TIA Solutions to the Fall 2018 LFV-U Exam

Introduction

This document contains my full solutions to questions on this exam. Since the syllabus evolves over time, please check the Analysis of Past Exams spreadsheet in the Supplementary and Review Material section of the course for questions that are still on syllabus and also newer reading titles that may be different from the original source mentioned in the solution.

In some cases my solution may be different from the model solution posted by the SOA. You can obtain past SOA exams and SOA model solutions here:

https://www.soa.org/multiple-choice/

It's important to remember that the SOA's model solutions are not intended to be perfect responses. Sometimes they are the best answer provided by an actual candidate that exam day. Other times, they represent a solution that the question writer and/or grader believes is sufficient for full credit. The exams are largely created and graded by volunteers, who, like all of us are human beings that sometimes make mistakes. As such, model solutions may be incomplete, may (unintentionally) contain errors, may contain superfluous information, and may represent only one of multiple possibilities for answering the question.

Because of these aspects of model solutions, they are not always the best instructional tool for future exam problems. My solutions and commentary in this document tend to focus on how best to solve the problem in a way that is most consistent with the syllabus readings and also present solutions with future exam problems in mind.

In many cases, the solutions in this document are much more thorough and complete than what you can reasonably produce under exam conditions. The chief goal of my solutions is to help reinforce the topics tested and present solutions in an instructional way. However, I try to emphasize solution writing "best practices" in my solutions (e.g. write formulas first before doing calculations).

General syntax:

- **Bold text** is generally text taken directly from the question.
- *Italicized text* is my commentary on the question and/or the SOA model solution.
- Regular text is my solution to the question.

When in doubt, always fall back on what you've learned in the online course materials and source material because that information is the most consistent with the current syllabus and will therefore prepare you the most for the next exam.

J. Eddie Smith, IV, FSA

Question 1

1(a)

Source: LFV-141

Critique the following statements pertaining to IFRS 17:

A. IFRS 17 allows multinational insurance companies to use different accounting policies to measure similar insurance contracts issued in different jurisdictions.

- False
- IFRS 4 allowed non-uniform accounting across insurers, especially multinationals
- IFRS 17 requires consistent accounting policies across all insurers and is the first truly international IFRS standard for insurance contracts

B. IFRS 17 requires insurance companies to recognize financial options and guarantees embedded within insurance contracts only when such options and guarantees are in the money.

- False
- The current value of financial options and guarantees are always included in fulfillment cash flows, consistent with observable market prices

C. IFRS 17 allows companies to determine how insurance contracts are aggregated for measurement purposes as long as relevant disclosures are provided.

- False
- IFRS 17 requires grouping contracts at initial recognition in a way that reflects profitability (show onerous separately, etc.)

D. IFRS 17 requires insurance companies to recognize losses on onerous contracts immediately in profit or loss.

- True for direct insurance contracts and reinsurance issued (assumed)
  - IFRS 17 does not permit a negative CSM for direct insurance contracts or reinsurance issued
  - Any excess of PV(Outflows) over PV(Inflows) at initial measurement is immediately recognized as a loss
- False for reinsurance contracts held (ceded)
  - Insurers are allowed to defer losses on reinsurance contracts held by way of a negative CSM

E. IFRS 17 applies to both reinsurance and insurance contracts, but does not apply to investment contracts with discretionary participation features, which will be covered by IFRS 9.

- True part: "IFRS 17 applies to both reinsurance and insurance contract"

- False part: "does not apply to investment contracts with discretionary participation features"
  - Entities that also issue insurance can apply IFRS 17 to investment contracts with discretionary participation features

F. IFRS 17 requires a company to recognize a group of insurance contracts when the coverage starts.

- False
- Groups of insurance contracts should be measured from the earliest of:
  - Beginning of the coverage period
  - Due date of policyholder's first payment
  - When the group becomes onerous

1(b)

Source: LFV-141, GAAP Ch. 4

Contrast the treatment of term life insurance under IFRS 17 and U.S. GAAP for each of the following:

Technically, this tested Appendix D of LFV-141. Appendix D was on syllabus in 2018 but was dropped in 2019. The answers you see in the SOA's model solution are basically lifted right from that appendix, which is a very brief comparison of US GAAP and IFRS 17. Clearly, you can still answer this question using the on-syllabus portions of LFV-141 and knowledge from GAAP Ch. 4, however. That's how I've structured my answers below. This was only a 3-point question, so it was important not to over-spend time on these 5 sub-parts.

(i) Revenue

- GAAP (FAS 60): Revenue includes premiums and investment income
- IFRS 17: Revenue recognized as insurer delivers insurance coverage
  - Excludes deposit components (e.g. premiums)
  - Insurance revenue is reported separately from finance income (e.g. investment income on assets

(ii) Discount rate

- GAAP (FAS 60): Best Estimate Asset Earned Rate – PAD
- IFRS 17: Based on current observable interest rates that reflect characteristics of insurance cash flows (timing, currency, liquidity)

(iii) Treatment of risk

- GAAP (FAS 60): PADs reflect uncertainty in best estimate assumptions for mortality, lapse, interest, etc.

- IFRS 17: uses an explicit risk margin for non-financial risk based on a specified confidence level; financial risks are reflected in the discount rate

(iv) Mortality assumptions

- GAAP (FAS 60): Assumption = best estimate + PAD. Locked in at issue and never changed unless there is a loss recognition event.
- IFRS 17: Based on a current estimate that is updated each reporting period

(v) Acquisition costs

- GAAP (FAS 60): Explicitly capitalized into a DAC asset that is amortized over time to defer the expensing of acquisition costs
- IFRS 17: Included in fulfillment cash flows, which lowers the CSM (lower profit deferral)—implicitly defers acquisition costs

1(c)

Source: LFV-141, GAAP Ch. 4

1(c)(i) Construct an income statement under U.S. GAAP and IFRS 17.

