

# EDUCATION COMMITTEE OF THE SOCIETY OF ACTUARIES (SOA)

## INTRODUCTORY STUDY NOTE

**EXAM SESSION:** FALL 2016

**EXAM:** ENTERPRISE RISK MANAGEMENT

**DATE & TIME:** Tuesday, November 1, 2016; 8:30 a.m. – 12:45 p.m.

1. The examination will consist of four hours of written answer questions. A read-through time of 15 minutes will be given prior to the start of the exam. No writing is allowed during the read-through time.
2. The following link shows a recommended FSA module/exam sequence for each track:  
<http://www.soa.org/Education/Exam-Req/edu-new-fsa-recommended.aspx>

This order is NOT mandated. Each candidate will determine the appropriate sequence based on factors including readiness to sit for an exam, exam administration schedules, or study time available. However, the Education committees believe that these recommendations provide the most effective guide for candidate success. An examination/module may assume familiarity with material that is covered in any requirement that is recommended to come before that examination or module.

3. The Syllabus material includes textbooks, online readings, and the study notes listed in the Appendix. Study notes listed with an asterisk (\*) will also be included in the Revision set of study notes. The Appendix also may contain additional important information regarding this exam. A complete listing of the Syllabus and Learning Objectives is located in this exam's home page on the SOA Web site.
4. Several book distributors carry some or all of the textbooks for the Society of Actuaries exams. A list appears on the SOA Web site: <http://www.soa.org/education/exam-req/resources/edu-txt-manuals.aspx>.
5. Any changes in the Syllabus for this exam will be published under "Updates" in this exam's home page on the SOA Web site.
6. Past exams, solutions and case studies are available at: <http://www.soa.org/education/exam-req/syllabus-study-materials/edu-multiple-choice-exam.aspx>
7. When registering for this examination, candidates must select from six reading extensions. The Case Study for this examination also includes some extension-specific portions. Twenty-five percent of the examination points will be based on the Case Study and the selected extension. These questions may also draw on material from the core reading. Be sure to answer the questions asked by referring to the case study. For example, if asked for advantages of a particular plan design to a company referenced in the case study, limit your response to the specifics for that company. Other advantages should not be listed as they are extraneous to the question and will result in no additional credit. Further, if they conflict with the applicable advantages, no credit will be given. Candidates are advised to familiarize themselves with the

case study. A copy will be included in the examination booklet. Candidates will not be allowed to bring their study note copy of the case study into the examination room.

8. The candidate should be very familiar with the Learning Objectives. These Learning Objectives are the first ingredient in developing the syllabus and also guide the examination committee when writing questions. The Learning Objectives set out the cognitive level needed to pass this exam. You will notice that the candidates are expected to “analyze,” “explain,” “calculate,” “describe,” “apply,” etc. While studying the syllabus material, candidates may want to refer back to the Learning Objectives to remain focused on the goals of the exam.
9. The examination questions for this exam will be based on the required readings for this exam. If a conflict exists (in definitions, terminology, etc.) between the readings for this exam and the readings for other exams, the questions should be answered on the basis of the readings for this exam.
10. Candidates may ONLY use these battery or solar-powered Texas Instruments models: BA-35, BA II Plus\*, BAII Plus Professional\*, TI-30Xa, TI-30X II\* (IIS solar or IIB battery), and TI-30X MultiView\* (XS solar or XB battery). Candidates may use more than one of the approved calculators during the examination.

Calculator instructions may not be brought into the exam room. During the exam, the calculator must be removed from its carrying case so the supervisor can confirm that it is an approved model. Candidates using a calculator other than the approved models will have their exams disqualified.

Candidates can purchase calculators directly from: Texas Instruments, Attn: Order Entry, PO Box 650311, Mail Station 3962, Dallas, TX 75265, phone 800/842-2737 or <http://epsstore.ti.com>.

