

Term Net Premium Reserve (NPR) Calculation

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The following excerpts and adapts a presentation given at the Farm Bureau Actuarial Conference August 7, 2013. The excel file *NPRTermCurtateTemplate.xls* contains a template to calculate the NPR (Net Premium Reserve) in the Valuation Manual VM-20 (based on the December 2, 2012, version).

The narration below walks through the calculation by providing the content of each presentation slide and commentary. The template can be adapted to other valuation functions such as semi-continuous and fully continuous through the standard adjustments to claims and premiums. Familiarity with current CRVM is assumed. The text to Sections 3.B.4, 3.C.3. and 3.D.1 from VM-20 is provided in the Appendix - references are made in the calculation narrative in the appropriate places.

This illustration is applicable for a typical non-cash value level term product (level premium for some initial period with an increase in premiums subsequent to the level period). This illustration is not applicable to Universal Life.

Slide 1: Brief comparison with current CRVM and current FAS60.

- $NPR = PV \text{ Benefit} - PV \text{ Net Premium}$ (PV: Present Value)
- Method
 - Similarities with current CRVM / FAS60
 - Adjusted Gross Premiums and simple Expense Allowance
 - Segments
 - Net premiums: k-factor
 - Net premium constraint
- Assumptions
 - Mortality: 2001 CSO Select & Ultimate
 - Interest: Similar to current Standard Valuation Law (SVL)
 - Lapses: prescribed based on level periods, premium increases and whether there are cash values (VM-20 3.C.3)
 - Locked in for calendar year of issues

Net premium reserves are a seriatim formulaic net premium calculation using fully prescribed assumptions with cash value floors similar to current CRVM with some differences. Term has a CRVM structure with several differences. The expense allowance is defined as \$2.50 per \$1,000 of insurance for the first policy year only (see VM-20 3.B.4.a). Prescribed lapse rates are introduced that are fixed and determined by product guarantees: the length of level periods and percent increase in the gross premium (see VM-20 3.C.3). Thus lapse rates are set at policy issue. There may be two “k-factors” (before and after the level period/shock year) to reflect an adjustment if beyond the level period the present value of valuation net premiums exceeds the present value of benefits by more than 35% (see VM-20 3.B.4.a i-iv).

Slide 2: Policy Example

Policy Parameters

- 20 Year Level Period + ART thereafter to age 95
- Male, Issue Age 35, Non-Smoker,
- \$1 million face, no cash values
- Gross Premium (GP): year 1-20 = \$610; year 21= \$7,100; increasing premiums annually thereafter

Valuation Assumptions

- Segments:** New segment when Gross Premium increases, thus, 1st segment = 20 years
- Mortality:** Select rates in first segment; Ultimate thereafter
- Lapses:** 6% years 1-19; 80% year 20; 10% years 21-60
- Interest** $Min(current\ SVL + 1.5, 1.25 \cdot current\ SVL) = Min(1.25 \cdot 4, 4 + 1.5) = 5\%$

The lapse rate (wx) reflects the level premium period of 20 years, a percent increase of greater than 400% at the end of the level period, and post-level period premium increases each and every year (see VM-20 C.3.b.i-iv)

Slide 3: Decrements

Columns C-E calculate the survivorship probability for each Policy Year.

PolYr	1000*qx	wx	px
1	0.37	6%	0.940
2	0.43	6%	0.940
3	0.49	6% $=(1-q)(1-w)$	
...			...
19	2.51	6%	0.938
20	2.79	80%	0.199
21	5.50	10%	0.895
22	6.14	10%	0.894

Slide 4: Adjusted Gross Premiums and Expense Allowance

Columns G-H calculate the Adjusted Gross Premium (AGP) and cell O2 calculates the Expense Allowance. The AGP is per VM-20 3.B.4.b and the allowance is per VM-20 3.B.4.a.

