ACTUARIAL STANDARDS BOARD

• THIRD EXPOSURE DRAFT •

Proposed
Actuarial Standard
of Practice

Modeling

Comment Deadline:
October 31, 2016

Developed by the
Modeling Task Force of the
General Committee of the
Actuarial Standards Board

Approved for Exposure by the
Actuarial Standards Board

T A B L E O F C O N T E N T S

APPENDIXES

THIRD EXPOSURE DRAFT—June 2016

June 2016

TO: Members of Actuarial Organizations Governed by the Standards of Practice of the Actuarial Standards Board and Other Persons Interested in Modeling

FROM: Actuarial Standards Board (ASB)

SUBJ: Proposed Actuarial Standard of Practice (ASOP) on Modeling

This document contains a third exposure draft of a proposed ASOP titled *Modeling*. Please review this exposure draft and give the ASB the benefit of your comments and suggestions. Each written response and each response sent by e-mail to the address below will be acknowledged, and all responses will receive appropriate consideration by the drafting committee in preparing the final document for approval by the ASB.

The ASB accepts comments by either electronic or conventional mail. The preferred form is e-mail, as it eases the task of grouping comments by section. However, please feel free to use either form. If you wish to use e-mail, please send a message to **comments@actuary.org**. You may include your comments either in the body of the message or as an attachment prepared in any commonly used word processing format. **Please do not password protect any attachments. If the attachment is in the form of a PDF, please do not copy protect the PDF.** Include the phrase "ASB COMMENTS" in the subject line of your message. Please note: Any message not containing this exact phrase in the subject line will be deleted by our system's spam filter. Also please indicate in the body of the e-mail if your comments are being submitted on your own behalf or on behalf of a company or organization.

If you wish to use conventional mail, please send comments to the following address:

Modeling (Third Exposure)
Actuarial Standards Board
1850 M Street, NW, Suite 300
Washington, DC 20036

The ASB posts all signed comments received to its website to encourage transparency and dialogue. Unsigned or anonymous comments will not be considered by the ASB nor posted to the website. The comments will not be edited, amended, or truncated in any way. Comments will be posted in the order that they are received. Comments will be removed when final action on a proposed standard is taken. The ASB website is a public website, and all comments will be available to the general public. The ASB disclaims any responsibility for the content of the comments, which are solely the responsibility of those who submit them.

Deadline for receipt of responses in the ASB office: **October 31, 2016**

THIRD EXPOSURE DRAFT—June 2016

Background

The ASB first began work on a standard for modeling in the late 1990s. Motivated primarily to address the role catastrophe modeling of earthquakes and hurricanes played in casualty ratemaking, this work was focused on the use of specialized models where actuaries would have to rely on a model that was developed by professionals other than actuaries. As a result of this work, ASOP No. 38, *Using Models Outside the Actuary's Area of Expertise*, was approved by the ASB in June of 2000 with the scope of the standard limited to the Property/Casualty area of practice. Historically, ASOP No. 38 had been the only ASOP that specifically addressed modeling.

Recently, the number and importance of modeling applications in actuarial science has increased, with the results of actuarial models often entering financial statements directly. Recognizing this trend, the ASB asked the Life Committee in 2010 to begin work on an ASOP focused on modeling. The Life Committee formed a task force to address this issue and, in February of 2012, a discussion draft titled *Modeling in Life Insurance and Annuities* was released and nineteen comment letters were received. The transmittal letter also mentioned that the scope might be expanded to all practice areas and asked for comments on this idea.

Based upon the feedback received, and numerous other discussions on the topic of modeling, in December of 2012 the ASB created two multi-disciplinary task forces under the direction of the General Committee: i) a general Modeling Task Force, charged with developing an ASOP to address modeling applications in all practice areas, and ii) a Catastrophe Modeling Task Force to consider expanding ASOP No. 38 to all practice areas while focusing exclusively on using catastrophe models. The membership of these task forces has experience in all actuarial practice areas, including enterprise risk management.

As the guidance in this proposed modeling ASOP and ASOP No. 38 currently titled *Catastrophe Modeling (for All Practice Areas)* is intended to be coordinated, the ASB will issue final versions of both ASOPs to be effective concurrently. To facilitate review of this proposed modeling ASOP, a link to the current working draft of ASOP No. 38 is provided here for your information. The working draft of ASOP No. 38 is not being exposed for comment but does reflect guidance that the ASB and General Committee believe works in concert with the guidance in the third exposure draft of this proposed modeling ASOP.

First Exposure Draft

The first exposure draft titled *Modeling* was released in June 2013 with a comment deadline of September 30, 2013. Forty-eight comment letters were received and considered in making changes that were reflected in the second exposure draft.

Second Exposure Draft

In November 2014, the ASB approved a second exposure draft with a comment deadline of March 1, 2015. Thirty-seven comment letters were received and considered in making changes

that were reflected in this third exposure draft. For a summary of issues contained in these comment letters, please see appendix 2.

Key Changes

Changes made to the second exposure draft in response to the comment letters include the following:

1. The scope was narrowed but, within that scope, the guidance is less subject to professional judgement as to its applicability.

2. Distinctions within section 2.6, Intended Purpose, were removed between "intended application" and "project objective."

3. The definitions were clarified, particularly for "model," "data," and "model run."

4. The guidance with respect to using models designed or built by others was clarified.

5. The guidance with respect to an actuary with a role on a modeling team was clarified.

6. The guidance in section 3.4.5 related to model structure was clarified.

Given the extensive clarifications, the ASB believes it would be appropriate to obtain additional feedback on the proposed Modeling ASOP through the issuance of this third exposure draft. The ASB thanks everyone who took the time to contribute comments and suggestions on the first and second exposure drafts.

Request for Comments

The ASB would appreciate comments on all areas of this proposed standard and would like to draw the reader's attention in particular to the following questions:

1. Does the proposed standard provide sufficient and appropriate guidance to actuaries working with models? If not, what suggestions do you recommend for improving the guidance?

2. Does the proposed standard provide sufficient and appropriate guidance to actuaries working with all types of models, including financial projection models, predictive models, and statistical models?

3. The scope of the proposed ASOP excludes "simple" models, which are defined in section 2.13. Is this definition appropriate and sufficiently clear?

