Statutory Valuation of Individual Life and Annuity Contracts

Fifth Edition

Donna R. Claire, FSA, MAAA

Louis J. Lombardi, FSA, MAAA

Sheldon D. Summers, FSA, MAAA

Volume II

ACTEX Learning

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Dedication

This book is dedicated to past, current and future actuaries
for the services that they have provided, are currently providing,
and will continue to provide to society.

Foreword

The actuarial science behind statutory reserving for life insurance companies has been relatively stable for nearly a century. The basic approach has always been formulaic and deterministic in nature. I had the good fortune to be introduced to actuarial mathematics and life contingencies and this formulaic approach as an undergraduate at Georgia State University under Robert W. Batten. It inspired me to witness someone explain difficult actuarial concepts at a level that anyone could understand.

Thirty-plus years later I had the pleasure of working with another pillar of actuarial academia while we were both on the faculty for an actuarial educational seminar, Louis J. Lombardi. I was able to witness firsthand Louis' amazing teaching style and his never ending quest to ensure students understood the material. He is constantly seeking new examples and methods to better educate his audience about life and annuity statutory reserving. His previous edition of *Valuation of Life Insurance Liabilities* was a staple of life and annuity actuarial reserve literature. So, when I heard there about the upcoming, greatly expanded 5th edition, I knew immediately that the actuarial community would significantly benefit from this seminal text. The inclusion of co-authors Donna Claire and Sheldon Summers, with their extensive experience and knowledge of the life, annuity and reinsurance area, makes this text even more relevant. They bring to bear many years of practical application that enhances the richness of the material. The addition of a second volume covering Principle-Based Reserving is invaluable as the approach to life reserving makes dramatic changes from the old formulaic to a new stochastic approach. The supplementary Excel models with explicit examples of all the reserve calculations and detailed formulae are invaluable for the practicing and aspiring valuation actuary.

As I sit here now writing this introduction, I am looking over fondly at my version of the Fourth Edition of this text, and I see the torn corners and bent up edges reflecting the multitude of times I have referenced this book. I eagerly await being able to replace my old version so the new version can be a permanent fixture on my bookcase and guide me in my practice.

D. Joeff Williams, FSA, MAAA

Joeff Williams will be the president-elect of the American Academy of Actuaries (Academy) in late 2018. He has been a consulting actuary for Actuarial Management Resources, Inc. in Winston-Salem, N.C., for the past 29 years. Prior to that, he worked at Integon Life Insurance Company in the Product Development area. His consulting work focuses on both the life and health insurance area. He has served as chairperson of the Academy's Life and Health Qualification Seminar and vice-chairperson of the Academy Council on Professionalism.

Preface

When the *Valuation Manual* became operative on January 1, 2017, it marked the most fundamental change to the valuation standards since 1943, the initial year the *Standard Valuation Law* went into effect. It was a complex undertaking and undoubtedly will evolve as the industry and regulators learn how these principles respond to changing conditions.

The primary goal of this book is to provide an understanding of the "old" and the "new" methods. Specifically, it covers the basic principles of the statutory valuation of individual life insurance and annuity contracts in the United States, including experience studies, model governance, and risk-based capital. It was written both for practicing actuaries and those considering a career in financial reporting, product development or risk management.

Like the fourth edition, the fifth edition has undergone a significant rewrite. Because of its length, the fifth edition has been divided into two volumes:

1. Volume 1 focuses primarily on basic principles, the valuation process, model governance, and formula-based reserves; and
2. Volume 2 focuses primarily on principle-based reserves, experience studies, and risk-based capital.

Equally important are the Excel workbooks. When reading these chapters, it may be helpful to have the Excel Workbook open to follow along with the text.

I want to thank Donna Claire and Sheldon Summers for agreeing to become co-authors of this edition. Their involvement over the years with the development of numerous reserve standards was invaluable. Second, I want to thank Anne Simpson for the significant amount of support she gave during the editing process. Although she has long been retired, she has not lost her gift of taking the technical jargon of actuaries and making them easier for others to understand.

I also appreciate the editorial and design contributions made by the staff at ACTEX Learning, especially, Stephen Camilli, Garrett Doherty, Victoria Grossack, and Jeff Melaragno.

Louis J. Lombardi, FSA, MAAA
Marlborough, CT
May 28, 2018

About the Authors

Donna Claire has over 40 years of experience in the insurance profession and heads Claire Thinking, Inc., which specializes in risk management and regulatory issues. She has worked on a number of American Academy of Actuaries committees on regulatory matters in the life and annuity areas. Mrs. Claire received the Jarvis Farley Award for volunteer service to the Academy and a 2016 Outstanding Volunteer Award for work on Principle-Based Reserves.

She is a Fellow of the Society of Actuaries, a member of the American Academy of Actuaries and a Chartered Enterprise Risk Analyst. She holds a Bachelor of Science Degree from The College of Insurance (now St. John's University School of Risk Management).

Louis Lombardi is a retired principal and actuary from the actuarial practice of PricewaterhouseCoopers, and a former director of the actuarial program at the University of Connecticut. He has forty years of experience in the life insurance industry with extensive knowledge of actuarial education, financial reporting, hedging, product development, software development, and surplus management.

He is a Fellow of the Society of Actuaries, a member of the American Academy of Actuaries and has a Master's Degree in pure mathematics from Tufts University.

Sheldon Summers is a consulting actuary with Claire Thinking, Inc. Prior to that he was Chief Actuary at the California Department of Insurance until his retirement in 2009 after 31 years of service. He has served on various committees of the National Association of Insurance Commissioners and of the American Academy of Actuaries on life insurance and reinsurance matters. In 2010, Sheldon received the American Academy of Actuaries' Robert J. Myers Public Service Award in recognition of contributions to the public good.

He is a Fellow of the Society of Actuaries, a member of the American Academy of Actuaries and holds a Master of Business Administration degree from the University of Southern California.

Access to Excel Models

As part of your purchase of this book, you should have received a key code to access the Excel models mentioned throughout this book. If you have any issues accessing these models, please contact the publisher at support@actexmadriver.com.

Part 4 | Principle-Based Reserves

23.
VM-20: PBR for Life Products

Determining minimum reserves for individual life insurance products under a principle-based valuation is considerably more complicated than determining minimum reserves under a formula-based valuation. As noted in Chapter 5, a formula-based valuation is usually based on a simplified model of cash flows and a single set of a limited number of assumptions (i.e., interest and mortality). In contrast, a principle-based valuation requires a more complex cash flow model based on explicit assumptions for premiums, expenses, investment income, capital gains, asset defaults, death benefits, morbidity benefits, partial withdrawals, full withdrawals, policyholder behavior, and other material contractual features under a range of economic scenarios.

This chapter will provide a detailed discussion of *VM-20: Requirements for Principle-Based Reserves for Life Products*.[1] VM-20 refers to the sections of the Valuation Manual that set forth the requirements for individual life insurance policies, whose minimum reserves are determined using a principle-based valuation. Because of the various methodologies, assumptions, and procedures that are being introduced with this change from a formula-based valuation to a principle-based valuation, VM-20 is a complex document covering a complicated subject.

Chapters 4 and 5 of this book are overviews of the Standard Valuation Law and the Valuation Manual, respectively. The reader needs a working knowledge of the concepts and content discussed in these two chapters to benefit effectively from reading Chapter 23.

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[1] The reader may find it helpful to have a copy of VM-20 readily available when reading this chapter. It can be obtained from the NAIC website. The 2018 manual is available at https://www.naic.org/documents/prod_serv_2018_valuation_manual.pdf

23.1 VUL Model

Associated with this chapter is a Microsoft excel workbook, VM20 - Model - VUL.xlsm (***VUL Model***), that utilizes Microsoft Access and Visual Basic to illustrate the concepts discussed in this chapter. Like VM-20, this model is complex; it requires Microsoft Office 2016. Security settings on the computer you wish to use to run the model may block the model from working. In this case, an Excel workbook without macros, Chapter 23 – VM20 – VUL without Macros.xls, contains the illustrations from this model and those shown in this chapter, can be found in the same location as the workbook with the model.[2]

This section will give an overview of the major sections of this model; however, it is not essential to understand every worksheet shown in this section. The other sections in this chapter will explain these worksheets as the model is used to illustrate various aspects of VM-20.