PolYr	Gross Premium	Adjustment	Adjusted GP (AGP)	Expense Allowance
1	610	* 0%	-	2,500
2	610	* 90%	549	EA = 2.5% * Issued Face
3	610	* 90%	549	
4	610	* 90%	549	
5	610	* 90%	549	
6	610	* 100%	610	
7	610	...	610	
...	
21	7,100	100%	7,100	

Slide 5: Calculation of k-factors and constraint criteria values

Columns K-L are standard present values of beginning of period (BOP) AGPs and Benefits. Cell O8 calculates the k-factor before consideration of the VM-20 constraint (i.e, VM-20 3.B.4.a i-iv) which compares present values beyond the level period. Column O contains the calculation of the constraint.

Constraint: Beyond the level period (LP)

- $PV(\text{Net Premium}) \leq 1.35 * PV(\text{Benefit})$
- If the inequality does not hold (i.e >) then adjust the post-shock (PS) Net Premium down to 135% AND adjust LP Net Premium up an offsetting amount

The adjustment utilizes the following relationship:

$$k^{LP} \cdot PV(AGP^{LP}) + k^{PS} \cdot PV(AGP^{PS}) = PV(\text{Benefit}) + EA$$

where LP denotes Level Period, PS Post Shock Period, AGP Adjusted Gross Premium, and EA Expense Allowance.

PV Post-Shock Benefit	1,606.80
PV Post-Shock Net Premium	4,573.97
Ratio = (4573 / 1606)	285%
Ratio is > 135% so Adjust	
k-Factor Post-Shock	72.2%
$k_{PS} = 1.35 * 1.52 / 2.85$	
PV Level Period AGP	4,366.92
PV Post-Shock AGP	3,006.10
k-Factor Level-Period	207%
$k_{LP} = (8718 + 2500 - .72 * 3006) / 4366$	

Slide 6: Application of constraint and calculation of terminal reserves

Column's P-R calculate the Net Premium with Column R being the Net Premium used to calculate the terminal reserve. Column's S-T calculate the PV of Net Premium and the terminal reserve (there is no need to recalculate PV of Benefits).

PolYr	Adjusted GP (AGP)	k-Factor	NetPremium	PV_Benefit	PV_NetPremium	Terminal Reserve
1	-		-	8,718.51	11,218.51	-
2	549	207.2%	1,137.66	9,348.60	12,535.95	(3,187.35)
3	549	207.2%	1,137.66	9,989.43	12,737.61	(2,748.17)
4	549	...	= k * AGP	10,642.35	12,963.74	= PV Ben - PV NP
5	549	...	1,137.66	11,287.78	13,217.51	(1,929.73)
6	610	...	1,264.07	11,946.00	13,501.96	(1,555.96)
...			
9	...	...	...	13,946.08	14,103.05	(156.98)
10	...	...	...	14,612.78	14,354.63	258.16
11	...	...	...	15,263.74	14,637.22	626.52
12	...	...	...	15,855.23	14,955.14	900.09
...			
20	610	207.2%	1,264.07	16,115.35	19,432.64	(3,317.30)
21	7,100	72.2%	5,123.31	70,853.24	95,651.88	(24,798.64)
22	8,060	...	5,816.03	76,974.37	106,200.77	(29,226.41)

Slide 7: Final Step: Apply a Half cx floor to Mean Reserve

VM-20 requires a cost of insurance floor (see VM-20 3.D.1): here we use a half cx floor, i.e., $NPR = \max(\text{Mean}, 0.5c_x)$

Columns U-W calculate the half cx floor, the mean reserve and the maximum.

PolYr	Mean Reserve	Half cx	NPR
1	(1,593.67)	176.19	176.19
2	(2,398.93)	204.76	204.76
3	(1,965.95)	233.33	233.33
...	<i>Mean = (Terminal.n + Terminal.n+1 + NP.n) / 2</i>		
9	682.62	438.10	682.62
10	1,074.37	480.95	1,074.37
11	1,395.34	542.86	1,395.34
12	1,615.93	604.76	1,615.93
13	1,708.34	680.95	1,708.34
14	1,641.42	757.14	1,641.42
15	1,401.52	828.57	1,401.52
16	978.64	895.24	978.64
17	324.15	990.48	990.48
18	(637.84)	1,100.00	1,100.00
...			