I will make the following assumptions in order to solve this problem:

- *Assuming the cash flows given in the problem are on a best estimate basis (no PADs)*
- *Assuming PV of Cash Flows is on a best estimate basis*

US GAAP

$$
\begin{aligned}
\text{Revenue} &= \text{Premiums} + \text{InvInc} \\
\text{Revenue}_1 &= 1000 + 200 = 1200 \\
\text{Revenue}_2 &= 500 + 250 = 750 \\
\text{Ben\&Exp} &= \text{Comm} + \text{Exp} + \text{DB} + \Delta\text{ExpRes} + \Delta\text{BenRes} \\
\text{Ben\&Exp}_1 &= 100 + (75 + 25) + 150 + (-150 - 0) + (500 - 0) = 700 \\
\text{Ben\&Exp}_2 &= 50 + (0 + 25) + 300 + (-100 - -150) + (700 - 500) = 625 \\
\text{Profit} &= \text{Revenue} = \text{Ben\&Exp}
\end{aligned}
$$

Income statement format:

	Year 1	Year 2
Revenue	1200	750
Benefits and Expenses	700	625
Profit	500	125

IFRS 17

$$\begin{aligned}
\text{InsRevenue} &= \text{ExpectedFCFRel} + \text{CSMRel} + \text{RiskAdjRel} \\
\text{CSM}_0 &= -\text{FCF}_0 = -(\text{PVCashFlows}_0 + \text{RiskAdj}_0) = -(-950 + 80) = 870 \\
\text{CSMRel} &= \frac{870}{3} = 290 \\
\text{ExpectedFCFRel}_1 &= 100 + 75 + 25 + 150 = 350 \\
\text{ExpectedFCFRel}_2 &= 50 + 0 + 25 + 300 = 375 \\
\text{InsRevenue}_1 &= 350 + 290 + (80 - 60) = 660 \\
\text{InsRevenue}_2 &= 375 + 290 + (60 - 30) = 695 \\
\text{IncurredClaims\&Exp} &= \text{ExpectedFCFRel (since no experience deviations)} \\
\text{InsServiceResult} &= \text{InsRevenue} - \text{IncurredClaims\&Exp}
\end{aligned}$$

Statement of Comprehensive Income:

	Year 1	Year 2
Insurance Revenue	660	695
Incurred Claims and Expenses	350	375
Insurance Service Result	310	320
Investment Income	200	250
Profit	510	570

1(c)(ii) Construct a balance sheet under U.S. GAAP and IFRS 17.

US GAAP

$$\begin{aligned}
\text{Assets}_t &= \text{Assets}_{t-1} + \text{NetCashFlow}_t + \text{InvInc}_t \\
\text{NetCashFlow}_t &= \text{Prem} - \text{Comm} - \text{Exp} - \text{DB} \\
\text{Assets}_0 &= 0 \\
\text{Assets}_1 &= 0 + (1000 - 100 - 75 - 25 - 150) + 200 = 850 \\
\text{Assets}_2 &= 850 + (500 - 50 - 0 - 25 - 300) + 250 = 1225 \\
\text{Liability} &= \text{BenRes} + \text{ExpRes} \\
\text{Liability}_1 &= 500 + (-150) = 350 \\
\text{Liability}_2 &= 700 + (-100) = 600 \\
\text{Equity} &= \text{Assets} - \text{Liabilities}
\end{aligned}$$

Balance Sheet:

	Time 0	EOY 1	EOY 2
Financial Assets	0	850	1225
Insurance Contract Liabilities	0	350	600
Equity	0	500	625

IFRS 17

$$\begin{aligned}
\text{Assets}_t &= \text{same as US GAAP} \\
\text{Liability}_t &= \text{FCF}_t + \text{CSM}_t \\
\text{Liability}_0 &= (-950 + 80) + 870 = 0 \\
\text{Liability}_1 &= (-300 + 60) + (870 - 290) = 340 \\
\text{Liability}_2 &= (-175 + 30) + (870 - 290 - 290) = 145 \\
\text{Equity} &= \text{Assets} - \text{Liabilities}
\end{aligned}$$

Balance Sheet:

	Time 0	EOY 1	EOY 2
Financial Assets	0	850	1225
Insurance Contract Liabilities	0	340	145
Equity	0	510	1080

Question 2

2(a)

Source: SVILAC Ch. 29

(i) Calculate the C-3 requirement based on the 12-scenario set. Show all work.

First, rank C-3 measures worst to best (rank 1 = worst)

- Rank 1 = 881 (Scenario 9)
- Rank 2 = 793 (Scenario 11)
- Rank 3 = 538 (Scenario 12)

C-3 requirement = Average of rank 2 and 3 but at least = $\frac{1}{2}$ rank 1

$$= \max\left(\frac{793 + 538}{2}, \frac{881}{2}\right) = 666$$

(ii) Describe how the calculation would be different if a 50-scenario set were used.

Same steps as 12-scenario set but take the weighted average of scenarios 5–17 instead of only 2 and 3

2(b)

Source: Multi-stakeholder approach

Calculate the additional capital amount DCA should hold, if any. Show all work.

DCA has 2 objectives:

1. Maintain RBC ratio of least 200% for solvency
2. Maintain S&P CAR to avoid downgrade

Since DCA weights the objectives equally all years, and since there is no discounting, the most constraining capital result occurs in year 3 for RBC (largest capital shortfall)

Therefore, DCA should hold capital of at least 158 to meet all objectives

Question 3

3(a)

Source: GAAP Ch. 8, LFV-100

Describe how FAS 133 and Derivatives Implementation Group Issues (DIG) are applicable to the GAAP accounting for this annuity.