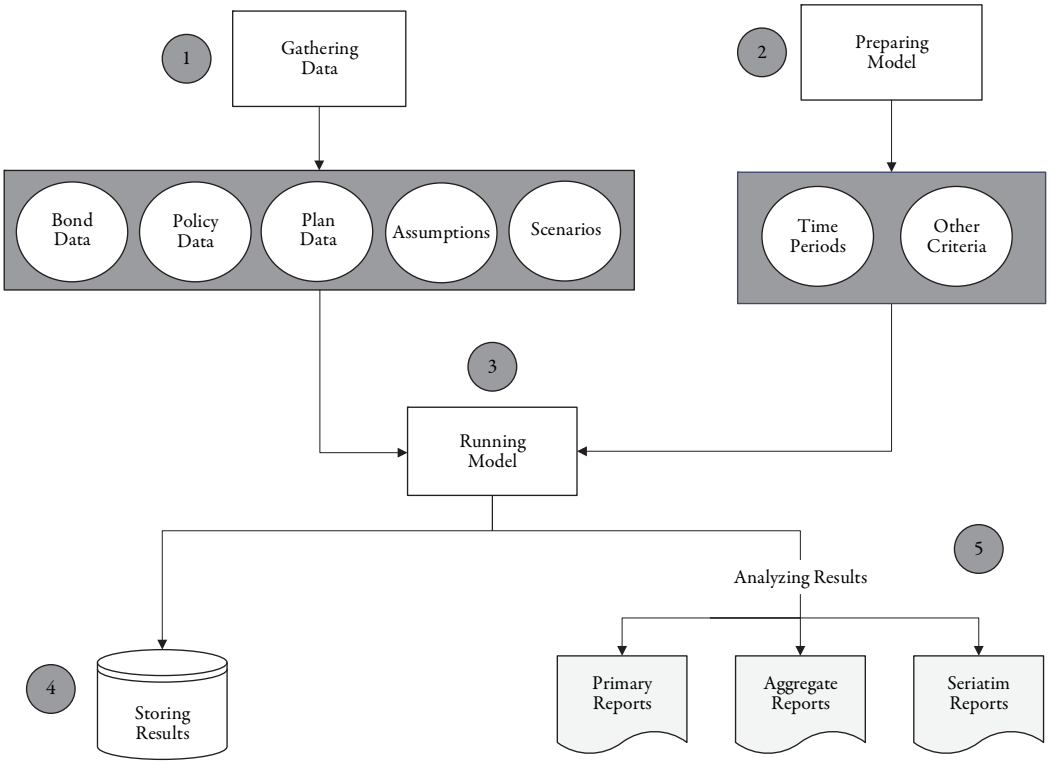
Finally, as noted in the first worksheet of the VUL Model (the Description Worksheet), this model is for educational purposes only and assumes that the user has a general understanding of how models are used for pricing, financial reporting, and risk management. It does not have all the functionality of a model that would be used for cash flow testing, principle-based valuations, or risk management.

[2] To install the model, please read the installation instructions for VM20 – Model – Installation Instructions.PDF.

23.1.1 Model Overview

Figure 23.1 is a high-level flow chart of the VUL Model that is used in this chapter to illustrate the various aspects of calculating reserves under VM-20:

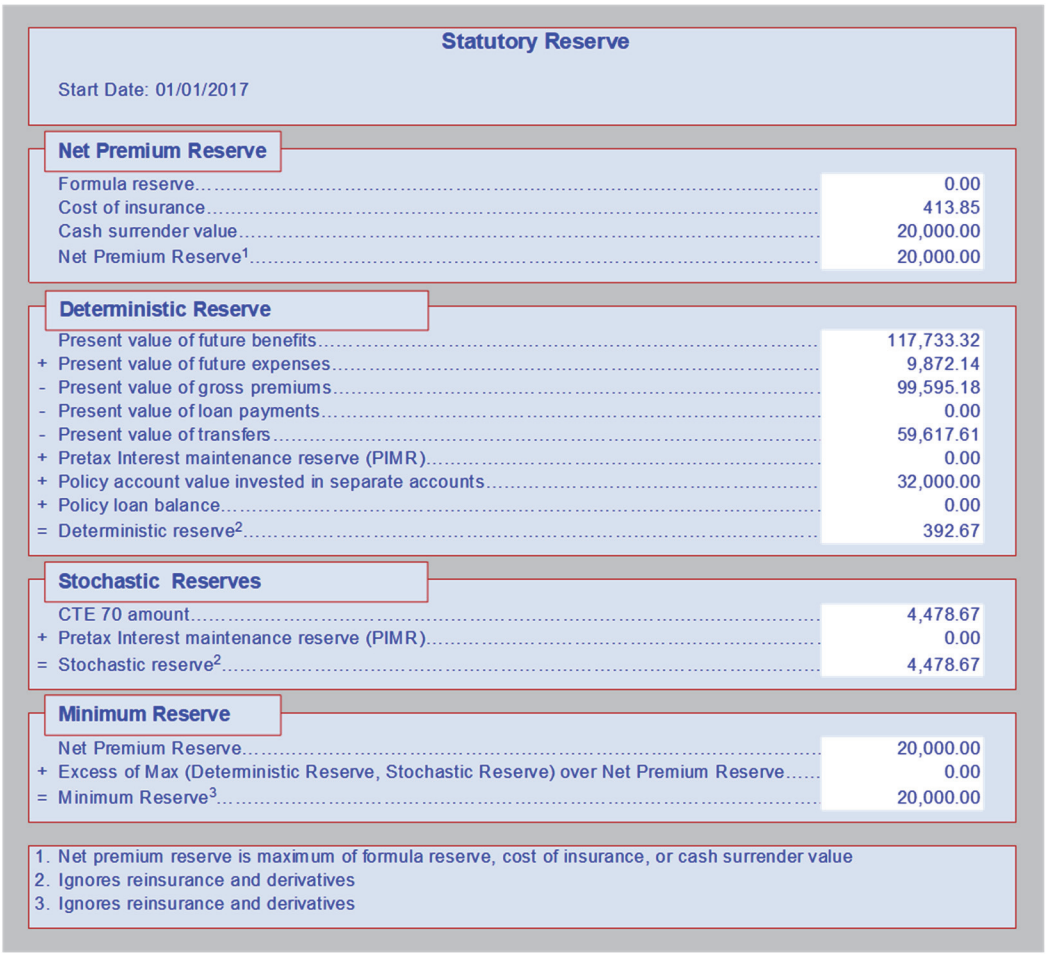
Figure 23.1: High-Level Flow Chart of VUL Model



Like most valuation systems, the procedures that must be followed to use the VUL model have been grouped into five major sections: gathering data, preparing the model, running the model, storing results, and analyzing results.

The most important worksheet in this model is the **Reserves Output Worksheet**, which shows the following summary of the various types of reserves prescribed in VM-20:

Figure 23.2: Reserves Output Worksheet: Summary of Statutory Reserves



Statutory Reserve

Start Date: 01/01/2017

Net Premium Reserve

Formula reserve	0.00
Cost of insurance	413.85
Cash surrender value	20,000.00
Net Premium Reserve[1]	20,000.00

Deterministic Reserve

	Present value of future benefits	117,733.32
+	Present value of future expenses	9,872.14
-	Present value of gross premiums	99,595.18
-	Present value of loan payments	0.00
-	Present value of transfers	59,617.61
+	Pretax Interest maintenance reserve (PIMR)	0.00
+	Policy account value invested in separate accounts	32,000.00
+	Policy loan balance	0.00
=	Deterministic reserve[2]	392.67

Stochastic Reserves

	CTE 70 amount	4,478.67
+	Pretax Interest maintenance reserve (PIMR)	0.00
=	Stochastic reserve[2]	4,478.67

Minimum Reserve

	Net Premium Reserve	20,000.00
+	Excess of Max (Deterministic Reserve, Stochastic Reserve) over Net Premium Reserve	0.00
=	Minimum Reserve[3]	20,000.00

1. Net premium reserve is maximum of formula reserve, cost of insurance, or cash surrender value
2. Ignores reinsurance and derivatives
3. Ignores reinsurance and derivatives

The purpose of this chapter and the model described in it is to explain how each value shown in Figure 23.2 was calculated.

23.1.2 Gathering Data

The first section, **Gathering Data**, refers to all the activities related to gathering and inputting policy data, plan data, asset data, assumptions, and scenarios into the data entry worksheets. Below are the data entry worksheets used for storing the data gathered:

Figure 23.3: Data Entry Worksheets

Worksheet	Purpose
BF	Specifies the bonds held at the start of the projection period.
IFE	Specifies the variable life insurance contracts inforce at the start of the projection period.
PDF	Describes the product (e.g., expenses charges, cost of insurance charges, guaranteed interest rate, and surrender charges) for the contracts specified in the IFE worksheet.
AA	Specifies the asset assumptions (e.g., default rates, risk premium and loan spreads).
LA	Specifies liability assumptions (e.g., expense, mortality, and lapse rates).
HR	Specifies historical equity and interest rates.
Scenarios	Specifies the equity and interest rate scenarios.

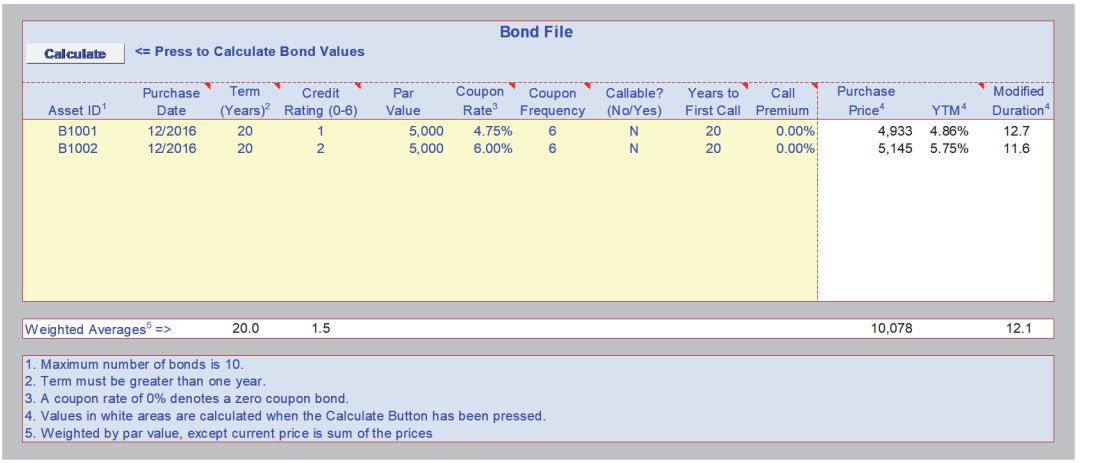
The remainder of this subsection describes the contents of these data entry worksheets. To simplify the data entry process, some of the worksheets do not have the amount of detail required by VM-20. For example, the default rates for the twenty rating categories that appear in Appendix 2 of VM-20 have been reduced to the following seven major rating categories:

Rating	Moody's	S & P
0	Risk-Free	Risk-free
1	Aaa, Aa	AAA, AA
2	A	A
3	Baa	BBB
4	Ba	BB
5	B	B
6	Caa, Ca, C	CCC, CC, C

Only seven of the twenty categories were used, to avoid getting too bogged down with details and to keep the focus on the key concepts.