*\*The memory of the **BA II Plus, BA II Plus Professional, TI-30X II and TI-30X MultiView** calculators will need to be cleared by the examination supervisor upon the candidate’s entrance to the examination room.*

11. A list of various seminars/workshops and study manuals appears on the SOA Web site <http://www.soa.org/education/exam-req/resources/edu-sem-workshops.aspx> and <http://www.soa.org/education/exam-req/resources/edu-txt-manuals.aspx>. These seminars/workshops and study manuals do not reflect any official interpretation, opinion, or endorsement of the Society of Actuaries or its Education Committee.

Please note that the Education Committee expects candidates to read the material cited in the *Syllabus* and to use other material as a complement to the primary sources rather than a substitution for them.

12. The Society of Actuaries provides study notes to persons preparing for this examination. They are intended to acquaint candidates with some of the theoretical and practical considerations involved in the various subjects. While varying opinions are presented where appropriate, limits on the length of the material and other considerations sometimes prevent the inclusion of all possible opinions. These study notes do not, however, represent any official opinion,

interpretation or endorsement of the Society of Actuaries. The Society is grateful to the authors for their contributions in preparing study notes.

The American Academy of Actuaries, the Canadian Institute of Actuaries, the Conference of Consulting Actuaries, and the Society of Actuaries jointly sponsor various examinations administered by the Society of Actuaries.

## APPENDIX

Study notes for this exam

Code	Title
	Case Study <b>(Available on syllabus page of Web site)</b>
ERM-52-15	Courseware – A Guide to the ERM Exam Core Readings
ERM-101-12	Measurement and Modelling of Dependencies in Economic Capital
ERM-102-12	Value-at-Risk: Evolution, Deficiencies and Alternatives
ERM-103-12	Developments in Modelling Risk Aggregation, pp. 72-89
ERM-104-12	Study Note on Parameter Risk
ERM-105-12	Coherent Measures of Risk: An Exposition for the Lay Actuary
ERM-106-12	Economic Capital Modeling: Practical Considerations
ERM-107-12	Chapter 7 of <i>Strategic Risk Management Practice: How to Deal Effectively with Major Corporate Exposures</i>
ERM-110-12	Derivatives: Practices and Principles
ERM-111-12	Key Rate Durations: Measures of Interest Rate Risks
ERM-112-12	Revisiting the Role of Insurance Company ALM within a Risk Management Framework
ERM-114-13	Introduction to Reinsurance
ERM-115-13	The Next Chapter: Creating an Understanding of Special Purpose Vehicles
ERM-117-14	AAA Practice Note: Insurance Enterprise Risk Management Practices
ERM-118-14	Model Validation Principles Applied to Risk and Capital Models in the Insurance Industry
ERM-119-14	Aggregation of Risks and Allocation of Capital
ERM-120-14	IAA Note on Stress Testing and Scenario Analysis
ERM-122-16*	Chapter 1 of <i>Captives and the Management of Risk</i> , Third Edition
ERM-123-14	S&P Enterprise Risk Management Criteria
ERM-124-15	Chapter 2 of <i>Counterparty Credit Risk: the New Challenge for Global Financial Markets</i>
ERM-125-15	Chapter 10 of <i>Loss Models: Further Topics</i>
ERM-126-15	ORSA—An International Requirement