DIG was formed to assist FASB staff in developing answers to questions about implementation of FAS 133

Equity index credits meet the definition of an embedded derivative under FAS 133

- Index credits = call option sold by insurer
- Must separate the embedded derivative from the host contract
- FAS 133 values the embedded derivative
- FAS 97 values the remaining host
- Total liability = FAS 133 value of embedded derivative + FAS 97 liability for host

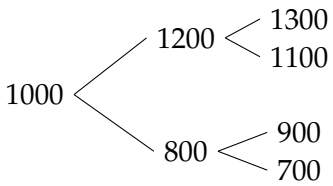
Note that the SOA model solution goes so far as to cite specific DIG numbers like B6 and B30 from GAAP Ch. 8. I suspect very few candidates were able to memorize those codes, but I don't think it was necessary to get full credit as long as you described what the "essence" of the DIG pronouncements as outlined above. That is, describe how to apply FAS 133 to EIAs.

3(b)

Source: GAAP Ch. 8

Calculate the projected GAAP reserves at end of year 1 assuming the Mars Index path 2 occurs. Show all work.

The SOA model solution notes that few candidates were able to calculate the option price correctly. As you will see below, the math itself is not very tricky, but you had to find your way through some smoke and mirrors first. After all, this is an actuarial exam! For starters, all of the EIA material in GAAP Ch. 8 is illustrated in the context of Black-Scholes option valuation instead of binomial pricing. Secondly, I found it a little time-consuming to interpret the table of index paths given under exam conditions. I definitely had to stare at the table for a little while before I realized that it was just a way to express a simple 2-period binominal tree with 4 distinct paths:



Once I sketched it out that way, it clicked that I need to calculate the option price using a simple binomial approach. Also, there was no Black-Scholes information to be found in the problem, so I had to rule that out! :)

Another "gotcha" in this problem was that the minimum guarantee given (90% of premium accumulated at 3%) does not actually climb above the initial premium paid in by year 2:

$$\text{GMAV}_2 = 0.90(1.03^2)(50{,}000) = 47{,}741 < 50{,}000$$

This situation is never addressed in the GAAP book, but hopefully you were able to reason that the "true" minimum guarantee is the initial premium of 50,000 because a PTP EIA guarantees that the policyholder will receive max(GMAV, Indexed FV) at maturity. So even if no index growth occurs at all, the indexed FV will remain 50,000. This becomes our minimum guarantee.

So. . . if you were able to get through the smoke and mirrors (no easy task under exam conditions), the calculations were pretty trivial.

Formulas

At issue, $\text{Host}_0 = \text{Prem}_0 - \text{VED}_0$

After issue, the host accumulates at a break-even rate toward the GMAV:

$$\text{Host}_t = \text{Host}_{t-1} \times (1 + r_{BE})$$

$$r_{BE} = \left(\frac{50{,}000}{\text{Host}_0}\right)^{1/T} - 1$$

$\text{GAAP Liability}_t = \text{Host}_t + \text{VED}_t$

Calculations

At issue, we don't know which of the 4 paths the index will take, but they have equal probability, and only 2 will result in payoffs at $t = 2$ (paths 1 and 2 where the index closes above the starting point of 1000)

Path	Payoff of one call option on the index at $t = 2$
1	$(1300 - 1000)^+ = 300$
2	$(1100 - 1000)^+ = 100$
3	$(900 - 1000)^+ = 0$
4	$(700 - 1000)^+ = 0$

For one call option on the index:

$$\text{OptionPrice}_0 = \frac{\frac{1}{4}(300 + 100 + 0 + 0)}{1.01^2} = 98.0296$$

For a single premium of 50,000, we would need 50,000/1000 = 50 calls:

$$\text{VED}_0 = 50 \times 98.0296 = 4901.48$$

This means the host value at issue is $50{,}000 - 4901.48 = 45{,}098.52$

$$r_{BE} = \left(\frac{50{,}000}{45{,}098.52}\right)^{1/2} - 1 = 5.2941\%$$

At $t = 1$, the host value is:

$$\text{Host}_1 = 45{,}098.52 \times 1.052941 = 47{,}486$$

At $t = 1$, we're at the "1200 node" in our binomial tree (this is why the tree is useful to draw!), meaning that there are only 2 remaining possibilities for the final index value at time 2:

The index will either close at 1300 or 1100, which means we are only one period away from a payoff of either 300 or 100:

$$\begin{aligned}
\text{OptionPrice}_1 &= \frac{\frac{1}{2}(300 + 100)}{1.01} = 198.0198 \\
\text{VED}_1 &= 50 \times 198.0198 = 9901 \\
\text{GAAP Liability}_1 &= 47{,}486 + 9901 = \boxed{57{,}387}
\end{aligned}$$

3(c)

Source: SVILAC Ch. 20

This problem tested AG 35 directly when it was still on syllabus, but you can solve it using the mechanics covered in SVILAC Ch. 20, especially if you work through our video lesson for SVILAC Ch. 20, which includes numerical examples of all 4 of the methods allowed under AG 35.

Calculate the projected death benefit at the end of the first year that would be used in the CARVM calculation that was performed at issue. Show all work.

MVRM Steps

1. Determine ending index level that produces a benefit equal to the sum of:
   - Guaranteed value
   - Value of call option required to fully hedge index benefit
2. Calculate the implied index growth rate

$$\left(\frac{\text{Step (1) Future Index Value}}{\text{Current Index Value}}\right)^{(1/n)} - 1$$

   - Use this rate to project intermediate index values
3. Calculate future annuity benefits using projected index levels
4. Do CARVM using Step 3 results

Note that we were NOT asked to do the last step (CARVM). We just need MVRM to get the projected index levels in order to calculate the projected DB.