The **BF Data Entry Worksheet** contains the bonds held in the general account in support of the variable universal life insurance policies that will be included in the financial projections. Figure 23.4 illustrates the contents of this worksheet:

Figure 23.4: BF Data Entry Worksheet of VUL Model



Bond File

Calculate <= Press to Calculate Bond Values

Asset ID[1]	Purchase Date	Term (Years)[2]	Credit Rating (0-6)	Par Value	Coupon Rate[3]	Coupon Frequency	Callable? (No/Yes)	Years to First Call	Call Premium	Purchase Price[4]	YTM[4]	Modified Duration[4]
B1001	12/2016	20	1	5,000	4.75%	6	N	20	0.00%	4,933	4.86%	12.7
B1002	12/2016	20	2	5,000	6.00%	6	N	20	0.00%	5,145	5.75%	11.6
Weighted Averages[5] =>		20.0	1.5							10,078		12.1

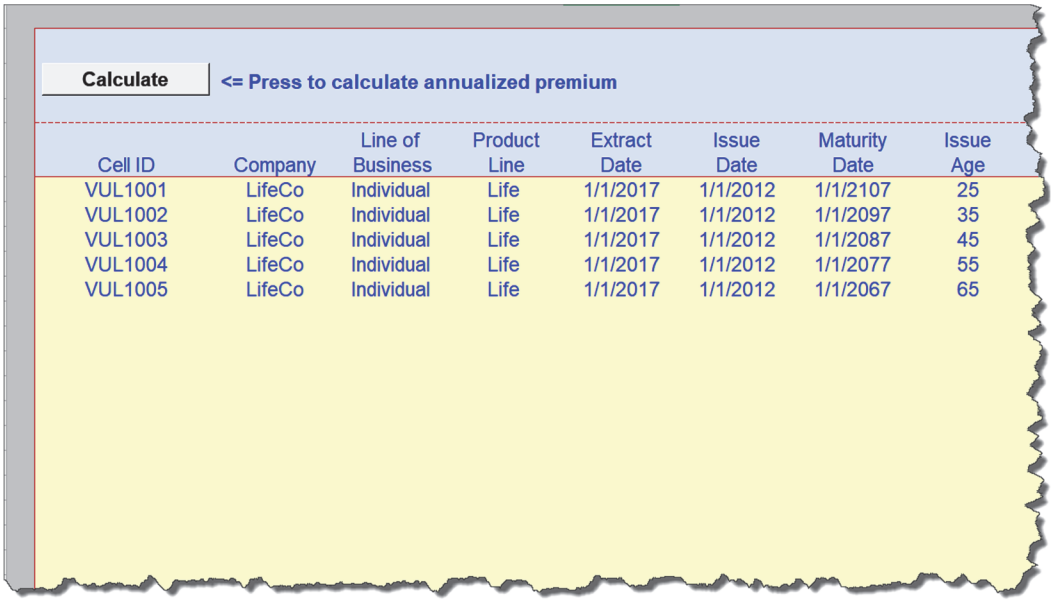
1. Maximum number of bonds is 10.
2. Term must be greater than one year.
3. A coupon rate of 0% denotes a zero coupon bond.
4. Values in white areas are calculated when the Calculate Button has been pressed.
5. Weighted by par value, except current price is sum of the prices

When the **Calculate** button in the upper left corner is pressed, the values in the white area are calculated by the model. It is not necessary to press this button prior to running the model.

This is another example of a simplification. A model used to calculate reserves under VM-20 would have to be able to handle a greater variety of investments held in the general account (e.g., mortgages, derivatives, etc.).

The **IFE Data Entry Worksheet** contains the variable universal life insurance policies that will be included in the financial projections. Figure 23.5 illustrates the kind of data contained in this worksheet:

Figure 23.5: IFE Data Entry Worksheet of VUL Model



Cell ID	Company	Line of Business	Product Line	Extract Date	Issue Date	Maturity Date	Issue Age
VUL1001	LifeCo	Individual	Life	1/1/2017	1/1/2012	1/1/2107	25
VUL1002	LifeCo	Individual	Life	1/1/2017	1/1/2012	1/1/2097	35
VUL1003	LifeCo	Individual	Life	1/1/2017	1/1/2012	1/1/2087	45
VUL1004	LifeCo	Individual	Life	1/1/2017	1/1/2012	1/1/2077	55
VUL1005	LifeCo	Individual	Life	1/1/2017	1/1/2012	1/1/2067	65

When the **Calculate** button in the upper left corner is pressed, the annualized premium will be calculated using the current cost of insurance charges, a four percent credited interest rate, and various data elements in this worksheet and the PDF Data Entry Worksheet (which is discussed below). It is not necessary to press this button prior to running the model. If the value of the planned annual premium field is set to zero, the model will calculate the annualized premium using the same criteria as when this button is pressed.

The **PDF Data Entry Worksheet** contains information about the variable universal life insurance plan associated with the policies in the IFE Data Entry Worksheet. Figure 23.6 shows the contents of this worksheet:

Figure 23.6: PDF Data Entry Worksheet of VUL Model

Plan Description

Plan	UL2010	
Expense Charges:		
Per $1 of Gross Premium First Year	2.00%	
Per $1 of Gross Premium Renewal Years	2.00%	
Per Policy (Annualize)	$120.00	
Cost of Insurance Charges:		
Age Rule	ANB	Age Nearest Birthday
Guaranteed: Mortality Table	2017 CSO	
Guaranteed: Preferred Class	A	Aggregate
Guaranteed: Smoking Class	S	Smoker Distinct
Guaranteed: Select Period	A	Aggregate
Current: Mortality Table	2017 CSO	
Current: Preferred Class	P	Preferred & Standard
Current: Smoking Class	S	Smoker Distinct
Current: Select Period	S	Select & Utlimate
Credited Interest Rates on Fixed Account:		
Guaranteed Credited Interest Rate	3.00%	
Term of U.S. Bond[1]	5	year(s)
Interest Margin[2]	0.50%	
Separate Account Asset Charges:[3]		
Mortality & Expense Charges	1.50%	
Investment Management Fees	0.50%	
Surrender Charges:		
Initial Surrender (% of Fund Value)	100.00%	
Yearly Decrease	10.00%	year(s)
Number of Years	10	
Free Partial Withdrawal (% of Fund Value)	10.00%	

1. Current credited rate on fixed account is interest rate on 5 year U.S. Treasury plus the interest margin.
2. Used to determine current credited interest rate on fixed account.
3. Only applies to variable funds.

Since this is a prototype, the model assumes all the policies will be related to one variable universal life plan. A more robust model would be able to handle multiple plans with significantly more contract features.

The data entry fields in the **Cost of Insurance Charges** section have drop-down lists. To change the value of a data element in this section, click on the cell and select an item from the drop-down list.

The **AA Data Entry Worksheet** contains the asset assumptions. Figure 23.7 shows the contents of this worksheet:

Figure 23.7: AA Data Entry Worksheet of VUL Model

Asset Assumptions

Initial Cash	0		
Interpolation Method	Cubic Spline		
Investment Expenses	0.25%	Annualized	
Cash Spread	0.25%	Annualized	
Loan Spread	0.50%	Annualized	
Cash Limit	20.00%		
Reinvestment Assumptions:			
- Term	5 year(s)	5 year(s)	
- Credit Rating	1 AAA,AA	2 A	
- Allocation %	50.00%	50.00%	<= Second allocation percentage is calculated

Bond Risk Premiums

	Risk-free	Aaa,Aa AAA, AA	A A	Baa BBB	Ba BB	B B	Caa,Ca,C CCC,CC,C
Term	0	1	2	3	4	5	6
3M	0.00%	0.50%	1.50%	3.00%	3.40%	4.25%	40.00%
6M	0.00%	0.50%	1.50%	3.00%	3.40%	4.25%	40.00%
1Y	0.00%	0.60%	1.60%	3.10%	3.50%	4.35%	39.00%
2Y	0.00%	0.70%	1.70%	3.20%	3.60%	4.45%	38.00%
3Y	0.00%	0.80%	1.80%	3.30%	3.70%	4.55%	37.00%
5Y	0.00%	1.00%	2.00%	3.50%	3.90%	4.75%	34.00%
7Y	0.00%	1.20%	2.20%	3.70%	4.10%	4.95%	30.00%
10Y	0.00%	1.50%	2.50%	4.00%	4.40%	5.25%	15.00%
20Y	0.00%	2.50%	3.50%	5.00%	5.40%	3.00%	5.00%
30Y	0.00%	3.50%	4.50%	6.00%	6.40%	3.00%	3.00%