4. Section 3.2 requires the actuary to make practical efforts to comply with applicable sections of this standard with respect to models designed or built by someone else, such

as a vendor or a colleague, when the actuary has a limited ability to obtain information about the model or to understand the underlying workings of the model. Is this guidance appropriate and clear?

5. Does any guidance in this exposure draft conflict with the guidance in the proposed working draft of ASOP No. 38, *Catastrophe Modeling (for All Practice Areas)*?

The ASB voted in June 2016 to approve this third exposure draft.

Modeling Task Force

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The Actuarial Standards Board (ASB) sets standards for appropriate actuarial practice in the United States through the development and promulgation of Actuarial Standards of Practice (ASOPs). These ASOPs describe the procedures an actuary should follow when performing actuarial services and identify what the actuary should disclose when communicating the results of those services.

THIRD EXPOSURE DRAFT—June 2016

PROPOSED ACTUARIAL STANDARD OF PRACTICE

MODELING

STANDARD OF PRACTICE

Section 1. Purpose, Scope, Cross References, and Effective Date

1.1 Purpose—This actuarial standard of practice (ASOP) provides guidance to actuaries selecting, designing, building, modifying, developing, using, reviewing, or evaluating **models** when performing actuarial services.

1.2 Scope—This ASOP applies to actuaries in all practice areas performing actuarial services when selecting, designing, building, modifying, developing, using, reviewing, or evaluating all types of **models** that are not **simple models**.

If the **model** results are not heavily relied upon by the intended user, or do not have material financial effect, the requirements of this ASOP are limited to certain disclosure requirements in section 3.1.

If the actuary departs from the guidance set forth in this ASOP in order to comply with applicable law (statutes, regulations, and other legally binding authority), or for any other reason, the actuary should refer to section 4.

1.3 Cross References—When this ASOP refers to the provisions of other documents, the reference includes the referenced documents as they may be amended or restated in the future, and any successor to them, by whatever name called. If any amended or restated document differs materially from the originally referenced document, the actuary should consider the guidance in this ASOP to the extent it is applicable and appropriate.

1.4 Effective Date—This ASOP is effective for work performed on or after nine months after adoption by the Actuarial Standards Board.

Section 2. Definitions

The terms below are defined for use in this actuarial standard of practice.

2.1 Assumptions—A type of **input** to a **model** that represents expectations or possibilities based on professional judgment, or that may be prescribed by law or by others.

2.2 Data—Facts or information that are either direct **input** to a **model** or inform the selection of **input**; **data** may be collected from sources such as records, experience, experiments, surveys, observations, or outputs from other **models**.

2.3 Granularity—The level of detail built into a **model**.

2.4 Implementation—An executable form of a **model**.

2.5 Input—Information such as **data**, **assumptions**, or **parameters** used in a **model** to produce output.

2.6 Intended Purpose—The planned uses for the **model** or the specific goal or question addressed or both, depending on the actuary's role at the time actuarial services are performed to meet the needs of the principal or the actuary. The "planned uses" definition applies if the actuary's role includes designing, building, or developing the **model**, or if the actuary's role includes modifying, reviewing or evaluating the **model** before being selected or used in a specific project. The "specific goal or question addressed" definition applies if the actuary's role includes selecting or using the **model** in a specific project or if the actuary's role includes modifying, reviewing, or evaluating the **model** when it is being selected or used in a specific project.

2.7 Model—A simplified representation of relationships among real world variables, entities, or events using statistical, financial, economic, mathematical, or scientific concepts and equations. **Models** are used to help explain a system, to study the effects of different parts of a system, and to derive estimates and guide decisions. A **model** consists of three components: an information **input** component, which delivers **assumptions**, **parameters** and **data** to the **model**; a processing component, which transforms **inputs** into estimates; and an output component, which translates the estimates into useful business information. A **model** evolves through a life cycle as follows: (1) a **specification** phase, (2) an **implementation** phase, and (3) a production phase, that consists of one or more **model runs**.

2.8 Modeling—Selecting, designing, building, modifying, developing, using, reviewing, or evaluating **models**.

2.9 Model Risk—The risk of adverse consequences resulting from reliance on a **model** that does not adequately represent that which is being modeled or that is misused or misinterpreted.

2.10 Model Run—The process and end result of transforming a particular selection of **input** to a particular set of output in a **model**.

2.11 Parameters—A type of mathematical, financial, contractual, economic, scientific, or statistical **input** to **models**. Examples include pension plan provisions, expected values in mathematical distributions, and coefficients of variables in regression formulas.

2.12 Simple Model—A **model** wherein, in the actuary's professional judgment, the **model** results are transparent and can be predicted without an actual **model run** or readily obtained from an external source that is not another **model**.

2.13 Specification—A description of a **model** that identifies the **inputs** and the formulas, algorithms, or logic (collectively referred to as "formulas") to be used to produce output. The **specification** may be explicit, or it may be implicit in the **implementation**.

Section 3. Analysis of Issues and Recommended Practices

3.1 Application of ASOP Guidance—The guidance in this ASOP applies to actuarial practice regarding **models** that are not **simple models** when, in the actuary's professional judgment, intended users of the **model** rely heavily on the results, and the use of the results of the **model** has a material financial effect for the intended user. In assessing materiality, the actuary should be guided by ASOP No. 1, *Introductory Actuarial Standard of Practice*, section 2.6. For example, corporate financial planning, ratemaking, and reserving **models** would typically require application of the guidance.

In **modeling** situations where, in the actuary's professional judgment, the results (1) are not heavily relied upon by the intended users or (2) do not have material financial effect, then application of the guidance in this ASOP is not required except that the actuary should disclose that the **model** was not deemed subject to the guidance of this ASOP for one or both of these two reasons.

In deciding whether this ASOP applies, the actuary should use professional judgment, considering the extent of reliance by the intended user and the materiality of the financial effect. This judgment should be made within the context of the use of the **model** results and the needs of the principal, based on facts known by the actuary at the time the actuarial services are performed.

In instances where a deviation from guidance is material, the actuary should disclose that deviation from guidance as addressed in section 4.3.

If an actuary is part of a **modeling** team, the actuary should identify the scope of his or her responsibilities. This scope could extend to the entire **model** or just to a small portion of the **model**. This standard only applies to the extent of the actuary's responsibility, as identified and disclosed pursuant to section 4.2.1.