We are told that the DB = the indexed FV at $t = 1$ plus 50% of unvested indexed credits:

$$\begin{aligned} \text{DB}_1 &= \text{IFV}_1 + 0.50(50)(\text{ProjIndex}_1 - 1000) \\ &= 50{,}000 + 0.50(50)(\text{ProjIndex}_1 - 1000) \end{aligned}$$

At $t = 1$, the IFV = 50K because no index interest has been credited (it's "unvested"). Remember that this is a 2-year PTP design, so the index interest will be credited at EOY 2 (assuming there is any to credit).

Before we can calculate the implied index growth rate for MVRM, we need to go back to part (b) and get the option price at issue (98.0296) and accumulate it at the 2% val rate through EOY 2 (same as UMV approach) for just EOY 2:

$$\text{ProjOptionPrice}_2 = 98.0296 \times 1.02^2 = 101.99$$

This implies a projected index level at maturity of 1000 + 101.99 = 1101.99

We can now calculate the MVRM implied annual growth rate over the 2-year period:

$$\left(\frac{1101.99}{1000}\right)^{1/2} - 1 = 4.9757\%,$$

which allows us to calculate the projected index level at $t = 1$:

$$\text{ProjIndex}_1 = 1000 \times 1.049757 = 1049.76$$

And now we can finally return to the formula for the DB at $t = 1$:

$$\begin{aligned} \text{DB}_1 &= 50{,}000 + 0.50(50)(1049.76 - 1000) \\ &= \boxed{51{,}244} \end{aligned}$$

Question 4

4(a)

Source: SVILAC Ch. 10, 18

Evaluate the appropriateness of using Plan Type A rates for discounting the following benefits:

(i) Withdrawals

(ii) Expected death benefit payments

Plan Type A is the most restrictive to policyholder → least risky to insurer → highest valuation interest rate

Withdrawal is either prohibited entirely or permitted only in the following situations:

1. With adjustment to reflect changes in interest rates or asset values
2. Without adjustment but in installments over 5+ years
3. As an immediate life annuity

Type A is not appropriate for this SPDA's withdrawal benefits because none of the above restrictions are in place

Type A would be appropriate for the DB payments since DB is simply the AV and represents a non-elective benefit

4(b)

Source: SVILAC Ch. 18

Calculate the CARVM Reserve at the end of year 3 for the above policy, ignoring non-elective benefits and assuming the valuation rate for elective benefits is 5%. Show all work.

This product guarantees a 6% credited rate for the first 3 years, and 1% after that

At EOY 3, the AV and CSV on a guaranteed basis is:

$$\begin{aligned} AV_3 &= 10{,}000 \times 1.06^3 = 11{,}910 \\ CSV_3 &= 11{,}910 \times (1 - 0.03) = 11{,}553 \end{aligned}$$

To get the CARVM reserve at EOY 3, we need to look at next 2 years to see what benefits would result in the highest PV as of $t = 3$

We can see from the product's features that the maximum benefit payable at each future time step would be the AV without surrender charges, which would happen if the bailout is triggered

Furthermore, since the 5% valuation interest rate > 1% credited rate, we can deduce that largest

PV at EOY 3 will be associated with the time 4 AV:

$$\frac{AV_4}{1.05} = \frac{11{,}910 \times 1.01}{1.05} = 11{,}456$$

Since this value is less than CSV_3, the company would hold a CARVM reserve of 11,456 and an excess CSV liability of $11{,}553 - 11{,}456 = 97$

Technically the problem only asked for the CARVM reserve, but it doesn't hurt to show that you know that the total liability should be no less than the CSV.

Also, it is perfectly acceptable and sometimes safer to go ahead and calculate all possible PVs. For this problem, I'm taking a more "logical" approach based on the approaches in our SVILAC Ch. 18 video lessons, which are designed to help you rule out unnecessary CARVM steps.

4(c)

Source: SVILAC Ch. 18

Contrast how elective and non-elective benefits are incorporated into the CARVM Reserve calculation for this product.

Non-elective benefits = benefits that are payable after the occurrence of a contingent or scheduled event independent of a contract owner's election of an option in the contract

- Includes the DB offered by this product

Elective benefits = benefit options that might be elected by the contractholder solely at the contractholder's discretion within the rights offered in the contract

- Includes the withdrawal and surrender benefits offered by this product

Integrated benefit stream – a series of possible combinations of benefit payments

Incidence rate = the probability that an elective or non-elective event will occur in a particular contract year

- A mortality rate, probability of withdrawal, etc.

For all mortality-based benefits, the incident rate is based on the annuity mortality table permitted under SVL

For elective benefits, all possible elective benefit incidence rates between 0% and 100% must be considered to determine the greatest PV for CARVM

- AG 33 states that in practice, companies will calculate using both 0% and 100% (and not values in between)

4(d)

Source: SVILAC Ch. 18

Recommend two changes to the product features that would reduce the statutory reserve requirements without affecting the guaranteed account values. Justify your response.

Only 2 of these were needed:

1. Remove bailout provision
2. Increase the surrender charge
3. Put restrictions on withdrawal options to increase the valuation interest rate from Type A

Question 5

5(a)

Source: LFV-833

Calculate the final VM-20 reserve at time 0. Show all work.

This was unfortunately a flawed question. The SOA model solution commentary indicates that they wanted to see you demonstrate knowledge of VM-20 by calculating the deterministic reserve, but that is impossible. The deterministic reserve that the SOA model solution calculates is actually a "scenario reserve," which would be just one of thousands of scenario reserves calculated as an intermediate step for the stochastic reserve. The information provided in the problem was designed to mimic the example of calculating an individual scenario reserve on p. 12 of the study note. It's possible the question author confused this part of the stochastic reserve process with the deterministic reserve, or perhaps other critical information was accidentally left out of the problem. Either way, since the problem gives the final stochastic reserve, it doesn't make much sense to calculate a specific scenario reserve.