Bond Default Rates

	Risk-free	Aaa,Aa AAA, AA	A A	Baa BBB	Ba BB	B B	Caa,Ca,C CCC,CC,C
Term	0	1	2	3	4	5	6
3M	0.00%	0.25%	0.75%	1.50%	1.70%	2.13%	20.00%
6M	0.00%	0.25%	0.75%	1.50%	1.70%	2.13%	20.00%
1Y	0.00%	0.30%	0.80%	1.55%	1.75%	2.18%	19.50%
2Y	0.00%	0.35%	0.85%	1.60%	1.80%	2.23%	19.00%
3Y	0.00%	0.40%	0.90%	1.65%	1.85%	2.28%	18.50%
5Y	0.00%	0.50%	1.00%	1.75%	1.95%	2.38%	17.00%
7Y	0.00%	0.60%	1.10%	1.85%	2.05%	2.48%	15.00%
10Y	0.00%	0.75%	1.25%	2.00%	2.20%	2.63%	7.50%
20Y	0.00%	1.25%	1.75%	2.50%	2.70%	1.50%	2.50%
30Y	0.00%	1.75%	2.25%	3.00%	3.20%	1.50%	1.50%

Bond Recovery Rates (i.e., Salvage factor)

All	1.0000	0.7000	0.6000	0.5000	0.4000	0.3000	0.3000

Definitions of the terms used in this worksheet are as follows:

- **Initial Cash** is the initial cash balance.
- **Interpolation Method** indicates the method used to determine interest rates for the non-key tenors.[3]
- **Investment Expenses** are the investment expenses expressed as a percentage of invested assets.
- **Loan Spread** is the percentage added to the three-month risk free rate (i.e., three-month U.S. Treasuries) to determine the loan rate on negative cash balances. A negative cash balance means the product line is borrowing money.
- **Cash Limit** specifies the maximum amount of cash held in the general account before bonds are purchased. In other scenarios, when cash as a percentage of general account invested assets exceeds this limit, the excess amount is used to purchase bonds.
- **Reinvestment Assumptions** specify the term and rating of the bonds that are purchased when cash is above the cash limit. Two types of bonds can be specified. The **allocation percentages** are used to split the excess cash between the two types. For example, Figure 23.7 specifies that when cash as a percentage of invested assets exceeds 20%, use 50% of the excess amount to purchase a five-year bond with a AAA/AA rating, and the remainder for the excess cash to purchase a five-year bond with an A rating.[4]

The data entry fields for the **Interpolation Method** and **the Credit Rating** have drop-down lists. To change the value of these data elements, click on the cell and select an item from the drop-down list.

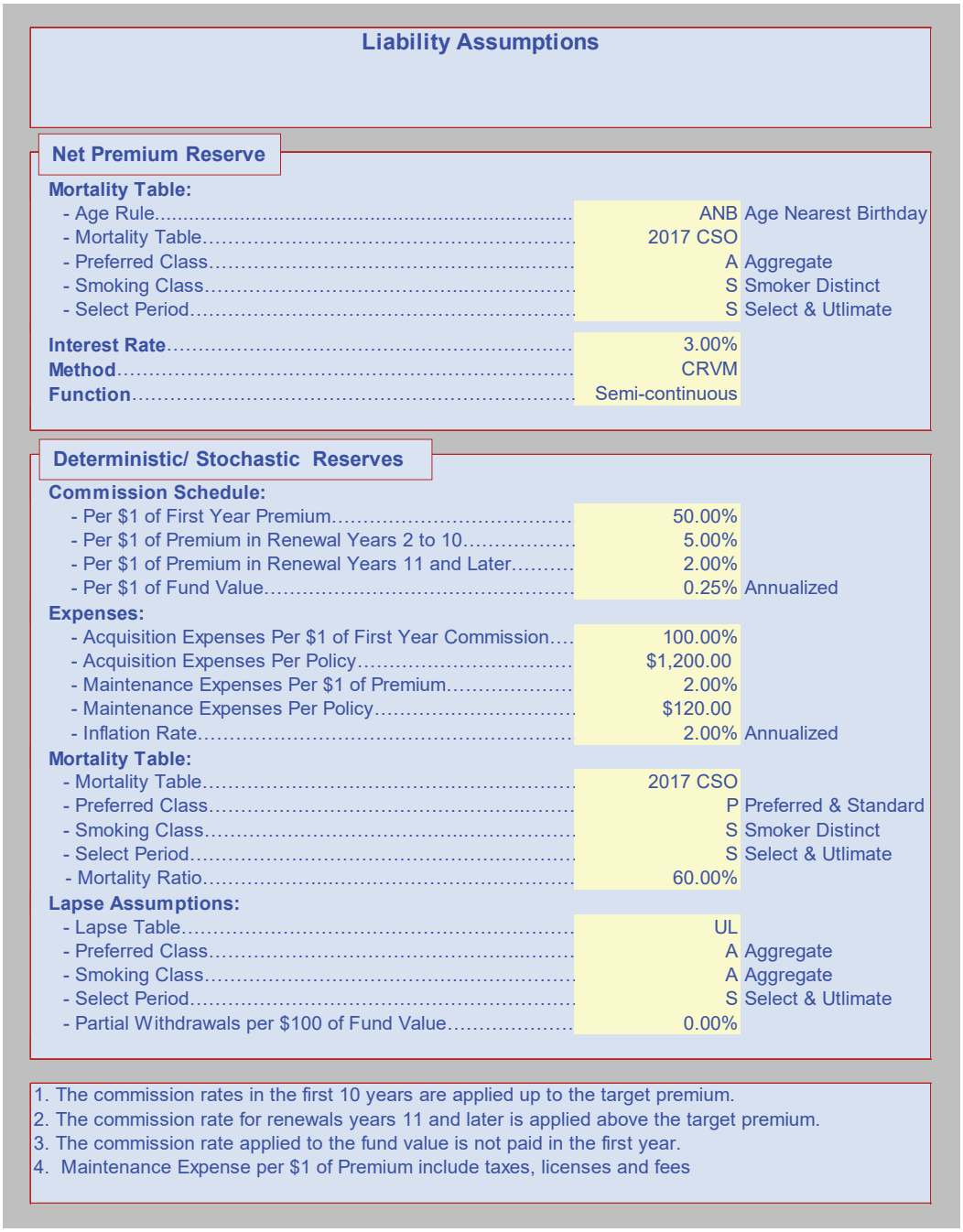
[3] Key tenors refer to the length of the term of the bonds actively issued by the U.S. Treasury (i.e., 1 month, 3 months, 6 months, 1 year, 2 years, 3 years, 5 years, 7 years, 10 years, 20 years, and 30 years).
[4] Two types of bonds are offered to comply with Section 7.E.1.g of VM-20.

The remainder of this worksheet contains the data entry areas for the bond risk premiums, default rates, and recovery rates for bonds with various ratings and terms to maturity. As noted above, to simplify the amount of data entry, the twenty rating categories that appear in the Appendix 2 of VM-20 have been reduced to the following seven major rating categories:

Rating	Moody's	S & P
0	Risk-Free	Risk-free
1	Aaa, Aa	AAA, AA
2	A	A
3	Baa	BBB
4	Ba	BB
5	B	B
6	Caa, Ca, C	CCC, CC, C

The **LA Data Entry Worksheet** contains the liability assumptions used to calculate the various types of reserves and liability cash flows. Figure 23.8 shows the contents of this worksheet.

Figure 23.8: LA Data Entry Worksheet of VUL Model



Liability Assumptions

Net Premium Reserve

Mortality Table:		
- Age Rule	ANB	Age Nearest Birthday
- Mortality Table	2017 CSO	
- Preferred Class	A	Aggregate
- Smoking Class	S	Smoker Distinct
- Select Period	S	Select & Utlimate
Interest Rate	3.00%	
Method	CRVM	
Function	Semi-continuous	

Deterministic/ Stochastic Reserves

Commission Schedule:		
- Per $1 of First Year Premium	50.00%	
- Per $1 of Premium in Renewal Years 2 to 10	5.00%	
- Per $1 of Premium in Renewal Years 11 and Later	2.00%	
- Per $1 of Fund Value	0.25%	Annualized
Expenses:		
- Acquisition Expenses Per $1 of First Year Commission	100.00%	
- Acquisition Expenses Per Policy	$1,200.00	
- Maintenance Expenses Per $1 of Premium	2.00%	
- Maintenance Expenses Per Policy	$120.00	
- Inflation Rate	2.00%	Annualized
Mortality Table:		
- Mortality Table	2017 CSO	
- Preferred Class	P	Preferred & Standard
- Smoking Class	S	Smoker Distinct
- Select Period	S	Select & Utlimate
- Mortality Ratio	60.00%	
Lapse Assumptions:		
- Lapse Table	UL	
- Preferred Class	A	Aggregate
- Smoking Class	A	Aggregate
- Select Period	S	Select & Utlimate
- Partial Withdrawals per $100 of Fund Value	0.00%	

1. The commission rates in the first 10 years are applied up to the target premium.
2. The commission rate for renewals years 11 and later is applied above the target premium.
3. The commission rate applied to the fund value is not paid in the first year.
4. Maintenance Expense per $1 of Premium include taxes, licenses and fees

The data entry fields in the **Mortality Table and Lapse Assumption** sections have drop-down lists. To change the value of the data elements in these sections, click on the cell and select an item from the drop-down list.

