Notation and Terminology Used on Exam FAM-L Questions
Version: July 29, 2022

Introduction

This notation note completely replaces similar notes used on previous examinations.

Reference to FAM-L and the FAM-L examination in this notation note applies to the long-term half of the Fundamentals of Actuarial Mathematics (FAM) examination and the separate FAM-L examination (topics 7 through 11 of the FAM syllabus).

In actuarial practice there is notation and terminology that varies by country, by application, and by source. The purpose of this study note is to present notation and terminology that will be used on the FAM-L examination for situations where notation or terms differ from that in the recommended resources (*Actuarial Mathematics for Life Contingent Risks* (3rd edition) (*AMLCR*)) for the examination and notation or terms that are unique to the examination. For notation and terms not discussed here, the meaning in *AMLCR* will apply.

The format of this note is to list common alternative notations for a given item. The specific notation(s) that will be used on the FAM-L examination will then be provided.

Notation and Terminology

The **force of mortality** may be represented by μ_x or $\mu(x)$ or μ_{x+t} or $\mu(x+t)$ where x and $x+t$ are attained ages. The symbol $\mu_{[x]+t}$ indicates selection at age x and attained age $x+t$. The symbols μ_x, μ_{x+t}, and $\mu_{[x]+t}$ will be used on the FAM-L examination.

The **survival function** may be represented by S or s. For the survival function, there are multiple symbols (all involving S) used in *AMLCR*. When the symbols for the survival function are used on the FAM-L examination, the definition will be clear from the context of the question, or the question will define the symbol.

The **number of lives** at age x can be represented by ℓ_x or l_x. Either symbol may be used on the FAM-L examination.

The **complete future lifetime of (*x*) random variable** can be represented by T_x or $T(x)$. The symbol T_x will be used on the FAM-L examination.

The **curtate future lifetime of (x) random variable** can be represented by K_x or $K(x)$. The symbol K_x will be used on the FAM-L examination.

The **present value of future losses random variable** may be represented by L or ${}_0L$ or L_0 for loss at issue and ${}_tL$ or L_t for loss from t years after issue. Superscripts may be included. When the symbol L is used to represent the present value of future losses random variable, the symbol including any subscripts or superscripts will be defined in the text of the question.

Duration subscripts can be used differently. For example, something happening in the first duration (between ages x and $x+1$) may be identified with a 0 or 1. The text of the question will define any notation used.

If benefits can vary continuously, the **benefit** at time t is represented by b_t. If benefits vary but as a step function, the **benefit** at the end of period k is represented by b_k. The text of the question will define the benefit either by formula or in words.

Actuarial present value and **expected present value** are terms used for the expectation of the random variable representing the present value of one or more contingent future payments. Either term may be used on the FAM-L examination.

Fully discrete insurance is an insurance where both the premiums and the benefits are paid only at discrete time points. **Semi-continuous** insurance is an insurance where the premiums are paid at discrete time points and the death benefits are paid at the moment of death. **Fully continuous** insurance is an insurance where the premiums are paid continuously, and the death benefits are paid at the moment of death. Unless stated otherwise in the text of the question discrete time points are the beginnings of years for premium payments and the ends of years for death benefit payments.

Special insurance is an insurance that has either non-level benefits or non-level premiums or both. The non-level aspects of the insurance will be described in the text of the question. If an insurance is not defined as "special" then premiums and benefits are assumed to be level, unless there is explicit information in the text of the question to the contrary.

Net premium is the premium determined by the equivalence principle and assuming no expenses. In the MLC exams this was called benefit premium. The term benefit premium will no longer be used on the FAM-L examination.

The **net premium for fully discrete insurances** will be represented by P with the appropriate symbols attached. P_x , $P^{1}_{x:\overline{n}|}$, $P_{x:\overline{n}|}^{1}$, and $P_{x:\overline{n}|}$ may be used on the FAM-L exam.

The symbols are defined in terms of an insurance, A, and an annuity, $\ddot{a}$, as follows:

$$P_x = \frac{A_x}{\ddot{a}_x} \ , \ P^{1}_{x:\overline{n}|} = \frac{A^{1}_{x:\overline{n}|}}{\ddot{a}_{x:\overline{n}|}} \ , \ P_{x:\overline{n}|}^{1} = \frac{A_{x:\overline{n}|}^{1}}{\ddot{a}_{x:\overline{n}|}} \ , \ P_{x:\overline{n}|} = \frac{A_{x:\overline{n}|}}{\ddot{a}_{x:\overline{n}|}}$$

The symbol P will be defined within the text of the question if it is not one of the symbols shown above.

Unless stated otherwise in the text of a question all expenses are equal to zero. If expenses are specified in the text of a question, then the expenses need to be considered in the solution to the question.