The final VM-20 reserve = NPR + Excess DR or SR

- Excess DR or SR = max[DR, SR] − NPR

The NPR and SR are given in the problem: 110,000 and 100,000, respectively

VM-20 allows 2 methods for the DR:

1. PV of Cash Flow Approach

$$\underbrace{\text{APV(Ben, Exp \& Related Amounts)}}_{\text{Include existing PLs \& Sep. Acct. AV}} - \underbrace{\text{APV(Prems \& Related Amounts)}}_{\text{Include PL, reinsurance, \& derivative cash flows}}$$

2. Discount rates vary by model segment (driven by assets in segment)
3. Direct Iteration Approach
    - Deterministic Reserve = starting asset amount that matures all future benefits & expenses
    - Project all cash flows iteratively until balance is found
    - Projected assets must remain positive during projection

The DR cannot be determined from the information given in the problem, so we can only compare the NPR and SR and see that the NPR is highest

VM-20 Reserve = NPR = $\boxed{110{,}000}$

Follow-up: someone asked me if the method in the SOA model solution is "direct iteration approach." It is not. While the DIA is somewhat similar conceptually the scenario reserve framework, there are important differences. For one, the scenario reserve calculation is required to use discount rates based on 105% of treasury rates, and it is based on a greatest PV of accumulated deficiencies method. The DIA would not involve any explicit PV'ing of cash flows, so explicit discount rates aren't relevant. VM-20 does

not prescribe the use of Treasury rates for any DR method. Treasury rates are only used within the SR framework. Carrying out the DIA requires running a model iteratively and adjusting the starting asset balance each time until you have sufficient starting assets to mature the liabilities and you don't get any projected negative asset balances. It has much more in common with CALM in Canada, where the idea is to iteratively solve for a starting asset balance that matures the liabilities, then setting the reserve equal to that solved-for asset amount. There is no closed form solution for this.

5(b)

Source: Stochastic Analysis of Long Term Multiple-Decrement Contracts, LFV-818

Calculate a source of earnings variance over plan, assuming all deaths and lapses occur at the end of the year, for each of the following:

(i) Mortality

(ii) Lapses

I will solve this using the framework in the main body of LFV-818, which does not contain an item labeled "lapse variance," but we can simply use the "surrender variance" in place of that. Note that the CSV = 0 for this term product.

Let q^a = "actual" experience based on the single stochastic scenario and q^e = expected experience

$$\begin{aligned}\text{Mortality Variance} &= \ell_x \times (q_x^{e\,(d)} - q_x^{a\,(d)}) \times (DB - V_{t+1}) \\ \text{Lapse Variance} &= \ell_x \times (q_x^{e\,(w)} - q_x^{a\,(w)}) \times (CSV - V_{t+1}) \\ &= \ell_x \times (q_x^{e\,(w)} - q_x^{a\,(w)}) \times (-V_{t+1})\end{aligned}$$

We are given:

- DB = 10,000,000
- V_{t+1} = 120,000
- $q_x^{e\,(d)} = 0.01$
- $q_x^{e\,(w)} = 0.05$

Since we are given the total DB and total reserve (instead of on a per dollar or per 1000 basis), we will just set $\ell_x = 1$

Using the framework in the "Stochastic Analysis" paper:

- Stochastic mortality factor = product of stochastic underwriting, volatility, and catastrophe factors
$$1.05 \times 0.99 \times 1.0 = 1.0395$$
- Single stochastic lapse factor = 1.1 (given)

Therefore, we have the following "actual" decrements in this particular scenario:

$$q_x^{a(d)} = 0.01 \times 1.0395 = 0.010395$$
$$q_x^{a(w)} = 0.05 \times 1.1 = 0.055$$

And we can use these to calculate the variance to plan:

$$\begin{aligned}\text{Mortality Variance} &= (0.01 - 0.010395) \times (10{,}000{,}000 - 120{,}000) \\ &= -3902.60 \\ \text{Lapse Variance} &= (0.05 - 0.055) \times (-120{,}000) \\ &= +600\end{aligned}$$

In other words, the higher-than-expected mortality lowered earnings by 3902.60, but higher-than-expected lapses increased earnings by 600

This is exactly what you should expect on a term product, so it's always a good idea to think about the reasonableness of the sign on your final answer. Higher-than-expected lapses are a benefit to earnings on a term product because there is no surrender value: More reserve is released into earnings than expected.

5(c)

Source: LFV-106, Strategic Management of Life Insurance Company Surplus

(i) Explain three methods of determining a reasonable purchase price for both blocks of business.

1. Comparable company analysis
   - Choose comparable companies based on operational performance or financial financial performance
     - Focus on companies large enough to be statistically significant
   - Develop a range of standalone values: multiple × appropriate seller value
2. Comparable transaction analysis
   - Choose comparable companies based on comparable transactions (sales)
   - Follow exact same process as comparable company analysis
   - Financial advisor must adjust out unique aspects of transactions
3. Discounted cash flow analysis
   - Project future after-tax shareholder dividends that will be paid by the seller (usually for 5 years)
   - Develop a terminal value for the final year (e.g. year 5)
   - Value = PV of future after-tax dividends and terminal value
   - Perform sensitivity analysis to develop high and low PVs

(ii) Recommend which block should be purchased assuming VCE's cost of capital is 10%. Justify your answer.

- A block of business creates economic value if its GAAP ROE > company's cost of capital; otherwise destroying
- Block 1 (term) would destroy economic value, but Block 2 (UL) would create economic value
- Therefore, purchase Block 2 (UL)

(iii) Describe additional considerations relevant to the recommendation.