The **HR Data Entry Worksheet** contains the historical equity, bond and money market returns as well as the historical spot rates for U.S. Treasuries for the key tenors. Figure 23.9 shows the values of these variables for a section of this worksheet.

Figure 23.9: HR Worksheet of VUL Model

Historical Equity, Bond , Money Market & Spot Rates on U.S. Treasuries Bi

				Term					
Date	Equities	Bonds	Money Market[1]	3M	6M	1Y	2Y	3Y	5Y
2000-01	-5.09%	-0.33%	6.08%	5.84%	6.06%	6.40%	6.73%	6.77%	6.84%
2000-02	-2.01%	1.21%	6.11%	5.88%	6.11%	6.31%	6.59%	6.61%	6.65%
2000-03	9.67%	1.32%	6.29%	5.97%	6.25%	6.38%	6.61%	6.54%	6.41%
2000-04	-3.08%	-0.29%	6.50%	5.91%	6.21%	6.34%	6.81%	6.76%	6.67%
2000-05	-2.19%	-0.05%	6.86%	5.71%	6.45%	6.47%	6.82%	6.78%	6.64%
2000-06	2.39%	2.08%	6.77%	5.97%	6.33%	6.17%	6.49%	6.41%	6.27%
2000-07	-1.63%	0.91%	6.72%	6.37%	6.52%	6.16%	6.41%	6.34%	6.25%
2000-08	6.07%	1.45%	6.68%	6.41%	6.48%	6.32%	6.27%	6.18%	6.06%
2000-09	-5.35%	0.63%	6.81%	6.33%	6.38%	6.16%	6.07%	5.99%	5.93%
2000-10	-0.49%	0.66%	6.76%	6.48%	6.46%	6.21%	6.02%	5.95%	5.91%
2000-11	-8.01%	1.64%	6.72%	6.31%	6.28%	6.01%	5.68%	5.58%	5.48%
2000-12	0.41%	1.86%	6.40%	5.98%	5.78%	5.39%	5.17%	5.12%	5.04%
2001-01	3.46%	1.64%	5.42%	5.05%	4.89%	4.65%	4.67%	4.73%	4.93%
2001-02	-9.23%	0.87%	5.05%	4.91%	4.76%	4.52%	4.46%	4.53%	4.78%
2001-03	-6.42%	0.50%	4.88%	4.35%	4.13%	4.13%	4.23%	4.39%	4.70%
2001-04	7.68%	-0.42%	4.34%	3.99%	4.01%	3.98%	4.36%	4.62%	5.08%
2001-05	0.51%	0.60%	3.99%	3.66%	3.62%	3.66%	4.28%	4.56%	5.06%
2001-06	-2.50%	0.38%	3.84%	3.68%	3.66%	3.76%	4.31%	4.59%	5.09%
2001-07	-1.08%	2.24%	3.67%	3.57%	3.50%	3.56%	3.83%	4.12%	4.67%
2001-08	-6.41%	1	3.46%	3.40%	3.31%	3.44%	3.68%	3.96%	4.56%

This worksheet, along with data elements from the AA Data Entry Worksheet, is used to calculate the initial value of the bonds in the BF Data Entry Worksheet.

The **Scenarios Data Entry Worksheet** contains the equity, bond, money market, and interest rate scenarios. To illustrate the kind of data in this worksheet, Figure 23.10 shows the values of these variables for a section of this worksheet:

Figure 23.10: Scenarios Worksheet of VUL Model

Equity, Bond , Money Market & Interest Rate Scenarios

Start date: 1/1/2017
Number of scenarios: 51 <= Includes deterministic scenario (i.e., Scenario = 0)

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Scenario	t	rEquity(t)	rBonds(t)	rMoney(t)	rs(t|3m)	rs(t|6m)	rs(t|1y)	rs(t|2y)	rs(t|3y)	rs(t|5y)
0	0	1.00000	1.00000	1.00000	0.51%	0.64%	0.87%	1.21%	1.50%	1.99%
0	1	1.03986	1.03419	1.00176	0.71%	0.82%	1.03%	1.37%	1.64%	2.02%
0	2	1.08131	1.06902	1.00527	0.87%	0.97%	1.15%	1.46%	1.70%	2.04%
0	3	1.12441	1.10415	1.01014	0.98%	1.08%	1.24%	1.52%	1.74%	2.06%
0	4	1.16922	1.13981	1.01608	1.07%	1.16%	1.32%	1.57%	1.78%	2.07%
0	5	1.21583	1.17618	1.02285	1.14%	1.22%	1.37%	1.61%	1.81%	2.08%
0	6	1.26429	1.21339	1.03028	1.20%	1.27%	1.41%	1.65%	1.83%	2.09%
0	7	1.31468	1.25157	1.03824	1.24%	1.31%	1.45%	1.67%	1.85%	2.10%
0	8	1.36708	1.29079	1.04663	1.27%	1.34%	1.47%	1.69%	1.86%	2.11%
0	9	1.42157	1.33115	1.05537	1.29%	1.36%	1.49%	1.70%	1.87%	2.11%
0	10	1.47824	1.37270	1.06440	1.31%	1.38%	1.51%	1.71%	1.88%	2.12%
0	11	1.53716	1.41553	1.07368	1.32%	1.39%	1.52%	1.72%	1.89%	2.12%
0	12	1.59843	1.45967	1.08317	1.33%	1.40%	1.53%	1.73%	1.89%	2.12%
0	13	1.66214	1.50520	1.09284	1.34%	1.41%	1.53%	1.74%	1.90%	2.13%
0	14	1.72839	1.55216	1.10268	1.35%	1.42%	1.54%	1.74%	1.90%	2.13%
0	15	1.79728	1.60060	1.11266	1.35%	1.42%	1.54%	1.74%	1.90%	2.13%
0	16	1.86892	1.65059	1.12279	1.36%	1.42%	1.55%	1.75%	1.91%	2.13%
0	17	1.94341	1.70216	1.13305	1.36%	1.43%	1.55%	1.75%	1.91%	2.14%
0	18	2.02087	1.75538	1.14343	1.36%	1.43%	1.55%	1.75%	1.91%	2.14%
0	19	2.10142	1.81029	1.15393	1.37%	1.43%	1.55%	1.75%	1.91%	2.14%
0	20	2.18518	1.86696	1.16454	1.37%	1.43%	1.55%	1.76%	1.91%	2.14%
0	21	2.34994	1.91791	1.17627	1.52%	1.59%	1.70%	1.88%	2.03%	2.24%
0	22	2.52713	1.97190	1.18978	1.65%	1.71%	1.82%	1.99%	2.13%	2.32%
0	23	2.71768	2.02912	1.20483	1.76%	1.81%	1.91%	2.08%	2.22%	2.41%
0	24	2.92259	2.08976	1.22133	1.85%	1.90%	1.99%	2.16%	2.29%	2.48%

These scenarios were generated using the NAIC/American Academy of Actuaries' Scenario Generator.[5] Note that the upper left corner specifies the date of the initial yield curve and the number of scenarios.

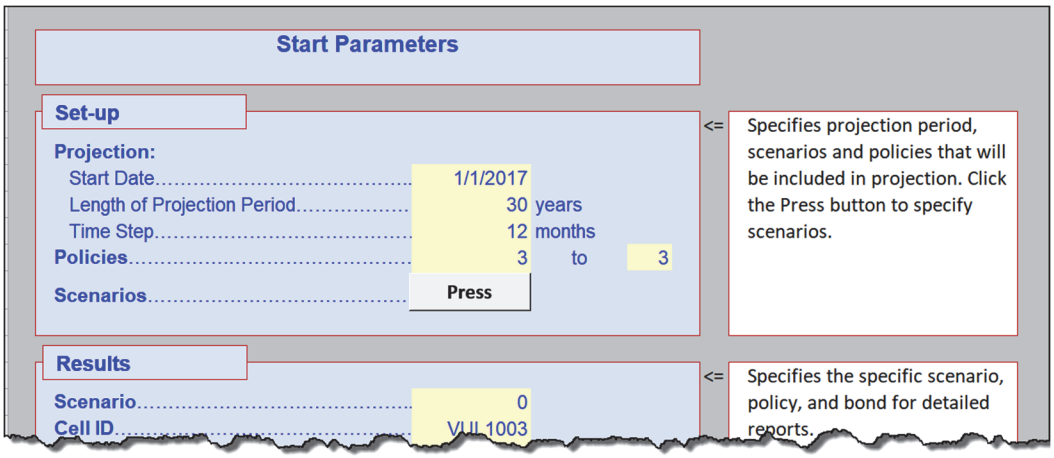
[5] https://www.soa.org/tables-calcs-tools/2017-research-airg-v7_1_201707/

23.1.3 Preparing the Model

The VUL Model projects, at regular time intervals, the following: cash flows, balance sheets, income statements, and various other values from the projection start date to the end of the projection period. The projection start date, the length of the projection period, and time step (e.g., yearly) must be specified before the model can be run.