A **policy value** is the expected value of the future loss random variable. This is consistent with the usage in *AMLCR*. LTAM exams and their predecessors used the term reserve for that expected value, and that term is still regularly encountered in literature and practice. On the FAM-L examination, **policy value** will be used.

In practice, the financial statements of an insurance company will include a liability amount in respect of future outgo on a policy in force, and this amount is called the reserve. *AMLCR* calls this "the actual capital held in respect of a policy" and uses the term reserve only in this context. (*AMLCR* discusses its distinction between reserve and policy value on page 225 and in chapter 13. Chapter 13 is not part of the FAM-L readings.)

The **policy value** at time ***t*** may be represented by ${}_tV$ or V_t. The symbol ${}_tV$ will be used on the FAM-L examination.

The **gross premium policy value** for a policy inforce at duration $t \geq 0$ is the expected value at that time of the gross future loss random variable based on the policy's actual gross premium. The mortality, interest and expense assumptions for the reserve would not necessarily be the same as those used in that gross premium calculation. That gross premium may not be the gross premium that would be determined using the equivalence principle. In MLC exams and LTAM exams these were called gross premium reserves. That term will not be used on the FAM-L examination for policy values. Additionally, the term expense reserve would have previously been used on the LTAM exam to represent the portion of the gross premium policy value from expenses. On FAM-L the term **expense policy value** will be used.

The **net premium policy value** for a policy inforce at duration $t \geq 0$ is the expected value at that time of the net future loss random variable assuming no expenses. It uses the premiums calculated on the policy value basis using the equivalence principle, not the actual premiums payable or the net premiums calculated on the premium basis at issue. In MLC exams these were called benefit reserves. In LTAM exams these were called net premium reserves. Neither the term benefit reserve nor net premium reserve will be used on the FAM-L examination for policy values.

As noted on page 225 of *AMLC*R, those definitions of policy value apply to more general types of policies beyond those with cash flows occurring only at the start or end of a policy year. These definitions of policy values for more general types of insurance, including policies with cash flows occurring continuously, may be tested on the FAM-L examination if the techniques to calculate the expected present value of premiums and benefits are covered in the course of reading.

A **modified reserve** is a reserve computed without expenses but adjusting the valuation premiums to allow implicitly for initial expenses. A full preliminary term reserve is an example of a modified reserve. All modified reserves have the expected present value at issue of the benefits equal to the expected present value at issue of the valuation premiums; valuation premiums are typically lower in the first year or first few years than in later years. Any modified

reserve questions on the FAM-L examination other than full preliminary term reserves will specify the modification basis in the question.

Modified reserves calculations are extremely comparable to policy value calculations. On the FAM-L examination (as in *AMLCR*) we call these reserves rather than policy values because their purpose is to be used as reserves for financial reporting, and because their valuation premium pattern may be very different from the policy's premium pattern.

If a **table of select and ultimate values** is presented in a question the format of the table will either follow the convention of (i) reading across the row of select rates and then down the column of ultimate rates for the values corresponding to each age at selection or it will follow the convention that (ii) all row entries indicate a current age but differ as to the age at selection. On the FAM-L examination, the table method can be inferred from the table headers.

Unless stated otherwise in the problem, the terms **death benefit**, **face amount**, **sum insured**, and **sum assured** are synonymous terms. Any of these four terms may be used on the FAM-L exam.

The terms **certain period** and **guarantee period** are synonymous terms. Either term may be used on the FAM-L exam.

Other terms and common equivalents

Terms used on the FAM-L examination	Equivalent or similar terms (**not** used on the FAM-L examination)
annuity due, annuity-due	due annuity
annuity immediate, annuity-immediate	immediate annuity
temporary life annuity	term annuity
temporary expectation of life	term expectation of life
premium paying period	premium paying term
net amount at risk	death strain at risk, sum at risk, amount at risk
net premium	benefit premium
gross premium	contract premium, expense-loaded premium, expense-augmented premium
net premium policy value	net premium reserve, benefit reserve
gross premium policy value	gross premium reserve
Variance, Var	V

Chapter 18 of *AMLCR* presents actuarial approaches to estimating survival models from data. This data may involve censored or truncated data. On the FAM-L examination, unless indicated otherwise by the question, there are no censored or truncated observation during the time period of the question.

Chapter 18 of *AMLCR* discusses estimated confidence intervals derived from data. On the FAM-L examination, such confidence intervals should be done consistently with *AMLCR*, in particular:

1. Confidence intervals are 2-sided.
2. Confidence intervals are based on the normal approximation, without continuity correction.

Unless specified otherwise within the FAM-L examination question, the following assumptions should be made:

1. The force of interest is constant and is greater than 0.
2. Future lifetimes are independent.
3. All lives in a question follow the same mortality table.
4. Expenses are payable at the start of each period.
5. Expenses (including commissions) that are expressed as a percent of premium are payable when the corresponding premium is payable and end when the premiums are no longer payable.