- Should evaluate the growth potential of each block
- Evaluate cash flow generated by term block
  - If generating sufficient free cash flow, the lower ROE may be tolerated
  - Could provide cash flow for other uses
- Evaluate VCE's ability to improve the term block's ROE
  - VCE may have more economies of scale (can lower unit expenses for the term block, increasing its ROE)
- Evaluate amount of ongoing capital each block will require in the future
- Evaluate expected future ROEs
- Evaluate the value of future new business each block could generate

Question 6

6(a)

Source: GAAP Ch. 4, 6

Construct a SFAS 97 and a hypothetical SFAS 60 income statement.

	FAS 60	FAS 97	
Revenues			
Premiums	1100		
COI Charges		325	
Expense Charges		10	
Surrender Charges		5	= AV Rel On Surr − SurrBen Paid
Net Investment Income	125	125	
Total Revenues	1225	465	
Benefits and other Deductions			
Death Benefits	70	60	= AV Rel On Death − DB Paid
Surrender Benefits	105		
Interest credited to AV		155	
Increase in Reserve	800		
DAC Amortization	35	35	
Commission	25	25	
Operating expenses	90	90	
Total Benefits & Deductions	1125	365	
Earnings Before Taxes	100	100	
Taxes	35	35	
Earnings After Taxes	65	65	

6(b)

Source: GAAP Ch. 6

(i) Calculate the DAC balance at end of year two. Show all work.

SOP 03-1 liability formulas:

$$\begin{aligned}
\text{SOPLiab}_t &= \text{SOPLiab}_{t-1} \times (1+i) \\
&\quad + \left[\text{BenRatio} \times \text{TotalAssess}_t - \text{ExcessPayments}_t\right] \times (1+i)^{0.5} \\
\text{BenRatio} &= \frac{\text{PV}_0(\text{ExcessPayments})}{\text{PV}_0(\text{TotalAssess})} \\
\text{TotalAssess} &= \text{COIs} + \text{Investment Margins} + \text{Other Fees \& Assessments} \\
\text{ExcessPayments} &= \text{DBs paid in excess of AV}
\end{aligned}$$

Don't forget that last "s," or you'll feel like TotalAsses!

Floor reported SOP liability at zero

Formulas for DAC:

$$\begin{aligned}
\text{DAC}_t &= k_t \times \text{PV}_t(\text{RevEGP}) - \text{PV}_t(\text{DAE}) \\
&= (\text{DAC}_{t-1} + \text{DAE}_t)(1+i) - k_t \cdot \text{RevEGP}_t \\
k_t &= \frac{\text{PV}_0(\text{DAE})}{\text{PV}_0(\text{Actual EGPs through } t) + \text{PV}_0(\text{Future RevEGPs})} \\
\text{DAE}_t &= \text{deferrable acquisition expense capitalized at BOY } t
\end{aligned}$$

where RevEGP = Revised EGP = Original EGP − ΔSOPLiab

- Original EGP = COIs + Investment Margins + Other Assessments − DBs in excess of AV

Calculations

Note: The crediting rate i = 0% in this problem, so there won't actually be any PV'ing, and the BOY vs. mid-year vs. EOY timing in the formulas above is irrelevant.

SOP Liability calculations:

$$\begin{aligned}
\text{TotalAssess}_1 &= 2058 + 5 + 1470 = 3533 \\
\text{TotalAssess}_2 &= 1518 + 10 + 1425 = 2953 \\
\text{TotalAssess}_3 &= 1021 + 14 + 1395 = 2430 \\
\text{PV(TotalAssess)}_0 &= 3533 + 2953 + 2430 = 8916 \\
\text{BenRatio} &= \frac{2580 + 0 + 1114}{8916} = 41.4311\% \\
\text{SOPLiab}_0 &= 0 \\
\text{SOPLiab}_1 &= 0 + 41.4311\%(3533) - 2580 = -1116 \Rightarrow \text{floor at } 0 \\
\text{SOPLiab}_2 &= -1116 + 41.4311\%(2953) - 0 = 107 \\
\text{SOPLiab}_3 &= 107 + 41.4311\%(2430) - 1114 = 0
\end{aligned}$$

DAC calculations:

$$\begin{aligned}
\text{RevEGP}_1 &= 2058 + 5 + 1470 - 2580 - (0 - 0) = 953 \\
\text{RevEGP}_2 &= 1518 + 10 + 1425 - 0 - (107 - 0) = 2846 \\
\text{RevEGP}_3 &= 1021 + 14 + 1395 - 1114 - (0 - 107) = 1423 \\
k &= \frac{1000}{953 + 2846 + 1423} = 19.15\%
\end{aligned}$$

Note that you'll get the correct k even if you ignore the change in the SOP Liability because there is no discounting in this problem. The 107 increase/decrease in SOP Liability just washes out giving you the same ∑EGPs regardless. However, it is still a good idea to include it to emphasize that you know this is the correct way to account for the SOP liability in the revised EGP calculation. ;)

To finish the problem, we need to calculate DAC_2, and the fastest way is prospectively since there is only one EGP remaining in the future, and the "PV" of future EGPs is simply that one last EGP since there is

no discounting:

$$DAC_2 = 0.1915 \times 1423 = \boxed{273}$$

(ii) Determine which approach to handling negative EGP would result in the lowest DAC balance at year two. Justify your response.

The SOA model solution commentary acknowledges that there was a flaw in the wording of this question since there weren't actually any negative EGPs in the problem. They accepted 2 possible answers:

Alternative 1:

There are no negative EGPs, therefore the DAC calculation is unaffected by the approach to handling negative EGP.

Alternative 2:

Approaches handling negative EGP if they are believed to be temporary:

1. Floor negative EGP – this will not increase DAC
2. Leave EGP at negative amount, but DAC is not allowed to exceed the original deferred amount.
3. Leave EGP at negative amount, but DAC is not allowed to exceed the original deferred amount plus interest at the credited rate.