The Set-up Section of the **Start Worksheet** contains the data entry fields for these values. Figure 23.11 shows the data entry portion of this worksheet:

Figure 23.11: Start Worksheet of VUL Model

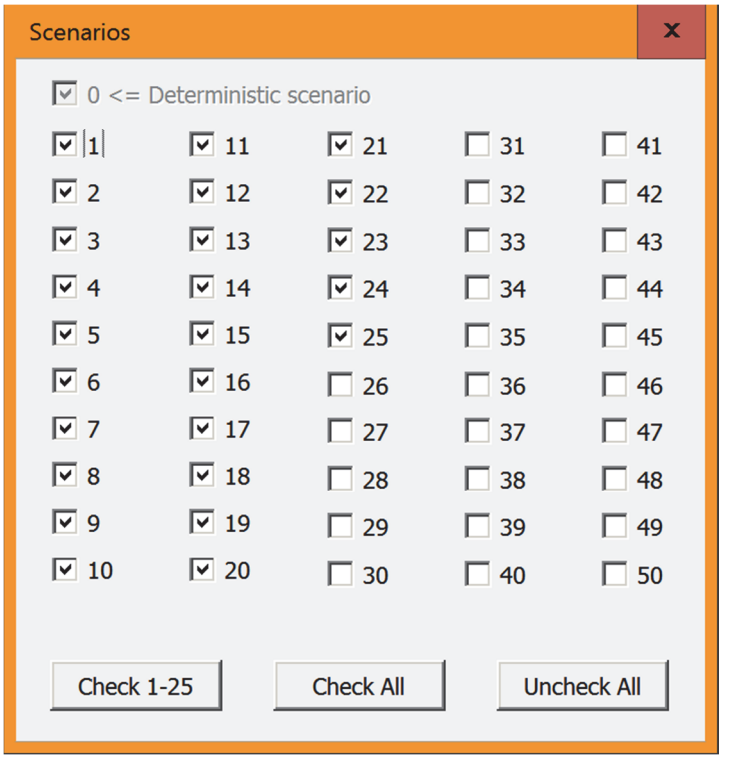


The following describes the purpose of these data entry fields:

- The Start Date indicates the initial projection date.
- Length of the Projection Period indicates how many years from the Start Date values are projected into the future.
- Time Step indicates the number of months between successive time periods that values are projected into the future.
- The two data entry cells next to "Policies..." specify which policies in the IFE Data Entry worksheet should be included in the projection. For example, Figure 23.11 indicates that only the third policy (i.e., VUL1003) would be included. To include all five policies, enter **1** in the cell before "to" and **5** in the cell after the "to." To include just the fourth policy, enter **4** in both cells.

Because of the large quantity of details created, the Time Step data entry field has been restricted to twelve months (i.e., annual).

Finally, to specify which scenarios to include in the projections, press the button next to the "Scenarios…" and the following form will appear:

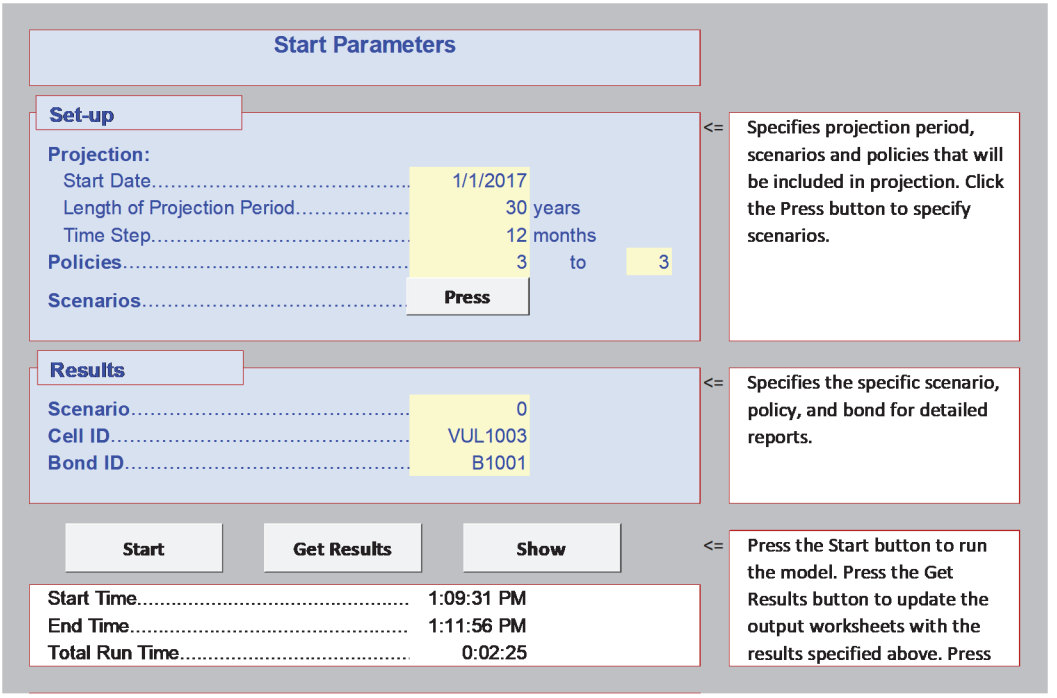


Check the boxes before the scenarios to be included in the projections. Note: Scenario 0 is the deterministic scenario, and will always be included in the projections.

23.1.4 Running the Model

In addition to specifying the model parameters discussed in the previous section, the Start Worksheet performs two other functions: it runs the VUL Model, and it shows various supporting reports. Figure 23.12 shows the entire contents of this worksheet:

Figure 23.12: Start Worksheet of VUL Model



The **Start** button runs the VUL Model. When this button is pressed, a dialog box will be displayed showing certain run time statistics. The total run time will depend on the number of scenarios, number of policies, and the environment in which this model is running.

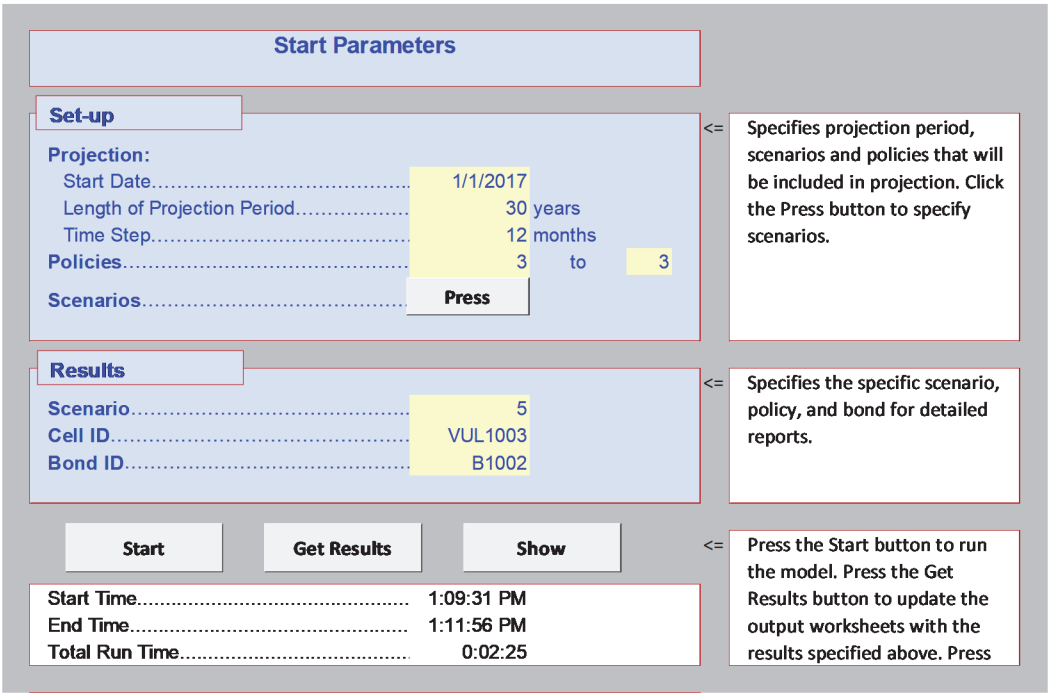
The **Hide** button hides the supporting worksheets. When these sheets are unhidden, this button shows the text **Hide**. When the sheets are hidden, this button shows the text **Show**. Press this button to toggle between these two states.

23.1.5 Storing the Results

While the model is running, various values are written to tables in the Access file, Results_VUL.accdb. As will be explained more fully below, this enables you to see how the various values were calculated for a particular scenario, policy and bond.

For example, after the model finishes running, and to see the values calculated for the fifth scenario, the VUL1003 policy, and B1002 bond, change the Results section of the Start Data Entry Worksheet as follows:

Figure 23.13: Getting Results



Then press the **Get Results** button. The model will extract the values for the fifth scenario, the VUL1003 policy, and B1002 bond from the various tables in the Result_VUL.accdb file. You can now see these values by reviewing various aggregate levels and seriatim output worksheets.

23.1.6 Analyzing Reports

The VUL Model produces three types of reports:

- Primary reports
- Aggregate level reports
- Seriatim level reports

The primary reports are the statutory reserves, cash flow, balance sheets, and income statements. These reports appear in the output worksheets called Reserves, CF, BS, and IS, respectively.