3.2 Models Developed by Others—If the actuary uses a **model** designed or built by someone else, such as a vendor or colleague, and the actuary has a limited ability to obtain information about the **model** or to understand the underlying workings of the **model**, the actuary should continue to make a reasonable attempt to have a basic understanding of the **model**, including the following:

a. the designer's or builder's original **intended purpose** for the **model**;

b. the general operation of the **model**;

c. major sensitivities and dependencies within the **model**; and

d. key strengths and limitations of the **model**.

In these instances, the actuary should make practical efforts to comply with other applicable sections of this standard.

3.3 Reliance on Another Actuary on a Modeling Team—When the actuary is part of a **modeling** team, the actuary may reasonably rely on another actuary who has selected, designed, built, modified, developed, reviewed, evaluated, or used the **model**. However, the relying actuary should be reasonably satisfied that the other actuary's selecting, designing, building, modifying, developing, reviewing, evaluating, or use of the **model** was performed in accordance with this ASOP and is appropriate for the **intended purpose**.

3.4 Model Meeting the Intended Purpose—The actuary should select, design, build, modify, develop, or use a **model** that reasonably meets the **intended purpose**. An actuary who is reviewing or evaluating a **model** should evaluate whether the **model** reasonably meets the **intended purpose**.

3.4.1 Designing, Building, or Developing the Model for the Intended Purpose—The actuary should confirm that the capability of the **model** is consistent with the **intended purpose** when the actuary designs, builds, or develops the **model**. In this confirmation, examples of items that the actuary should consider, if applicable, include but are not limited to **granularity**, the relationships recognized, and the **model**'s ability to identify possible volatility around expected values. Further, when appropriate, the actuary may consider whether the **model** can be easily updated for anticipated changes in **data**, **parameters**, or **assumptions**.

3.4.2 Selecting or Using the Model for the Intended Purpose—The actuary should select or use the **model** to meet the **intended purpose**. In the actuary's use of the **model**, efforts to revise the **inputs** and formulas, documentation, controls, validation, and presentation of results should be consistent with the **intended purpose**.

3.4.3 Reviewing, Evaluating, or Modifying the Model—When reviewing or evaluating a **model** for its planned uses, or when modifying a **model** to change the planned uses or to improve the **model's** ability to meet its planned uses, the actuary should be guided by section 3.4.1. When reviewing or evaluating a **model** for a specific use, or when modifying a **model** to improve the **inputs**, formulas, and outputs to meet the specific goal or question being addressed by the **model**, the actuary should be guided by section 3.4.2.

3.4.4 Understanding the Model—The actuary's responsibilities may include expressing an opinion, using or communicating results, or preparing documentation based on or in relation to a **model**. In these instances, the actuary should understand the following:

a. important aspects of the **model** being used, including but not limited to, basic operations, important relationships, major sensitivities, strengths and potential weaknesses; and

b. whether, and the extent to which, the **model** can fulfill its **intended purpose**, recognizing limited information, time constraints, and other practical considerations.

3.4.5 Model Structure—The actuary should evaluate whether the structure of the **model** is appropriate for the **intended purpose**. Where applicable for a particular **model** structure, the actuary should consider the following:

a. which provisions and risks specific to a business segment, contract, or plan are material and appropriate to reflect in the **model**;

b. whether the use of the **model** dictates some level of **granularity**, such as whether grouping **inputs** will produce reasonable results;

c. whether deterministic or stochastic results, or both, are appropriate; and

d. whether the **model** appropriately represents options that are available either to the entity or its counterparties, where the options could have a material effect on the results of the **model**. Examples of options include call options on fixed income assets, policyholder surrender options, and early retirement options.

3.4.6 Data—The actuary should use **data** appropriate for the **model's intended purpose** and should refer to ASOP No. 23, *Data Quality*, when selecting, reviewing, or evaluating **data** used in the **model**, either directly or as the basis for deriving **assumptions** and **parameters**.

3.4.7 Assumptions and Parameters—The actuary should use **assumptions** and **parameters** that are appropriate in light of the **model's intended purpose**.

a. Experience Reflected in Setting Assumptions and Parameters—When setting **assumptions** and **parameters**, the actuary should consider using the following:

1. **assumptions** and **parameters** based on actual experience, to the extent it is available, relevant, and sufficiently reliable;

2. other relevant and sufficiently reliable experience, such as industry experience that is properly modified to reflect the circumstances being modeled, if actual experience is not available or relevant, or is not sufficiently reliable; and

3. professional judgment to modify other available sources of information.

b. Margins—The actuary may consider whether adjusting the **assumption** or **parameter** to include a margin having a material effect would be appropriate, given the **model's intended purpose**. Possible reasons for a margin include a) experience **data** that are not fully reliable, b) conservatism, c) an adjustment for the cost of bearing risk, or d) future unpredictability.

c. Range of Assumptions and Parameters—The actuary should consider whether the range of **assumptions** and **parameters** used and the number of **model runs** analyzed reflect a range of conditions consistent with the **intended purpose**.

d. Consistency—Where appropriate, the actuary should use **assumptions** and **parameters** for the **model** that are reasonably consistent with one another for a given **model run**. For example, where appropriate, the actuary should use **assumptions** and **parameters** consistent with the underlying economic scenario(s) assumed in the **model**.

If the actuary is aware of any material inconsistencies among **assumptions** and **parameters** used by the actuary in the **model**, the actuary should disclose the inconsistencies and the reasons for the inconsistencies in accordance with section 4.1.3. This disclosure applies whether the inconsistencies are (i) required by legal constraints or by the principal, (ii) the result of intentional redundancy such as added conservatism, or (iii) for any other reason. However, in the case of **assumptions** and **parameters** prescribed by applicable law (statutes, regulation, or other legally binding authority), the actuary's disclosure may be limited to identifying the possibility of an inconsistency with other **assumptions** and **parameters**.

e. Appropriateness of Input in Current Model Run—Where practical and appropriate, the actuary reusing an existing **model** should evaluate whether the **input** is still appropriate for use in the current **model run**. For example, **models** used in financial reporting may offer opportunities to compare **assumptions** and **parameters** to emerging experience in the aggregate.

3.5 Mitigation of Model Risk—The actuary should examine the potential for **model risk** and undertake reasonable and appropriate steps to mitigate such risk, using validation, governance, and controls, as appropriate to the **intended purpose**. When deciding on what steps to undertake that would be reasonable and appropriate, the actuary may consider the balance between the cost of the mitigation efforts and the reduction in potential for **model risk**.