In these situations under exam conditions, always write something. I think Alternative 2 was the best approach since it demonstrates that you know how to deal with negative EGPs in general based on the source material. Just don't ever leave a problem like this blank because that will guarantee zero credit for the problem—even though it's not your fault it was a bad problem! :)

Question 7

7(a)

Source: ASOP 41

Evaluate the appropriateness of this report as it relates to ASOP 41, Actuarial Communications.

Appropriate:

- Scope and purpose of audit is identified
- Intended user is identified (internal audit dept.)
- Information date is identified (Sept 30, 2017)
- Reliance on others—the memo identifies the Experience Studies team as the responsible party for developing assumptions

Not appropriate or needs improvement:

- It is not clear who the responsible actuary is—need to identify person, role, etc.
- Clarity: it's not clear who the person writing the memo represents. Is it the VA reserving team? Internal Audit?
- Lack of timeliness – report date is 3 months after information date
- Does not note any subsequent events that may impact the findings after the information date

7(b)

Source: Model Audit Rule

Identify the risks that are present in the process, according to Model Audit Rule (MAR) section 16, after the resolution of the identified material weaknesses.

1. Preliminary data input: data risks
    - May be inaccurate, incomplete, or inconsistent across regions or LOBs
    - May not reconcile to reported financial data
    - Data transfers from data warehouse to the actuarial files
        - IT-controlled DWH has less risk, however
    - Loading from actuarial files to valuation system
2. Analysis of model or valuation system results: possible risks
    - Corruption of formulas by unauthorized personnel

- Model/application not updated correctly
- Improper assumptions from inexperienced actuary
- Improper documentation of manual adjustments or peer review processes

3. Risks in the reporting of the actuarial reserving process results
   - Inaccurate reporting of reserves
   - Inappropriate aggregation of reserves
   - Lack of reconciliation between reported reserves and reserves approved/prepared by the actuary

7(c)

Source: Model Audit Rule

Critique the actuarial student's recommendation regarding the MAR section 16 assertion. Propose possible changes.

Regarding the 3 bullets at the end of the memo:

- Bullet 1 – Inappropriate. Management is not permitted to conclude that the internal control over financial reporting is effective if there are un-remediated items
- Bullet 2 – Inappropriate. An auditor's attestation of internal control is not required under MAR 16
- Bullet 3 – Inappropriate. Signatures of the CEO and the CFO are required

7(d)

Source: LFV-824

Recommend testing techniques that can be used to mitigate the model risk in the VA reserving model.

This was a tough 1-pointer. They were testing a little list buried under the 5th step ("model testing") within the "Model Development Documentation (Life Cycle Phase 1)" of LFV-824. The phrasing of the question ("mitigate the model risk") hopefully made you think of LFV-824, but recalling that little list and also tying it to the specifics of the memo would have been challenging under exam conditions.

- Back-testing to measure the VA reserving model's performance with past data
- Benchmark the VA reserve model against other models or data
- Sensitivity and stress analysis to understand how changes to assumptions drive different reserve levels produced by the model

Question 8

8(a)

Source: GAAP Ch. 3-4

Perform the recoverability test and quantify any necessary adjustments. Show all work.

If ExpPrem% + BenPrem% > 100% $\Rightarrow$ premium deficiency

$$\frac{\text{PVFB} + \text{PVFE}}{\text{PVGP}} = \frac{40{,}102 + 9387 + 184}{37{,}948} = 131\% > 100\%$$

Therefore, there is a premium deficiency

How to resolve:

1. Remove PADs

   $$\frac{37{,}288 + 9335 + 181}{37{,}377} = 125\% > 100\%$$

   Since premium deficiency still exists, go to next step

2. Recategorize DAE to Non-DAE (write down DAC)
   - Since PVGP = 37,377 > PVFB + PV(MaintExp) = 37288 + 181 = 37,469, the premium deficiency still exists even after writing down all DAC

3. If DAC = 0, then premium deficiency liability = GPV − Net GAAP Liability
   - Uses best estimates only (no PADs)
   - Does not include an acquisition expenses (or DAC) since we've written those down (future acquisition costs will be expensed as incurred)
   - GPV = PVFB + PV(MaintExp) − PVGP = 37,288 + 181 − 37,377 = 92
   - Net GAAP liability = BenRes + MaintExpRes = (37,288 − 37,288) + (181 − 181) = 0
   - Premium deficiency liability = 92 − 0 = 92

8(b)

Source: GAAP Ch. 3–4

Perform the loss recognition test as of the valuation date and quantify any necessary adjustments. Show all work.

Probable loss exists if best estimate GPV > Net GAAP Liability

$$\begin{aligned}
\text{GPV} &= 37{,}227 + 3479 + 187 - 38{,}666 = 2227 \\
\text{NGL} &= \text{BenRes} + \text{MaintExpRes} - \text{DAC} \\
&= (51{,}302 - 41{,}635) + (191 - 191) - (9746 - 3545) \\
&= 9667 + 0 - 6201 = 3466
\end{aligned}$$

Therefore, no adjustments are needed

8(c)

Source: GAAP Ch. 4

List three reasons why earnings for the term life block may not emerge as a level percentage of premium.

Only 3 were required for full credit, and other answers could be possible too

1. Actual experience ≠ GAAP reserve assumptions with PADs
2. Establishment of premium deficiency reserves
3. Non-deferrable acquisition expenses or overhead
4. Federal income taxes
5. Grading GAAP reserves to statutory reserves at later policy durations
6. Changes in GAAP accounting standards
7. Effects of reinsurance, etc.

Question 9

9(a)

Source: SVILAC Ch. 14

(i) Calculate the CRVM reserve at the end of year 5 based on the Universal Life Model Regulation. Show all work.