Appendix

VM-20 Excerpts (based on the December 2, 2012, version)

VM-20 Section 3.B.4

4. For all policies other than universal life policies, on any valuation date the net premium reserve shall be equal to the actuarial present value of future benefits less the actuarial present value of future annual valuation net premiums as follows:

- a. The annual valuation net premiums shall be a uniform percent of the respective adjusted gross premiums, described in Section 3.B.4.b, such that at issue the actuarial present value of future valuation net premiums shall equal the actuarial present value of future benefits plus an amount equal to \$2.50 per \$1,000 of insurance for the first policy year only.

For policies subject to the shock lapse provisions of Section 3.C.3.b.iii, valuation net premiums for policy years after the shock lapse shall be limited and may result in two uniform percentages, one applicable to policy years prior to the shock lapse and one applicable to policy years following the shock lapse. For these policies, these percentages shall be determined as follows:

- i. Compute the actuarial present value of benefits for policy years following the shock lapse.
- ii. Compute the actuarial present value of valuation net premiums for policy years following the shock lapse.
- iii. If ii/i is greater than 135%, reduce the net valuation premiums in ii uniformly to produce a ratio of ii/i of 135%.
- iv. If the application of iii produces an adjustment to the net valuation premiums following the shock lapse, increase the net valuation premiums for policy years prior to the shock lapse by a uniform percentage such that at issue the actuarial present value of future valuation net premiums equals the actuarial present value of future benefits plus \$2.50 per \$1,000 of insurance for the first policy year only.

- b. Adjusted gross premiums shall be determined as follows:
 - i. The adjusted gross premium for the first policy year shall be set at zero.
 - ii. The adjusted gross premium for any year from the second through fifth policy year shall be set at 90% of the corresponding gross premium for that policy year.
 - iii. The adjusted gross premium for any year after the fifth policy year shall be set equal to the corresponding gross premium for that policy year.
- c. The gross premium in any policy year is the maximum guaranteed gross premium for that policy year.
- d. Actuarial present values are calculated using the interest, mortality, and lapse assumptions prescribed in Section 3.C.

VM-20 Section 3.C.3

3 Lapse Rates

- a. For policies other than universal life policies or riders which provide nonforfeiture values, universal life policies not containing a secondary guarantee, and universal life policies for which

the longest secondary guarantee period is five years or less, the lapse rates used in determining the present values described in subsection 3.B shall be 0% per year during the premium paying period and 0% per year thereafter.

- b. For policies other than universal life policies or riders which provide no nonforfeiture values (i.e., term policies), the annual lapse rates used to determine the present values described in subsection 3.B shall vary by level premium period as stated below:
 - i. 10% per year during any level premium period of less than five years, except as noted in iii.
 - ii. 6% per year during any level premium period of five or more years, except as noted in iii.
 - iii. 10% per year during any premium paying period after an initial level premium period of less than five years.
 - iv. For policies or riders having a level premium of five years or longer, the lapse rate for the first year of the renewal premium period shall be determined based on the length of the current and renewal premium periods and the percent increase in the gross premium as shown in the table below instead of what would otherwise apply from i or ii above.

Current Premium Yrs	Length of Renewal Prem.	Percent increase in gross premium per	Rate for first Yr. of Renewal
≤1	ART	Any 1	0%
1<PP≤5	ART	Any	50%
1<PP≤5	1<PP5	Any	25%
5<PP≤10	ART	< 400%	70%
5<PP≤10	ART	Over 400%	80%
5<PP≤10	1<PP≤5	Any	50%
5<PP≤10	5<PP≤10	Any	25%
10<PP	ART	< 400%	70%
10<PP	ART	Over 400%	80%
10<PP	1<PP≤5	Any	70%
10<PP	5<PP≤10	Any	50%
10<PP	10<PP	Any	50%

VM-20 Section 3.D.1

D. Net Premium Reserve Calculation and Cash Surrender Value Floor

- 1. For policies other than universal life policies, the net premium reserve shall not be less than the greater of:
 - a. The cost of insurance to the next paid to date. The cost of insurance for this purpose shall be determined using the mortality tables for the policy prescribed in subsection 3.C; or
 - b. The policy cash surrender value, calculated as of the valuation date and in a manner that is consistent with that used in calculating the net premium reserve on the valuation date.