3.5.1 Validation—The nature and degree of validation selected by the actuary should be consistent with the complexity of the **model** and the **intended purpose**.

a. Model Integrity—For each **model run** or set of **model runs** generated at one time or over time, that is to be relied upon by the intended user, the actuary should validate that the **model** reasonably represents that which is being modeled. Examples of validation of the **model** may include the following:

1. reconciling relevant **input** values to actual information, addressing and documenting the differences appearing in the reconciliation, if material;

2. checking formulas, logic, and table references; and

3. testing, where applicable, **model** projection results against historical actual results to verify that modeled results would bear a reasonable relationship to actual results over a given time period if **inputs** to the **model** were set to be consistent with the conditions prevailing during such period. However, such a test may not be applicable, even for a projection **model**, if the **model** is concerned with certain catastrophic scenarios or if the historical results are from a period with infrequent events.

The degree of reconciliation, checking and testing that is appropriate will depend on the **intended purpose**, the context and nature of the **model**, the operating environment and controls related to the **model**, whether there have been any changes to the **model** or the **model** environment, and the residual risk that may remain after the **model** integrity efforts.

b. Analyzing the Output—The actuary should take appropriate steps to evaluate whether the **model** results are reasonable. Depending on the **intended purpose**, the actuary should consider the following:

1. performing analytical tests on **model** results to assess their reasonableness;

2. reconciling the results of a **model run** to prior **model runs**, given any changes in **assumptions** and **parameters**, **data**, formulas, or other aspects of the **model** since the prior **model run**;

3. running tests of variations on key **assumptions** and **parameters** to test that changes in the results are consistent with the changes in those **assumptions** and **parameters**; and

4. comparing **model** results to those of alternative **model**(s), where appropriate.

c. Peer Review—The actuary should consider obtaining a peer review, where appropriate, depending on the **intended purpose** and the actuary's role. Such peer review, if obtained, may include items such as review of the reasonableness of the **input** to the **model**, the **implementation** of the **model**, and the **model** results.

3.5.2 Appropriate Governance and Controls—The actuary should use or, if appropriate, rely on others to use appropriate governance and controls to minimize **model risk**, to maintain the integrity of the **model**, and to avoid the introduction or use of unintentional or untested changes.

3.6 Presentation of Results—When the actuary presents results of the **model**, the actuary should explain methodology, key **assumptions** and **parameters**, and possible **model** limitations, consistent with the guidance in ASOP No. 41, *Actuarial Communications*. If appropriate, the actuary should consider describing any material changes in methodology, key **assumptions** and **parameters**, and possible **model** limitations affecting results since the prior communication.

3.6.1 Explanation of Limitations of Models—In actuarial reports that include information derived from **models**, the actuary should include explanations of the following, if applicable:

a. the extent to which a **model** fails to fulfill its **intended purpose**, due to limited information, time constraints, or other practical considerations; and

b. any other known material limitations of the **models** that have been used and the implications of those limitations.

If there is anything to explain pursuant to (a) or (b), then the actuary should refer to section 4.1.

3.6.2 Discussion of Models—In actuarial reports that include information derived from **models**, the actuary should consider including explanations of the following:

a. the **intended purpose** of the **models** and how the intended users' needs

are addressed by those **models**; and

b. any significant uncertainty in the **model** results.

3.6.3 Comparison to Prior Reports—The actuary should consider including in the actuarial report a comparison to corresponding items in a prior actuarial report, as applicable depending on the type of the **model**. Such a comparison, if any and where reasonably possible, should include an explanation of **assumptions** and **parameters** or methods that have changed materially from that prior actuarial report.

3.6.4 Description of Conservatism or Optimism—The actuary should consider including a description of the conservatism or optimism inherent in the **inputs** and methodology selected in relation to anticipated future experience, as applicable depending on the type of the **model**. Terminology may include language such as "conservative," "most likely," "reflecting asymmetric outcomes," or "optimistic," along with a description of the relationship to anticipated future experience by appropriate quantitative, qualitative, or directional language.

If applicable law specifies some or all of the **inputs** or methodology, then this section 3.6.4 does not apply with respect to the **inputs** or methodology so specified.

3.7 Reliance on Data or Other Information Supplied by Others—When relying on **data** or other information supplied by others, the actuary should refer to ASOP Nos. 23 and 41 for guidance. When relying on outputs from other **models** supplied by others, the actuary should refer to ASOP No. 23, deeming such outputs from other **models** as **data** covered by that standard. Similarly, the actuary should refer to ASOP No. 41 with respect to the disclosure of responsibility for **data**, **assumptions**, **parameters**, and methods.

3.8 Documentation—For **model** results used in actuarial communications, the actuary should document the nature of the **data** used, and material **assumptions** and **parameters** used in the **model** and, in the case of an actuarial report, the actuary should follow the guidance of ASOP No. 41, including section 3.2 in ASOP No. 41.

If no actuarial report is created, the actuary should consider documenting the items mentioned in sections 3.6.1 and 3.6.2 of this standard, and the actuary may consider documenting other items mentioned in sections 3.1-3.7 that the actuary believes may be helpful to subsequent users.

3.9 Relation to Other ASOPs—Other ASOPs provide specific requirements for actuarial services that often use **modeling**, including guidance on selecting **assumptions**, **parameters**, and **data** (see ASOP No. 23) and providing disclosures (see ASOP No. 41). If such specific guidance from an applicable ASOP is inconsistent with the guidance of this ASOP, the guidance of such other ASOP governs.

Section 4. Communications and Disclosures

4.1 Actuarial Communications—In any actuarial communications that use results of work subject to this ASOP, the actuary should note the guidance in sections 3.1 and 3.6-3.9.

4.2 Actuarial Report—In any actuarial report that uses the results of work subject to this ASOP, the actuary should disclose the following, as applicable:

4.2.1 Scope of Actuary's Responsibility—Where the actuary is responsible for only a portion of the overall **model**, the actuary should disclose the extent of the responsibility (as discussed in section 3.1).

4.2.2 Failure to Meet Intended Purpose—Any reasons that prevent the **model** from meeting its **intended purpose**, as discussed in sections 3.4.4 and 3.6.1. In this situation, the actuary should disclose the **intended purpose** of the **model**.