<b>Code</b>	<b>Title</b>
ERM-301-12	Pension Investing and Corporate Risk Management
ERM-304-12	Mind the Gap: Using Derivatives Overlays to Hedge Pension Duration
ERM-307-12	Pensions Risk in an ERM Context
ERM-308-12	Chapter 7 of <i>Integrated Risk Management</i> (booklet)
ERM-309-13	Risk Assessment Framework for Federally Regulated Private Pension Plans
ERM-311-13	Strategies for Hedging Interest Rate Risk in a Cash Balance Plan
ERM-314-13	Financial Economics and Actuarial Practice
ERM-315-14	LDI In a Risk Factor Framework
ERM-316-14	How Corporate Pension Plans Impact Stock Prices
ERM-317-14	Allocating Shareholder Capital to Pension Plans
ERM-318-14	Longevity Hedging 101: A Framework for Longevity Basis Risk Analysis and Hedge Effectiveness
ERM-319-14	The Tax Consequences of Long-Run Pension Policy
ERM-321-14	LDI Evolution: Implementing Dynamic Asset Allocation Strategies that Respond to changes in Funded Status
ERM-323-14	Level 1 LDI: Selecting an Appropriate Benchmark
ERM-324-14	Level 2 LDI: Three Key Implementation Considerations
ERM-325-14	The Credit Rating Impact of Pension De-Risking
ERM-326-16*	Market-Consistent Valuation and Funding of Cash Balance Pensions
ERM-401-12	Mapping of Life Insurance Risks
ERM-402-12	Countering the Biggest Risk of All
ERM-405-14	Secondary Guarantee Universal Life: Practical Considerations
ERM-406-14	Income Annuities Improve Portfolio Outcomes in Retirement
ERM-407-14	Equity Indexed Annuities: Downside Protection, But at What Cost
ERM-408-14	The Captive Triangle: Where Life Insurers' Reserve and Capital Requirements Disappear
ERM-409-14	A Brief Primer on Financial Reinsurance
ERM-410-14	Coinsurance and its Variants
ERM-501-12	Risk Based Capital—General Overview

<b>Code</b>	<b>Title</b>
ERM-502-12	Healthcare Reform's Minimum Medical Loss Ratios
ERM-503-12	Hedging with Derivatives in Traditional Insurance Products
ERM-509-13	PPACA Regulations
ERM-511-13	PPACA 3R's Programme Description
ERM-512-13	Sections 5.4 and 5.5 of <i>Health Economics and Financing</i>
ERM-513-13	Extending the Insurance ERM Criteria to the Health Insurance Sector
ERM-515-14	Health Insurance Market Reforms: Rate Restrictions
ERM-516-14	Financial Reporting Implications Under the Affordable Care Act
ERM-517-15	The Cost of Waiting
ERM-602-12	<i>Investment Management for Insurers</i> , Babbel and Fabozzi, Chapter 11, The Four Faces of an Interest Model
ERM-603-12	<i>The Handbook of Fixed Income Securities</i> , Fabozzi, Seventh Edition, Chapter 47, Bond Immunization: An Asset Liability Optimization Strategy
ERM-604-12	Impact of Skewness and Fat Tails on Asset Allocation Decision
ERM-605-12	<i>Modern Investment Management</i> , Litterman, Chapter 10, Strategic Asset Allocation in the Presence of Uncertain Liabilities
ERM-606-12	<i>Fixed Income Securities</i> , Tuckman, Second Edition, Chapter 7, Key Rate and Bucket Exposures
ERM-609-15	A Constant-Volatility Framework for Managing Tail Risk
ERM-702-12	IAA Note on ERM for Capital and Solvency Purposes in the Insurance Industry, Pages 9–38
ERM-705-12	P&C RAROC: A Catalyst for the Improved Capital Management in the Property and Casualty Insurance Industry
ERM-708-13	Natural Catastrophe Loss Modeling
ERM-709-14	Managing Interest Rate Risk: ALM, Franchise Value, and Strategy
ERM-710-14	Allocation of Capital in the Insurance Industry
ERM-711-16*	Risk Appetite Working Party (GIRO) Risk Appetite for a General Insurance Undertaking
ERM-712-16*	Catastrophe Modelling: Guidance for Non-Catastrophe Modellers
ERM-713-16*	Stochastic Modelling of Catastrophe Risks in DFA Models
ERM-806-14	IAIS Global Systemically Important Insurers: Initial Assessment Methodology
ERM-807-14	FSB Principles for An Effective Risk Appetite Framework
ERM-808-14	Federal Sentencing Guidelines, Chapter 8, Section 2.1

