only future cash. Pricing includes time zero expenses. But for reserves a few seconds after issue, these expenses are in the past. If the policy is profitable with a first year commission of 20-100% and underwriting expenses, then the present value of future premiums simply has to exceed present value of future benefits and expenses, and by a considerable amount. One could think of the first year reserve as equal to the negative of the first year expense plus a second order adjustment.

4.1 Bühlmann Credibility Factor

This pair of experiments explores the impact mortality margins determined by credibility factors have on deterministic reserves. The first experiment considers Bühlmann credibility factors. The VM-20 9.C table for Bühlmann margins has 24 columns. We present results for 11 of those 24 columns. The 83-87% column has been our baseline.

The graph may look crowded. But what is noticeable is that the results are not one big thick curve but there is visual separation between each trial to see the impact between each trial, that is, moving to the right 1-2 table columns. For 10 year term policy years 3-9 credibility affects DR plus DPA and hence the minimum reserve. In policy years
three and four once a certain level of credibility is reached, further improvements decreased DR plus DPA but have no impact on the minimum reserve since NPR is larger. However, in years 5-9, DR plus DPA is the minimum reserve and the differences are considerable. Looking at the ratio graph shows that better credibility by 20-30% can lower reserves by 40 to 60%. To answer the hypothesis question, going from the 83-87% trial, trial 6 to the 94-95% trial, trial 9, lowers reserves in years 4-8 on average by 13%. The next graph looks at ratios of successive trials. Ignoring the larger decreases due to small reserves in policy years 3 and 4, reserves decrease in each successive trial by 3-10% in year 5, by about 2-6% in years 6-7, and 1-4% in years 8-9.

**Bühlmann Credibility Factor – 10 Year Term**

20 year term results also show a considerable impact. For the first 16 policy years NPR is bigger than DR+DPA so although credibility has a great impact on DR plus DPA, it does not change the minimum reserve. However, reserves are not determined on a single issue year cohort and we will see in later experiments that credibility can impact the minimum reserve. Looking at the ratio graph, similar to the 10 year we see the cumulative effect from lower numbered trials to higher numbered trials. To answer the hypothesis question, going from the 83-87% trial to the 94-95% trial lowers reserves in years 4-14 on average by 8%. The ratio of successive trials graph shows a similar pattern to the 10 year ratios. The 48-52% decrease in reserves is an outlier since the 33-37% margins significantly drive the first trials to be very high.
Bühlmann Credibility Factor – 20 Year Term

In what will become a theme from experiment to experiment, the 10&20 year block looks like a blend between the two blocks with a lot more weight towards the 20 year. What is important for the block is that credibility only impacts the minimum reserve in policy years 18 & 19.

Bühlmann Credibility Factor – 10&20 Year Term

4.2 Projected Valuation Assumptions
This experiment explores the impact due to not projecting valuation assumptions.

For 10-year term, visually there are two distinct results. The top curve is the pair of trials - Mortality Improvement and None Projected. The rest of the trials are on the bottom curve – all assumptions projected, STP not projected, defaults and spreads not projected, and scenario not projected. Thus we can see that only projecting mortality improvement in the valuation assumption is material. Looking at a ratio graph, we see that not reflect mortality improvement would overstate projected reserves by 35% in year four grading down to 15% by year nine. The Y axis scale is too big to discern differences in the other trials but zooming in shows there is a 2/10 of a percent difference in year four due to not projecting the deterministic scenario and the most miniscule difference by not projecting future valuation defaults and spreads.

Projected valuation assumptions have a similar impact on 20-year term as on 10-year term. Only projected mortality improvement matters. Looking at a ratio graph, we see that not reflect mortality improvement would overstate projected reserves by 35% in year 5 and is about 27% from years 6 to 19. The other assumptions are again small. Defaults is about a tenth or two of a percent for years 4 and 5. Not projecting the DR
scenario is 2% in year 4 grading to 0.25% by year 9 and then to 0 by year 14. I now notice that SDP, the black dash, appears to be exactly 100%, that is, not projecting SDP had no impact at all.

And what has and will be recurring trend, is that the 10 & 20 Year block blends the 10 and 20 results with a strong lean towards the 20 year patterns.
What is driving these results? Mortality improvement of 0.8% or 1.2% per year compounded as we progress each year through the projection. For example, by year 10, that is about a 10% improvement in the mortality rates. And as we can see in the results – that is significant. Why do the other assumptions have little or no impact? We leave you with a cliff-hanger and provide explanations in the lessons covering those assumptions. We leave you with other questions to ponder? Are the impacts in this experiment always the case, sometimes the case, or did we stumble on the rare instance that produces these results.

5. Conclusion
The Valuation Manual is not only a paradigm shift in U.S. statutory reserve valuation, but also a game changer. Actuary needs to learn what the new rules are, how to apply them and then discover strategies to win. Concurrence to any degree as being applicable to the business context may warrant a call to action to navigate through many challenges – financially and operationally – possibly much sooner than thought. Our project will continue to working on the rules and a lot of “what’s” in VM with models runs and results.