4.2.3 Inconsistent Assumptions and Parameters—Any material inconsistencies among **assumptions** and **parameters** and the reasons for such inconsistencies, as discussed in section 3.4.7(d).

4.3 Deviation from Guidance in the Standard—In any actuarial communication that uses the results of work subject to this ASOP, the actuary should refer to ASOP No. 41 and should include the following where applicable:

a. the disclosure in ASOP No. 41, section 4.2, if any material **assumption**, **parameter**, or method was prescribed by applicable law (statutes, regulations, and other legally binding authority);

b. the disclosure in ASOP No. 41, section 4.3, if the actuary states reliance on other sources and thereby disclaims responsibility for any material **assumption**, **parameter**, or method selected by a party other than the actuary; and

c. the disclosure in ASOP No. 41, section 4.4, if, in the actuary's professional judgment, the actuary has otherwise deviated materially from the guidance of this ASOP.

Appendix 1

Note: This appendix is provided for informational purposes but is not part of the standard of practice.

Current Practices

Models are used to help explain a system, to study the effects of different components, and to derive estimates and guide decisions. Models have always played a fundamental role in actuarial work, with every discipline relying on a broad range of modeling applications, ranging from simple spreadsheets to complex capital models. The number and importance of modeling applications in actuarial science have continued to increase, with the results of actuarial models often entering financial statements directly.

Actuaries often develop and use models when analyzing uncertain outcomes. Even a model that is prudently developed and carefully used does not eliminate inherent uncertainty and variability and actual experience may differ, sometimes significantly, from the estimates derived from the model results. A model is only an approximation of reality, not the reality itself, and the differences between the model and actual experience, by themselves, do not indicate a flawed model or noncompliance with standards.

When a model will be used repeatedly, it is common that the model will be subject to appropriate governance and controls. Examples of model governance and controls include the following:

- limitations on access to use and modify the model (that is, restricting access to model inputs, model code and calculations, and model outputs);
- confirmation that model results are reproducible upon rerun (if the model allows for such reproducibility);
- implementing a model change management process;
- specification, documentation, and programming standards for the implementation;
- procedures for secure back-up of the media storing the implementation and data;
- appropriate staff training or cross-training for continuity of use;
- plans for periodic consideration of the organization's continued ability to access and maintain the model, including data, software, staff, hardware, and vendor relationships;
- plans for periodic updating of model input; and
- plans for periodic review of the assumptions, parameters, functionality, and methodology.

Appendix 2

Comments on the Second Exposure Draft and Responses

The second exposure draft of this ASOP, *Modeling*, was approved by the ASB in November 2014 with a comment deadline of March 1, 2015. Thirty-seven comment letters were received, some of which were submitted on behalf of multiple commentators, such as by firms or committees. For purposes of this appendix, the term "commentator" may refer to more than one person associated with a particular comment letter. Where similar opinions are expressed, even in the case of essentially identical letters submitted by different commentators, this appendix refers to "several commentators." The Modeling Task Force carefully considered all comments received, reviewed the exposure draft, and proposed changes. The General Committee and the ASB reviewed the proposed changes and made modifications where appropriate.

Summarized below are the significant issues and questions contained in the comment letters and responses.

The term "reviewers" in appendix 2 includes the Modeling Task Force, the General Committee, and the ASB. Also, unless otherwise noted, the section numbers and titles used in appendix 2 refer to those in the second exposure draft.

GENERAL COMMENTS	
Comment	Several commentators suggested that "modeling" was too broad a subject for an ASOP and that aspects of actuarial work involving modeling should be addressed by more specific standards. Other commentators expressed the view that there is a need for a broad standard on modeling, even if the standard of care is already implied by existing more general standards.
Response	The reviewers believe that it is appropriate to have a broad standard on modeling, providing a foundation for the specific guidance of more narrow standards and, therefore, made no change.
Comment	One commentator suggested that the guidance in the standard would be better positioned as an educational or practice note. The commentator felt that as a standard it might lead to the use of checklists, impede the exercise of professional judgment about applicability of guidance and require extensive caveats and limitations to ward off litigation.
Response	The reviewers believe that the latest revisions to scope and applicability address these concerns.

Comment	Several commentators suggested that consideration of materiality should include the extent to which additional disclosures would benefit rather than distract the intended user. One specific suggestion was explicit non-application of the proposed standard when the work is covered by other standards or by government or accounting regulations. Finally, the commentators asked for additional examples of models that would or would not be subject to full application of the guidance.
Response	The reviewers believe existing standards and regulatory specifications do not sufficiently address the issues of modeling that are addressed in this exposure draft, and made no change. The reviewers revised the scope and believe the guidance is sufficiently clear without the addition of specific examples.
Comment	Several commentators expressed concern that the ASOP would not be relevant for or could even impede actuaries doing predictive modeling (also called statistical modeling). They suggested the ASOP scope be restricted to projection modeling.
Response	The reviewers believe that this proposed ASOP should cover all forms of modeling. In the transmittal memorandum of this third exposure draft, the reviewers request comments regarding any perceived problem applying the guidance in the proposed ASOP to predictive modeling.
Comment	One commentator felt the scope of the ASOP was too broad and should be narrowed to only include modern statistical/predictive models.
Response	The reviewers intend the broad scope and, therefore, made no change.
Comment	One commentator asked for clarification about whether the ASOP applied both to methods and to executable models.
Response	The guidance has been revised to narrow the scope to exclude simple models, which may correspond in many cases to what the commentator refers to as "methods." The reviewers note that the definition of a model includes not only a specification, which could be thought of as a method, but also an implementation and model runs.
Comment	One commentator suggested that the use of "should" was too prescriptive throughout the ASOP and suggested that "could" be used in its place in many instances.
Response	ASOP No. 1, *Introductory Actuarial Standard of Practice*, provides for use of "may" when not using "should" or "should consider." The commentators reviewed the guidance throughout and have confirmed the use of these terms.