Code	Title
ERM-809-14	Increasing the Intensity and Effectiveness of Supervision—FSB Guidance on Supervisory Interaction with Financial Institutions on Risk Culture
ERM-811-15	Agency Theory and Asymmetric Information
ERM-812-15	Chapter 1 of <i>Valuation for Mergers and Acquisitions</i> , Second Edition
ERM-813-15	Financial Structure, Capital Structure (Capitalization), and Leverage Explained
ERM-814-15	Cognitive Bias and their Implications on the Financial Market
ERM-815-15	Developments in Modelling Risk Aggregation, Sections 3–8

The following additional information applies to this exam:

1. ERRATA:

- **Financial Enterprise Risk Management (attached)**
- **ERM-114-13:**  
 The examples on Page 12 contains an incorrect analysis for Example 2. For stop-loss reinsurance, the priority (deductible) is first exhausted and then the copayment applies to the excess. The example has a priority of 80% of the premium, a capacity (maximum to be paid by the reinsurer) of 20%, and a copayment of 25%.  
  
 Example 1 – claims are 70%. The priority reduces the reinsurer's obligation to 0. The insured pays the full claim.  
  
 Example 2 – claims are 100%. The priority reduces the reinsurer's obligation to 20%. The copayment reduces it to  $0.75(20\%) = 15\%$ . This is below the capacity, so the reinsurer's share is 15% and the insured pays 85%. (It appears the author used 20% as the copayment)  
  
 Example 3 – claims are 115%. The priority reduces the reinsurer's obligation to 35%. The copayment reduces it to  $0.75(35\%) = 26.25\%$ . This is above the capacity, so the reinsurer's share is 20% and the insured pays 95%. (Adding the amounts allocated to the cedant by the author,  $80 + 6.67 + 8.33$ , produces the same result).

2. **EXAM OVERVIEW**

The syllabus for this exam trains candidates in the financial and risk management aspects of operating and evaluating a financial institution or other entity, with particular emphasis on enterprise risk management (ERM) concepts. This includes gaining an understanding of several subjects, including risk identification, risk measurement and management, risk modelling and risk measures.

This overview section is intended to provide candidates with an approach for organizing the course of reading for studying the various sections of the syllabus. In addition, the candidates

should be familiar with the Learning Objectives as described in the syllabus. These Learning Objectives were the first ingredient in developing the syllabus, and provide an indication of the level of understanding required for each major area of focus. While studying the syllabus material, candidates may want to consider both the organizational approach provided by this overview note, and to refer back to the Learning Objectives to remain focused on the goals of the Enterprise Risk Management exam. The courseware study note provides additional guidance with regard to relating the core readings to the learning objectives.

The syllabus has been organized into five major areas of focus, which align with the Learning Objectives: Risk Categories and Identification; Risk Modelling and Aggregation of Risks, Risk Measures, Risk Management Tools and Techniques and Economic Capital. Note that many syllabus sources relate to more than one topic. In the exam, candidates will be expected to integrate material across the various topics.

The candidate should focus on both the concepts and principles addressed in the exam syllabus. Candidates may be asked to apply concepts and principles in a particular context in an examination question. For example, although the candidate is not expected to remember detailed economic capital requirements the candidate is expected to understand how the concept of economic capital may apply to different business entities as specified in the examination.

The exam comprises three types of questions: Focus (covers single Learning Objective), Integrated (synthesizes multiple Learning Objectives) and Case Study.