Listing out the steps of the UL CRVM process was not necessary, but I'm just including it here for reference:

1. Calculate GMP using guaranteed values
2. Project GMF from issue using GMP
3. Each valuation date, project future FV starting with max(Current FV, GMF)
4. Calculate NLP on a guaranteed basis from issue:

$$\text{NLP} = \frac{\text{PVFB From Issue Date}}{\text{PVGMP From Issue Date}} \times \text{GMP}$$

5. Calculate PVFB using step (3) projected values and valuation mortality/interest
6. $r = \min(1, \text{AV}/\text{GMF})$ at valuation date
7. Net Level Reserve = $r \times$ (PVFB − PVNLP) using valuation interest rate
8. CRVM Reserve = Net Level Reserve – $r \times$ Unamortized CRVM EA

Calculations

The only value that is not explicitly given in the problem is the Unamortized CRVM EA, but we can calculate it by backing into the implied annuity factor in the PV(NLP) number:

$$\begin{aligned} \text{PV(NLP)} &= \text{NLP} \times \ddot{a}_{x+5} \\ 31{,}000 &= 2200\ddot{a}_{x+5} \\ \ddot{a}_{x+5} &= 14.0909 \end{aligned}$$

Now we can stroll across the finish line. . .

$$\begin{aligned} r &= \min\left(1, \frac{7600}{9500}\right) = 0.8 \\ \text{CRVM Reserve} &= 0.8 \times (41{,}000 - 31{,}000 - 125 \times 14.0909) \\ &= \boxed{6591} \end{aligned}$$

(ii) Explain whether the CRVM reserve would increase or decrease if the current fund value exceeded the GMF value at the end of year 5. No calculations are required. Justify your answer.

The CRVM reserve would increase because of two effects:

1. If the current FV > GMF, then r is capped at 1. Increasing r from 0.8 to 1.0 would increase reserves.
2. PVFB would increase because the guaranteed maturity benefit would increase if the current FV > GMF. There would be no offsetting increase in the PV of NLP or EA because those items are locked in based on issue date calculations.

9(b)

Source: Not On Syllabus

Question 10

10(a)

Source: Tiller 4th ed. Ch. 5

Construct a post reinsurance balance sheet for this block similar to the above, assuming the treaty structure is:

(i) Mod-Co

(ii) Mod-Co with Funds Withheld

(iii) Part-Co

Under mod-co, the cedant retains all assets, but the reinsurer pays the initial allowance in cash:

- CededRes $\times$ QS% $\times$ EA% = $500 \times 0.50 \times 0.05 = 12.5$

Balance	Cedant	Reinsurer
(+) Cash	12.5	−12.5
(+) Bonds	500	0
(−) Reserves	500	0
(+) Receivable (Payable)	0	0
Surplus	12.5	−12.5

Mod-co with FW is similar to mod-co except the initial allowance is not paid in cash—a receivable/payable is set up instead

Balance	Cedant	Reinsurer
(+) Cash	0	0
(+) Bonds	500	0
(−) Reserves	500	0
(+) Receivable (Payable)	12.5	−12.5
Surplus	12.5	−12.5

Part-co is a blend of mod-co and regular coinsurance

- Initial coinsurance reserve = initial allowance = 12.5
  - Eliminates need to transfer assets since initial coinsurance premium and allowance exactly offset
- Remaining reserves are mod-co reinsured: $500 - 12.5 = 487.5$
  - Eliminates need to transfer assets on remaining reserves
- Therefore, the cedant's net reserve = 487.5
- Asset balance is unchanged

Balance	Cedant	Reinsurer
(+) Cash	0	0
(+) Bonds	500	0
(−) Reserves	487.5	12.5
(+) Receivable (Payable)	0	0
Surplus	12.5	−12.5

10(b)

Source: Tiller Ch. 7, 8, 11

Evaluate the proposal from the perspective of regulatory compliance.

- Experience refund
  - Evaluate to ensure risk transfer—the reinsurer should incur losses if the business performs poorly
  - Should not cause the ceding company to absorb losses
  - The mere existence of an experience refund does not mean there are risk transfer problems, but some regulators may be overly cautious and view it as a warning flag
- Bermuda domicile – the reinsurer is likely not authorized, which means the ceding company will have to maintain one of the following to receive the reserve credit:
  - Trust fund in a qualified US financial institution
  - Assets are placed either in a security arrangement or held in trust for the exclusive benefit of the ceding insurer
- Mod-co could be another solution to reserve credit issue since no assets are transfered to reinsurer
- Assets backing 100% of the reserves reinsured should be held in a qualified trust instead of 50%
- Collateral – In order for the LOC to be admitted as an asset in the trust, it must be unconditional and irrevocable
- Recapture provision – the reinsurer should not be allowed to terminate the treaty unconditionally

10(c)

Source: Tiller Ch. 11, 13, 17

After entering into the agreement described in (b), your employee makes the following statements. Critique the statements.

A. Statutory accounting still requires us to reflect the ceded block in our Actuarial Opinion analysis

- True
- Include effects of reinsurance in the cash flows analyzed

B. An alternative and potentially cheaper approach to achieving surplus relief could have been to enter into a non-proportional reinsurance treaty

- False
- Non-proportional agreements rarely qualify for a ceded reserve credit since they cover risks beyond what normal reserves cover

C. If the regulator refuses to acknowledge risk transfer in our treaty at any point, we are required to account for premiums and benefits of the treaty on our income statement

- False
- Must use deposit accounting if risk transfer is insufficient
- Income and losses are recognized only when earned and the other party has no recourse to repayment in the future

D. We must disclose the financial impacts of the treaty on our statutory statements. The counterparty will also become public information.

- True
- All of this is contained in Schedule S

E. At the time of the transaction, any gain or loss we incur will be recognized immediately in the Summary of Operations

- True for losses
- False for gains, which should be recorded in Record in the C&S Account on the "Changes in Surplus as a Result of Reinsurance" line