Comment	One commentator stated that the scope of the standard is too broad and that the proposed ASOP is impractical and inappropriate for the modeling actuaries do every day. The commentator stated that modeling is too broad a topic to be covered in a single standard and is not exclusively an actuarial discipline. The commentator recommended that the standard be limited in scope to a single type of modeling such as stochastic solvency modeling. The commentator recommended that other, future standards address other models in common actuarial practice. The commentator recommended that the scope of all such standards omit models from other disciplines that are not central to actuarial practice, even if some actuaries use such models in non-traditional roles. Lastly, the commentator suggested the introduction of standards of practice around topics such as process governance and validation procedures, which apply to work that both does and does not entail modeling.
Response	The reviewers believe that the standard should apply to models used in all practice areas, but that the ASOP applies only to actuaries when performing actuarial services (as defined in ASOP No. 1) when selecting, designing, building, modifying, developing, using, reviewing, or evaluating models. Accordingly, the reviewers made no change.
Comment	Several commentators suggested the ASOP was not needed in situations involving straightforward calculations (such as a benefit calculation) that could be done using pencil and paper. The commentators suggested excluding simple models from the scope of the standard.
Response	The reviewers agree that certain models should be excluded, and have added a definition of simple model and excluded simple models from the scope of the standard.
Comment	Several commentators suggested splitting the standard into two or more separate parts, some of which may become practice notes rather than ASOPs.
Response	The reviewers disagree and believe that a broad standard is needed to act as a foundation for modeling guidance, and made no change.
Comment	One commentator asked for distinct guidance for actuaries who assume the distinct roles of developer, customizer, and user.
Response	The reviewers believe that the proposed standard provides appropriate guidance to actuaries working in all those roles and added a paragraph to section 3.1 for clarification.
Comment	One commentator noted that an aspect of pension actuarial models has to do with actuarial cost methods such as those used to allocate the cost of pension benefits to past, current and future years. There are several generally accepted methods, and some are prescribed by law or by another party. This should be incorporated into the standard.
Response	The reviewers clarified the guidance in section 3.9 of this exposure draft.

Comment	One commentator suggested specific reference to ASOPs such as Nos. 4, *Measuring Pension Obligations and Determining Pension Plan Costs or Contributions*; 6, *Measuring Retiree Group Benefits Obligations and Determining Retiree Group Benefits Program Periodic Costs or Actuarially Determined Contributions*; 27, *Selection of Economic Assumptions for Measuring Pension Obligations*; and 35, *Selection of Demographic and Other Noneconomic Assumptions for Measuring Pension Obligations* to note that the specific requirements of those standards would supersede any conflicting guidance in this standard. Having to follow two different sets of guidance for the same activity could be confusing and difficult for actuaries to follow.
Response	The reviewers agree in part, and clarified the guidance in section 3.9 of this exposure draft.
Question 1: Section 3.1.1 discusses situations when the actuary judges whether full guidance is or is not warranted. Is this section clear and appropriate? If not what changes would you suggest?	
Comment	Several commentators stated the application of ASOP guidance is clear and appropriate, while others thought it could be made clearer or more appropriate by addressing both materiality and complexity.
Response	The reviewers agree in part and modified the guidance in sections 1.2 and 3.1.
Question 2: Section 3.1.3 discusses the actuary's responsibility when the actuary is part of a modeling team. Is this section clear and appropriate? If not what changes would you suggest?	
Comment	Two commentators thought the guidance is clear and appropriate, while others thought the guidance could be made clearer by clarifying that reliance could be placed on other actuaries only rather than on members of the team that are not actuaries. Several commentators thought the guidance was unclear given the complexity of modeling teams, varying roles and responsibilities, and cooperation between actuaries and non-actuaries on a modeling team.
Response	The reviewers modified the language, which now appears in section 3.3.
Question 3: Section 3.3.1(a)(2) describes the degree of checking as being dependent on a list of possible factors, and this list includes both the "intended application" and the "project objective," which apply in different stages of modeling, rather than just referring to the "intended purpose," which encompasses either. Is this separate mention of the two possible stages of purpose helpful? Would the guidance be clearer if only the term "intended purpose" was used?	
Comment	Many commentators stated that guidance in section 3.3.1(a)(2) would be clearer if only "intended purpose" were used, instead of using both "intended application" and "project objective" for different phases of modeling.
Response	The reviewers agree and made the change, which now appears in section 3.5.
Question 4: Does the proposed standard provide sufficient guidance to actuaries working with models?	
Comment	Several commentators suggested that simpler models be exempted from full application of the guidance.
Response	The reviewers agree and have excluded simple models from the scope of this standard.
Comment	Several commentators suggested that the ASOP should be less prescriptive, or at least not more prescriptive.
Response	The reviewers have narrowed the scope and believe that the guidance is appropriate within that revised scope.

Comment	Several commentators stated that once the applicability of the guidance is clear, the standard provides sufficient guidance. Several commentators suggested specific concerns and improvements.
Response	The reviewers have revised and clarified the guidance in several sections as cataloged below.
SECTION 1. PURPOSE, SCOPE, CROSS REFERENCES, AND EFFECTIVE DATE	
Section 1.2, Scope	
Comment	Several commentators were concerned with the wide scope of the standard, driven by the wide definition of "model."
Response	The reviewers agree and narrowed the scope.
Comment	Several commentators were concerned with the need for the actuary to decide applicability of the standard in specific situations, leading to sections that sound optional. One commentator believes that once applicability is decided, none of the rest of the guidance in the standard should involve any options to reflect additional professional judgment.
Response	The reviewers modified the language in this section and section 3.1 to clarify the applicability of the guidance.
Comment	One commentator wanted more specific guidance comparing the scope of this standard and ASOP No. 38, *Using Models Outside the Actuary's Area of Expertise (Property and Casualty)*.
Response	The reviewers considered the working draft of the revision of ASOP No. 38 in developing the scope of this proposed *Modeling* ASOP.
Comment	One commentator questioned the need for the third paragraph under scope.
Response	The reviewers note that the third paragraph is a standard paragraph common to most standards, believe that the guidance is appropriate, and made no change.
Comment	One commentator expressed confusion about the definition of "actuarial services."
Response	The reviewers note that "actuarial services" is defined in ASOP No. 1.
SECTION 2. DEFINITIONS	
Section 2.1, Assumptions	
Comment	Several commentators indicated that they use the same terms as the defined terms, but with different meanings.
Response	The reviewers have defined the terms as intended to be understood in the guidance provided in the standard and made no change.
Comment	One commentator suggested that information required to be used by law should be defined as "data" rather than "assumptions."
Response	The reviewers disagree and made no change. The reviewers note that the term "prescribed assumption" is the term used in several standards.
Section 2.2, Data	
Comment	One commentator suggested that a more appropriate definition of "data" would be "facts or information that comprise or inform the selection of model input; data may be collected from sources such as records, experience, experiments, surveys, or observations."
Response	The reviewers agree and clarified the language.