## Financial Enterprise Risk Management – Paul Sweeting

### ERRATA

3 October 2011

<u>Page</u>	<u>Words/ref</u>	<u>Line</u>	<u>Comments</u>
12	6+7	6	Delete “by”
29	3.2.10	3	“lie” should be “like”
34		7	Second “as” should be “of” (“...as a result of...”)
44		1	Insert “the” (“One of the main...”)
47	Para 2	3	Replace “cannot” with “might not”
52	3.6.2	7	“presence” should be “present”
55	4.3	14	Delete “is” (“however, it should...”)
57		5	“determine” should be “determines”
71		16	“lose” should be “lost”
73	Para 3	6	“where” should be “were”
80	Para 2	1	“is” should be “are”
86	Para 2	2	“The” should be “They” (“They also...”)
91	Para 6	2	“of” should be “as” (“as well as the question...”)
95	Para 8	2	Second “in” should be “is” (“...in that there is both incidence...”)
110	7.11	10	“in” should be “is” (“...is unable...”)
112	8.2	1	“are” should be “is” (“...is discussed...”)
114	8.2.3	5	“where” should be “are”
115	8.3	1	“Each have their...” should be “Each has its...”
118	8.3.5	7	Missing “on” after “based” (“...are based on the responses...”)
124	9.3	8	Capital N for “negative”
148		7	Superfluous “the” (“...to test whether...”)

149	Ex. 10.6	17	Superfluous "be" ("...than 0.05 is needed")
166	10.2.18	2	"distributions" is mis-spelled
171	Para 3	1	Missing "be" ("...can also be defined)
177	Para 2	4	First "in" is superfluous "...shown for...")
246	11.5.1	Last line	Delete "and" after "logit;"
256	11.5.5	4	Replace "networks" with "machines"
257	Para 3	4	Insert "it" between "if" and "is" ("...whilst if it is...")
286	Para1(13.4.2)	9	Replace "as" with "a" ("Such a process is...")
300	Para 2	Last line	Delete "a" ("vertical axis is defined...")
307	Para 1	5	Replace "on" with "or" ("...undertaken or not...")
312	Para 4	3	Replace "are" with "area" ("the first area of interest is...")
338	14.5.1	1	Insert "a" between "in" and "large" ("...itself in a large...")
341	Para2(14.5.3)	2	Delete "for" ("...profile is...")
359	14.5.5	3	Replace "lost" with "loss" ("...proportion of loss...")
361	Para 1	5	Replace "used" with "use" (...of little use...")
385	Para 5	2	Replace "reflect" with "reflects" ("...that it reflects how...")
		5	Delete "when developing strategies" ("...mental anchors so that...")
401	Convex risk measures	4	Delete "the" ("...words, a convex...")
421		Last line	Delete "a" before "differential rates"
428	16.2.5 Para 3	2	Replace "limits" with "limit" ("...be used to limit the...")
430	16.3 Para 2	(16.17)	Replace theta with "v" in the equation ("v = dC_0/d sigma_X)
430	16.3 Para2	2	Insert "is" between "This" and "partly"

472	19.1	1	Replace “to” with “with” (“...be complied with...”)
477	Criticisms of Basel II. Para 3	2	Replace “or” with “of” (...the list of risks...”)
483	Comp of Basel II. Para 2	1	Replace “difference” with “differences” (“...major differences between...”)
485	COSO ERM	3 <sup>rd</sup> from end	Replace “cover” with “covers” (“...framework covers eight...”)
493	Framework for Management etc	Final bullet	Replace “organizations” with “organisations”
499	19.3.1 Para 1	1,2	Replace “was” with “were” and “it” with “they”
507	Last Para	1	Replace “are” with “is” (“...of earnings is paid...”)
511	20.3.1 Para 1	4	Replace “manger” with “manager”
515	Para 4	2	Insert “were” (“...interest rates were high.”)
	Para 5	1	Insert “were” (“...personal pensions were introduced...”)
	Para 6	4	Insert “the” (“...when the role existed...”)
525	20.10 Para 4	1	Replace “important” with “crucial” (...of incentives is crucial.”)

The legend for high and low variance in figure 9.1 is wrong (dotted should be high, continuous should be low).