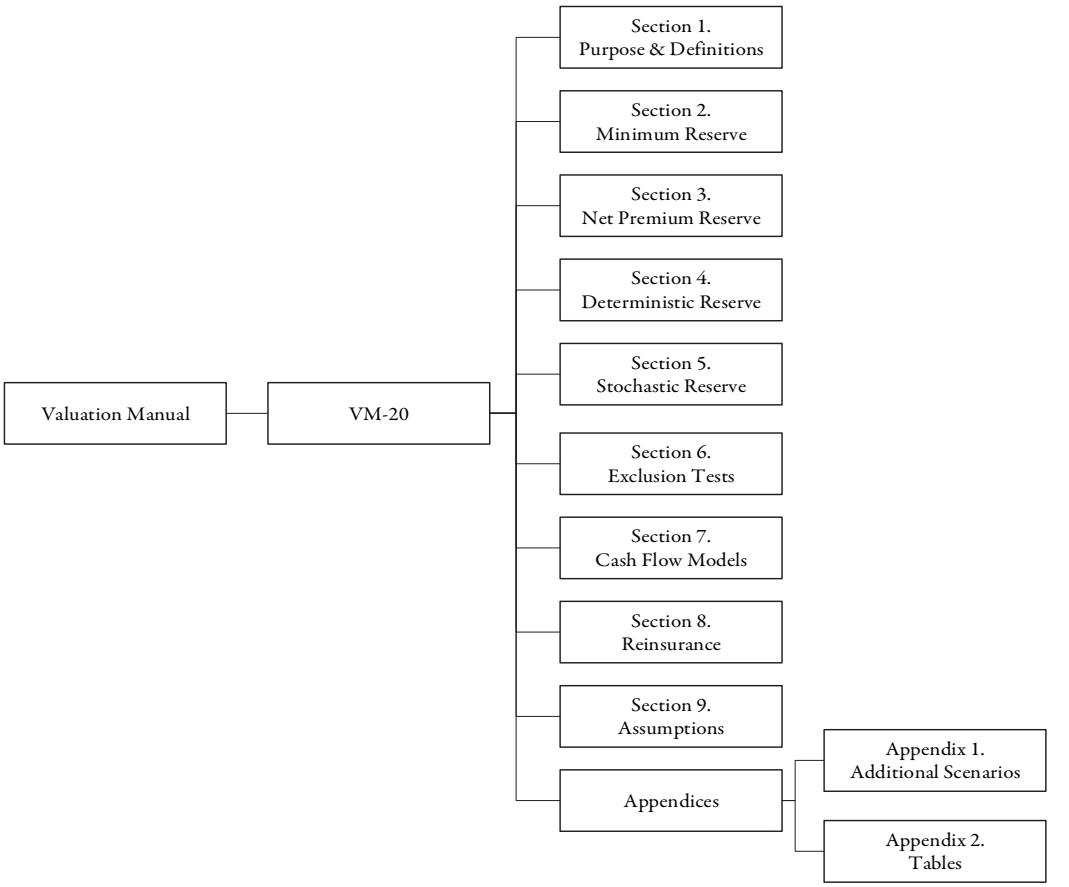
The supporting reports are used to provide additional information to help in analyzing the primary reports, and for testing the model. Aggregate level reports include the values of all policies included in the projection (i.e., specified on the Start Data Entry Worksheet). The aggregate level reports are the Analysis of the Increase in The Fund Value, Gross Margin Analysis, and Policy Exhibit. These reports appear in the output worksheets called FV, GOM, and PE, respectively.

In addition, the output worksheets that show how the deterministic reserve and stochastic reserve are aggregate level reports. These reports appear in the output worksheets that are unhidden when you press the Show button on the Start Data Entry Worksheet. For example, Cx_DRV shows how the present value of benefits and expenses were calculated for the deterministic reserve.

Seriatim level reports show the values for one bond or one policy included in the projection (i.e., the last policy specified on the Start Data Entry Worksheet). The seriatim level reports appear in the output worksheets that are unhidden when you press the Show button on the Start Data Entry Worksheet. These reports are used to analyze various detailed calculations at the bond or policy level.

23.2 Overview of VM-20

As shown in the following high-level diagram, VM-20 has nine major sections and two appendices:[6]



The remainder of this chapter will discuss the sections of VM-20 in the order listed in this diagram. Sections of VM-20 discussed more fully in the next section of this book may not apply to a specific individual life insurance policy.

[6] Appendix 1 provides additional information on the economic generator and how it generates interest rates and equity scenarios. It also discusses the 16 scenarios used for the Stochastic Exclusion Test. Appendix 2 contains tables for calculating asset default costs and assets spreads.

23.3 Scope of VM-20

The first step in calculating the reserve for an individual life insurance policy is to determine if this policy falls within the scope of VM-20. The second step is to determine what type of reserves must be calculated. These determinations are made by answering the following questions:

Q1. Is this a term insurance policy or a universal life insurance policy with secondary guarantees (ULSG)?
Q2. Was this policy issued on or after January 1, 2017?
Q3. Is there a companywide exemption?[7]
Q4. Did this policy pass the stochastic exclusion test?
Q5. Did this policy pass the deterministic test?

The responses to questions Q1 through Q3 determine whether an individual life insurance policy falls within the scope of VM-20. An individual life insurance policy that has not been classified as a term insurance policy or a universal life insurance policy with secondary guarantees will not fall within the scope of VM-20, if it was issued prior to January 1, 2017. As was discussed in Chapters 13 and 14, a term insurance policy or a universal life insurance policy with secondary guarantees may be subject to calculations based on VM-20 even if it was issued prior to January 1, 2017.

Each fiscal year, a company may apply to its domestic insurance commissioner for a ***company-wide exemption***. If granted, individual life insurance policies issued on or after January 1, 2017 would be exempted from falling within the scope of VM-20 provided these policies do not have material secondary guarantees.

[7] A life insurance company has up until January 1, 2020 to implement VM-20.

The answers to questions Q4 and Q5 determine what type of reserves must be calculated. There are three types:

- Aggregate Net Premium Reserve (NPR)
- Deterministic Reserve (DR)
- Stochastic Reserves (SR)

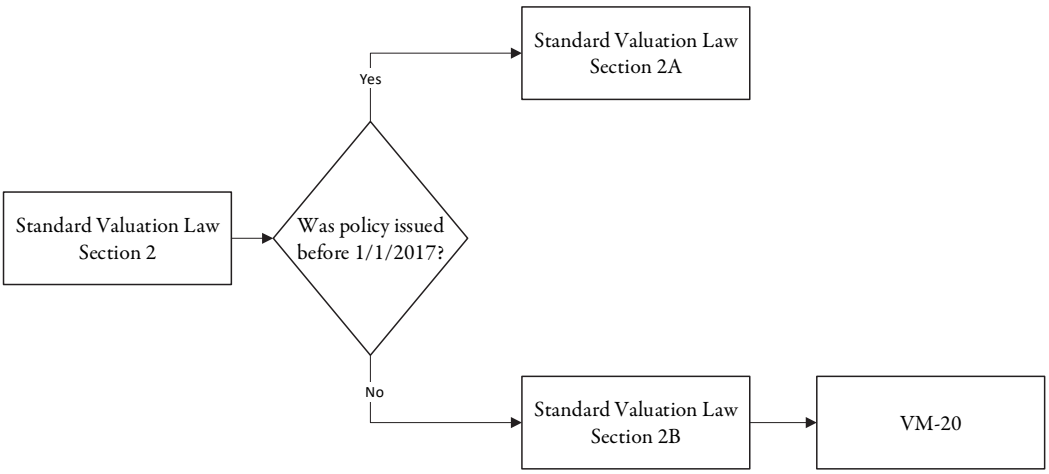
An aggregate net premium reserve is calculated for all policies that fall within the scope of VM-20. A deterministic reserve is calculated for all policies that fall within the scope of VM-20 and did not pass the ***Deterministic Exclusion Test***. A deterministic reserve and a stochastic reserve are calculated for all policies that fall within the scope of VM-20 and did not pass the ***Stochastic Exclusion Test***. The stochastic exclusion test and the deterministic exclusion test are defined in Section 6*, Stochastic and Deterministic Exclusion Tests*, of VM-20, and are discussed below.

23.4 Purpose and Definitions

Section 1, *Purpose and Definitions*, of VM-20 discusses the purpose of the requirements for principle-based reserves for life insurance products and defines various terms. This section begins by stating that the purpose of these requirements is to establish the minimum reserve valuation standard for individual life insurance policies issued on or after the operative date of the Valuation Manual, which was January 1, 2017.

It also states that these requirements "constitute the Commissioners' Reserve Valuation Method (CRVM) for policies of individual life insurance."[8] This is important because the determination of tax reserves under Section 807 of the Internal Revenue Code (IRC) refers to the Commissioners' Reserve Valuation Method (CRVM). However, the phrase "life insurance reserves were determined using CRVM" should not be narrowly interpreted to mean only the method discussed in Chapter 11. It requires knowing which sections of the Standard Valuation Law apply.