Comment	One commentator suggested expanding the definition of "data" to include "output from other models."
Response	The reviewers agree and made the change.
Section 2.3, Granularity	
Comment	One commentator said that the definition of granularity fails to mention that an important drawback of granularity is that a more granular model may be less accurate.
Response	The reviewers have simplified the definition to address this issue.
Section 2.4, Implementation	
Comment	One commentator asked whether the use of "executable" was meant to imply that any "implementation" must be a piece of software.
Response	The reviewers believe the definition is appropriate and made no change.
Comment	One commentator uses the word "implementation" more broadly within an organization, including socialization, training, and measurements of success.
Response	The reviewers believe the definition is appropriate and made no change.
Section 2.5, Input	
Comment	One commentator suggested that confusion could occur with the use of "model input."
Response	The reviewers agree and changed the standard to use only the term "input."
Section 2.6, Intended Application	
Comment	One commentator noted that the word "designer" used in the definition of intended application was not used elsewhere in the document.
Response	The reviewers removed the definition to improve clarity.
Section 2.7, Intended Purpose (now section 2.6)	
Comment	In response to the question posed in the cover letter, several commentators said that the definitions for intended purpose, intended application and project objective were confusing.
Response	The reviewers agree and simplified the standard to use "intended purpose" alone.
Section 2.8, Model (now section 2.7)	
Comment	One commentator suggested finding a narrower definition of "model" that would makes it naturally a subpart of actuarial work rather than a broader "model" that might be of use to non-actuaries outside of providing actuarial services.
Response	The reviewers believe a broad definition of "model" is appropriate because section 1.1 and section 1.2 of the standard limits the application of the standard to actuarial services.
Comment	Several commentators suggested alternative definitions of "model."
Response	The reviewers agree that there are several alternatives that have merit, and have used the suggestions to revise the definition and improve understanding of the guidance.
Comment	One commentator suggested adding some examples of what would be a model.
Response	The reviewers believe the list would need to be extensive and may cause more confusion, and made no change.

Comment	One commentator suggested adding to the definition of model "A model may contain model components (i.e. nested models) that are also models, e.g., stochastic loss reserve estimation within an economic capital model."
Response	The reviewers agree and modified the language defining "model" and "data."
Section 2.9, Modeling (now section 2.8)	
Comment	One commentator suggested that the definition of "modeling," rather than just citing "modifying" or "using", ought to explicitly include "maintaining" or "periodically updating" a model that is used for financial reporting subject to a high degree of model governance and controls.
Response	The reviewers believe that the guidance is sufficient and, therefore, made no change in the definition but added a sentence to section 3.4.1 to address this concern.
Section 2.10, Model Risk (now section 2.9)	
Comment	Several commentators suggested alternative revisions to the definition of model risk, including one that read, "The risk of adverse consequences resulting from reliance on a model that does not adequately represent that which is being modeled or that is misused or misinterpreted."
Response	The reviewers agree and adopted the suggested language above.
Section 2.11, Model Run (now section 2.10)	
Comment	Several commentators noted that the definition and use of "model run" could be improved to clarify that it includes the process as well as the actual output.
Response	The reviewers agree and modified the language in the definition.
Section 2.12, Parameters (now section 2.11)	
Comment	Several commentators suggested that certain models produce parameters as output and some suggested that the term "input" be used without reference to "parameters" and "assumptions" (and presumably "data").
Response	The reviewers agree that some models produce parameters as output but believe this fact does not affect the meaning of the definition and the guidance in the standard and, therefore, made no change.
Comment	Several commentators made suggestions regarding the definition of "parameters", and some suggested merging "parameter" with either "assumptions" or "data."
Response	The reviewers acknowledge that the distinctions can be unclear, but the guidance does not differ for "assumptions" and "parameters." Two terms are maintained because many actuaries use the terms for different types of inputs but would expect similar guidance. The standard has defined the terms as intended to be understood in the guidance provided in the standard and, therefore, the reviewers made no change.
Comment	One commentator suggested that examples of "parameter" could explicitly include pension plan provisions.
Response	The reviewers agree and added the example.

Section 2.15, Specification (now section 2.13)	
Comment	One commentator found the term "interactions" confusing because of a different statistical use of that word.
Response	The reviewers agree and revised the definition to eliminate use of the word.
SECTION 3. ANALYSIS OF ISSUES AND RECOMMENDED PRACTICES	
Comment	One commentator suggested requiring documentation of the model used (e.g., vendor and version) when the actuary is relying on a vendor model
Response	The reviewers disagree with requiring such documentation in this standard and made no change.
Comment	Two commentators stated guidance on applicability is given in sections 1.2 and 3.1. Later sections continue to suggest judgement on applicability is still needed.
Response	The reviewers modified the language in sections 1.2 and 3.1 to clarify the applicability of the guidance.
Section 3.1.1, Applicability of Guidance (now section 3.1, Application of ASOP Guidance)	
Comment	One commentator stated that an actuary is often required to give an answer in a short time period and rigorous validation is not possible. Consideration should be given that in such cases full application is not necessary.
Response	The reviewers believe that the need for professional work is especially necessary in hurried situations and that the guidance of ASOP No. 41, *Actuarial Communications*, still applies.
Comment	Several commentators suggested that in addition to "materiality," the complexity of the model should also dictate what and how much of the ASOP needs to be applied.
Response	The reviewers agree in part and revised the standard to exclude simple models.
Comment	One commentator suggested the following wording for paragraph 1: "Full application of the guidance in this ASOP is required when, based on the actuary's reasonable professional judgment, intended users of the model will rely on the results of the model to make decisions which are financially material to the Principal."
Response	The reviewers clarified the language in this section.
Comment	Several commentators stated that the examples regarding situations when full application of the guidance may not be necessary or practical were confusing or misleading.
Response	The reviewers agree and removed the examples.
Comment	One commentator stated section 3.1 on the applicability of the guidance is both clear and appropriate, but that some parts of the section seem redundant with the second paragraph of section 1.2, Scope.
Response	The reviewers agree and modified the paragraph in section 1.2.
Comment	One commentator stated that applicability should be left to the actuary's professional judgement, without consideration of materiality or the intended user's reliance on the results of the model.
Response	The reviewers disagree and, therefore, made no change.