Also, on page 212/213 – final paragraph onwards should read “From the formulae for Kendall’s tau in Table 10.2, it can be seen that the generalised Clayton copula is indeed a generalisation of the Clayton copula. In particular, it becomes the standard Clayton copula if  $\beta = 1$ . This formulation...” etc. In other words, there should be no reference to the Gumbel copula, and it should be  $\beta = 1$  rather than  $\beta = 0$ .

Finally, in table 10.2, the first formula in that column is wrong – it should read:

$$\frac{(\alpha + 2)\beta - 2}{\alpha + 2}$$

rather than

$$\frac{(2 + \alpha)}{\alpha + 2}$$

## Financial Enterprise Risk Management – Paul Sweeting

### ERRATA

17 October 2011

P127 – para 3 line 4 should be “...correlation coefficients do not...” (“do” rather than “to”)

P327 – the first formula both denominators should have 0.0525 and not 0.0520 in them; the last term in the second formula should be  $105e^{-2s_2}$  rather than  $105e^{-s_2}$

P339 – para 2 first line should be “...credit risk is that it...” (“it” rather than second “is”)

## Sweeting further errata

Page 138 – Equation 10.7 is missing a beta ( $\beta$ ) in the denominator

Page 146 – The excess kurtosis of the t-distribution is  $6/(\text{gamma} - 4)$

Page 153 – Equation 10.31 is missing a beta ( $\beta$ ) in the denominator

Page 167, Figure 10.21; Page 169, Figure 10.23 – the horizontal axis labels are too large (the area under these density functions is not one)

Page 204 – in the last line, the independence copula requires  $p = q = 0$

Page 215 – In Example 10.9, lines 2 and 5 on this page, the expressions for the probability of surviving  $x$  and  $y$  years should have the  $x$  and  $y$  in the exponent

Page 273 – The references to alpha being greater than, equal to, and less than zero should be to gamma

Page 305 – In line 1, the second formula should have a square on  $\sigma_t$ ; equations 13.62 and 13.63 each have a right parenthesis that should be removed

Page 352 – Example 14.5, in the second bullet, the first 0.00% should be 0.02%; with rounding, the answer is unchanged

Page 358 – Equation 14.34, all the numerals should be subscripts

Page 366 – Table 14.13, in the first column,  $x$  should go from 0 to 4, not 1 to 5

Sweetening further errata, updated August 16, 2012

Page 119 – Section 8.5, line 3 “in” should be “is”

Page 127 – In the third full paragraph, the reference should be to Chapter 10

Page 138 – Equation 10.7 is missing a beta ( $\beta$ ) in the denominator

Page 146 – The excess kurtosis of the t-distribution is  $6/(\text{gamma} - 4)$

Page 153 – Equation 10.31 is missing a beta ( $\beta$ ) in the denominator

Page 167 – Figure 10.21; Page 169, Figure 10.23 – the horizontal axis labels are too large (the area under these density functions is not one)

Page 199 – 5 lines from the bottom of the page, “was” should be “way”

Page 201 – In the last paragraph, in the phrase “say that the coefficient of upper” the word “upper” should be “lower”

Page 204 – in the last line, the independence copula requires  $p = q = 0$

Page 212 – The last formula on the page, 10.175, should be

$${}_{GC}C_{\alpha,\beta}(F(x_1), F(x_2), \dots, F(x_N)) = \left( \left\{ \sum_{n=1}^N [(F(x_n))^{-\alpha} - 1]^{\beta} \right\}^{1/\beta} + 1 \right)^{-1/\alpha}$$

Page 215 – In Example 10.9, lines 2 and 5 on this page, the expressions for the probability of surviving  $x$  and  $y$  years should have the  $x$  and  $y$  in the exponent

Page 216 – Formula 10.185, the last term of the formula should have a subscript of lower case “ $n$ ” rather than “ $N$ ”

Page 273 – The references to alpha being greater than, equal to, and less than zero should be to gamma

Page 305 – In line 1, the second formula should have a square on  $\sigma_t$ ; equations 13.62 and 13.63 each have a right parenthesis that should be removed

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