As was discussed in Chapter 4 of this book, Section 2, *Reserve Valuation*, of the Standard Valuation Law is divided into two major subsections: Section 2.A and Section 2.B:



Section 2.A sets forth the valuation of reserves for policies and contracts issued prior to the Operative Date of the Valuation Manual, and are the valuation standards discussed in this book's Chapters 11-17. Section 2.B sets forth the valuation of reserves for policies and contracts on or after the Operative Date of the Valuation Manual, and these are the valuation standards that are discussed in this chapter.

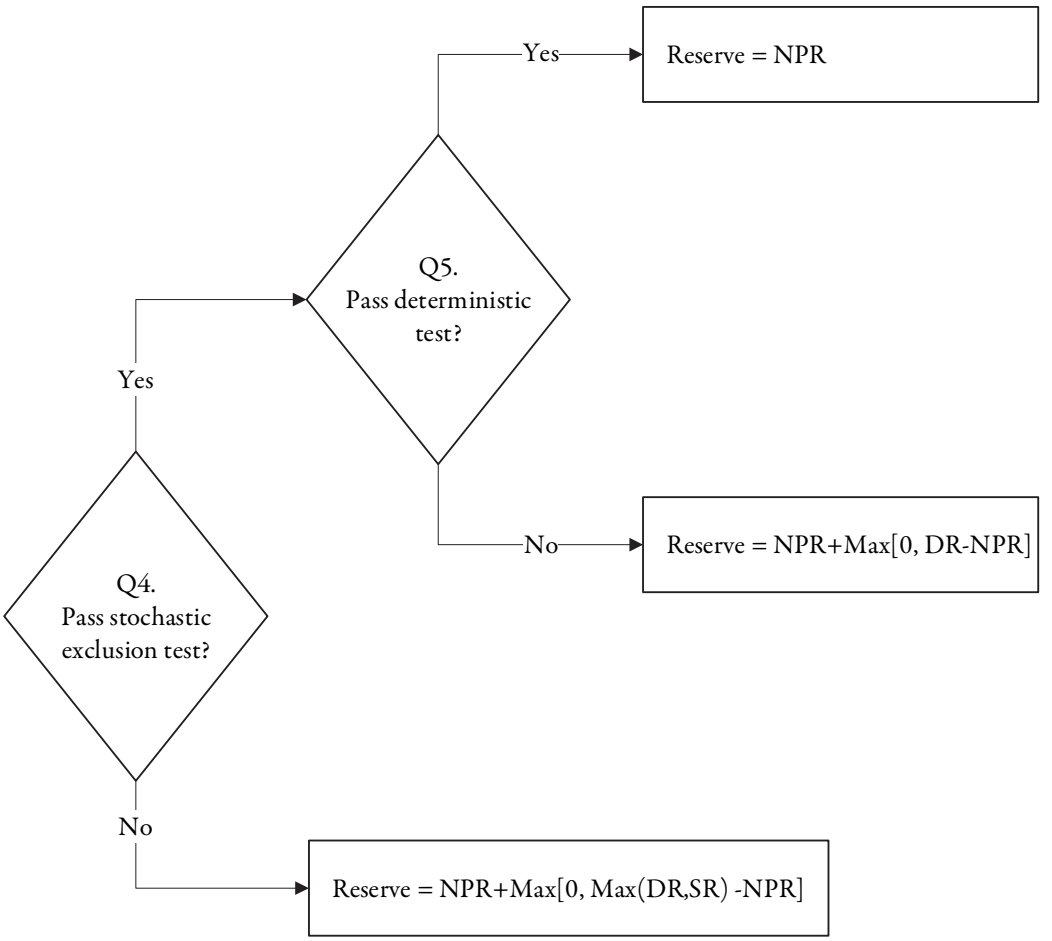
[8] Valuation Manual, *National Association of Insurance Commissioners* (2017): VM-20, Section 1.B.

23.5 Minimum Reserves

Section 2, *Minimum Reserves*, of VM-20 defines the minimum reserve for a *group* of individual life insurance policies. This minimum reserve will depend on whether these policies collectively:

- Pass both the stochastic exclusion test and the deterministic exclusion test
- Pass the stochastic exclusion test, but do not pass the deterministic exclusion test
- Fail both the stochastic exclusion test and the deterministic exclusion test

Depending on the answers to these exclusion tests, the following diagram shows the resulting reserve:



If the group of policies passes both the stochastic exclusion test and the deterministic exclusion test, then the minimum reserve is the aggregate net premium reserve for the life insurance policies comprising this group. The ***aggregate net premium reserve*** is the sum of the net premium

reserve as defined in Section 4, *Net Premium Reserve*, of VM-20, less any net premium reserve credit for reinsurance ceded pursuant to Section 8.B.[9]

If the group of policies passes the stochastic exclusion test, but fails the deterministic exclusion test, then the minimum reserve is the sum of (A) and (B), where:

(A) is the aggregate net premium reserve for the life insurance policies comprising this group; and
(B) is the excess, if any, of the deterministic reserve over the aggregate net premium reserve less any due and deferred net premium asset held on account of these policies.[10]

Algebraically, the minimum reserve is:

$$V^{CRVM} = V^{NPR} + Max\left[0,\ V^{DR} - \left(V^{NPR} - V^{Deferred}\right)\right],$$

where

V^{CRVM} = minimum reserve (i.e., CRVM reserve);

V^{NPR} = net premium reserve;

V^{DR} = deterministic reserve; and

$V^{Deferred}$ = aggregate deferred premium asset.

The deterministic reserve is defined in Section 5, *Deterministic Reserve*, of VM-20, and is discussed below.

[9]This chapter will ignore reinsurance until Section 8 of VM-20 is discussed.
[10] The due and deferred net premium asset is related to the due and deferred premium discussed in Chapter 10. For the sake of brevity, this chapter will refer to both assets as deferred premium asset.

If the group of policies fails both the stochastic exclusion test and the deterministic exclusion test, then the minimum reserve is the sum of (A) and (B), where:

(A) is the aggregate net premium reserve for the life insurance policies comprising this group; and
(B) is the excess, if any, of (1) minus (2), where:
  (1) is the larger of the deterministic reserve or the stochastic reserve, and
  (2) is the aggregate net premium reserve less any due and deferred net premium asset held on account of these policies.

Algebraically, the minimum reserve is:

$$V^{CRVM} = V^{NPR} + Max\left[0, Max\left(V^{DR}, V^{SR}\right) - \left(V^{NPR} - V^{Deferred}\right)\right],$$

where

V^{CRVM} = minimum reserve (i.e., CRVM reserve);

V^{NPR} = aggregate net premium reserve;

V^{DR} = deterministic reserve;

V^{SR} = stochastic reserve; and

$V^{Deferred}$ = aggregate deferred premium asset.

The stochastic reserve is defined in Section 6, *Stochastic Reserve*, of VM-20, and is discussed below.

The above discussion defined the *aggregate* minimum reserve for a *group* of policies. Subsection C of Section 3 defines the minimum reserve for *each* policy within this group. The determination of the minimum reserve for each policy requires allocating the excess of the deterministic reserve or the stochastic reserve to each policy within the group.

If the group of policies passes the stochastic exclusion test, but fails the deterministic exclusion test, then the allocation of the excess, if any, of the deterministic reserve is calculated using the following formula:

$$ {}_tV^{XDR}_{[x_i]} = \frac{{}_tV^{NPR}_{[x_i]}}{\sum_{i=1}^{N} {}_tV^{NPR}_{[x_i]}} \cdot \max\left[0,\ V^{DR} - \left(\ V^{NPR} -\ V^{Deferred}\right)\right], $$

where

$[x_i]$ = issue age of the i^{th} policy in the group;

t = number of time periods from issue date to valuation date;

N = number of polices in the group;

${}_tV^{XDR}_{[x_i]}$ = the portion of the excess, if any, of the deterministic reserve allocated to the i^{th} policy in the group

${}_tV^{NPR}_{[x_i]}$ = net premium reserve for the i^{th} policy in the group;

V^{DR} = deterministic reserve for the entire group;

V^{NPR} = aggregate net premium reserve for the entire group; and

$V^{Deferred}$ = aggregate deferred premium asset for the entire group.

If the group of policies fails both the stochastic exclusion test and the deterministic exclusion test, then the allocation of the excess, if any, of the larger of the deterministic reserve or stochastic reserve is performed using the following formula:

$$ {}_tV^{XSR}_{[x_i]} = \frac{{}_tV^{NPR}_{[x_i]}}{\sum_{i=1}^{N} {}_tV^{NPR}_{[x_i]}} \cdot \text{Max}\left[0, Max\ \left(V^{DR},\ V^{SR}\right) - \left(\ V^{NPR} -\ V^{Deferred}\ \right)\right], $$

where

$[x_i]$ = issue age of the i^{th} policy in the group;

t = number of time periods from issue date to valuation date;

N = number of polices in the group;

${}_tV^{XSR}_{[x_i]}$ = the portion of the excess, if any, of the larger of the deterministic reserve or the stochastic reserve, allocated to the i^{th} policy in the group;

${}_tV^{NPR}_{[x_i]}$ = net premium reserve for the i^{th} policy in the group;

V^{DR} = deterministic reserve for the entire group;

V^{SR} = stochastic reserve for the entire group;

V^{NPR} = aggregate net premium reserve for the entire group; and

$V^{Deferred}$ = aggregate deferred premium asset for the entire group.[11]

[11] The determination of the minimum reserve is performed separately for ULSG, term, and all other life insurance.