Comment	One commentator stated that the actuary should not be able to decide whether the ASOP is applicable.
Response	The reviewers believe that the guidance is sufficient and, therefore, made no change.
Comment	Several commentators suggested deleting paragraphs four, five, and possibly six due to redundancy.
Response	The reviewers agree in part and revised the section.
Comment	One commentator suggested that the words "heavily" be removed and that "data validation" is a poor example.
Response	The reviewers agree in part and modified the section.
Comment	Several commentators suggested that determining materiality is subject to actuarial judgement and once that determination is made, the full ASOP guidance is appropriate. Several additions and deletions were suggested.
Response	The reviewers agree in part and modified the section.
Comment	One commentator suggested that the standard should require disclosure when the actuary does not apply the guidance in the standard because the actuary judges the model to be out of the scope of the standard.
Response	The reviewers agree and made the change.
Section 3.1.2, Models Developed by Others (now section 3.2)	
Comment	One commentator asked whether "making a reasonable attempt" excused the actuary from having to perform all of the other requirements.
Response	The reviewers believe that the guidance to "make a reasonable attempt to have a basic understanding of the model" is sufficiently clear and, therefore, made no change.
Comment	One commentator suggested that the guidance in this section should be excluded as it is covered by ASOP No. 38.
Response	The reviewers considered the working draft of the revision of ASOP No. 38 in developing the scope of this proposed *Modeling* ASOP.
Comment	One commentator asserted that requiring the actuary to make a reasonable attempt to reach a basic understanding of the model is not sufficient when the use of model is instrumental to performing a calculation or to a project objective. Another commentator suggested the guidance be modified to state that "it is necessary for the actuary to demonstrate a good understanding of such models…."
Response	The reviewers believe that the guidance to "make a reasonable attempt to have a basic understanding of the model" is sufficient and, therefore, made no change.
Comment	Several commentators suggested adding additional bullets to the four listed components of a basic understanding of a model. The commentator suggested adding the following: "e. the reasons to be comfortable with the continued use of the model" "f. key risks associated with using the model" "g. confirm the expertise of those who developed the model and assess the level of care that was taken in developing the model"
Response	The reviewers believe that the guidance is sufficient and, therefore, made no change.

Section 3.1.3, Role of the Actuary on a Modeling Team (now section 3.3)	
Comment	Several commentators thought the guidance was unclear given the complexity of modeling teams, varying roles and responsibilities, and cooperation between actuaries and non-actuaries on a modeling team.
Response	The reviewers modified the language, which now appears in section 3.3.
Section 3.2, Model Meeting the Intended Purpose (now section 3.4)	
Comment	In the second sentence, one commentator felt that the word "confirm" might not reflect the approximate nature of models and suggested that the word "confirm" be replaced with the words "confirm the reasonableness." Another commentator suggested that the word "reasonably" be added.
Response	The reviewers agree and revised the language.
Comment	One commentator suggested the use of "fits" or "suits" in place of "meets" the intended purpose.
Response	The reviewers believe that the use of the term "meet" with reference to "intended purpose" is widely used and sufficiently clear, and made no change.
Comment	One commentator suggested a clearer distinction between creating new models and modifying existing models be present in both headers and in the text in section 3.2.1 and section 3.2.2.
Response	The reviewers disagree and made no change.
Section 3.2.1, Designing, Building, Developing, Reviewing, or Evaluating the Model for the Intended Application (now section 3.4.1, Designing, Building, Developing, Reviewing, or Evaluating the Model for the Intended Purpose)	
Comment	One commentator suggested changing "should consider" to "could consider," given the broad scope of standard.
Response	The reviewers believe that the guidance, in conjunction with ASOP No. 1, is appropriate and made no change.
Comment	One commentator believed that for clarity it would be more accurate to change the last phrase from "the model's ability to identify possible volatility around expected values" to "the model's volatility around the expected values."
Response	The reviewers believe the examples in the guidance are appropriate because they are all determinable in advance of actually building or running the model and made no change.
Comment	One commentator suggested adding "maintaining" or "periodically updating" in this section as a requirement for appropriate design.
Response	The reviewers clarified the language by stating that the actuary may consider, when appropriate, whether the model can be conveniently updated for anticipated changes in data, parameters, or assumptions.
Section 3.2.2, Selecting, Reviewing, Evaluating, or Using the Model for the Project Objective (now section 3.4.2, Selecting or Using the Model for the Intended Purpose)	
Comment	One commentator suggested including "validation" in section 2 as a defined term for modeling, perhaps referring to the use of the term in section 3.3.1, as the definition.
Response	The reviewers believe that the meaning of the term "validation" is broadly understood and, therefore, made no change.

Section 3.2.3, Modifying the Model (now section 3.4.3, Reviewing, Evaluating, or Modifying the Model)	
Comment	Two commentators suggested that section 3.2.3 be incorporated into sections 3.2.1 and 3.2.2.
Response	The reviewers disagree with the commentators' suggestion to fold the guidance into other sections, but added "reviewing and evaluating" to improve clarity.
Comment	One commentator requested clarification for when modifying a model would cause the model to deviate from its intended application, thus resulting in a "new model."
Response	The reviewers have clarified the language related to consideration of a model's intended purpose.
Section 3.2.5, Model Structure (now section 3.4.5)	
Comment	One commentator suggested defining "model structure" in section 2. Possible examples include the model type (multiple scenarios vs one scenario), the model aggregation level, the presentation of model results (average versus median versus 99th percentile), and the choice of computing methodology (distributed database versus unitary system).
Response	The reviewers believe that the term "model structure" is broadly understood and that the guidance is clear and, therefore, made no further change.
Comment	One commentator asked, in the context of predictive modeling in section 3.2.5(b), whether it is appropriate to interpret that the grouping can be both by rows, e.g., binning, missing imputation and by columns, e.g., principal component analysis.
Response	The reviewers believe that level of detail is beyond the scope of this proposed ASOP and, therefore, made no change.
Comment	One commentator suggested that the actuary should be required to ensure that the accuracy of the model is not compromised by the input grouping methodology selected, as discussed in section 3.2.5(b).
Response	The reviewers believe the guidance is appropriate and made no change.
Comment	Two commentators asked whether the guidance in section 3.2.5(b) was seeking a particular level of granularity, or simply to verify that the particular level of granularity is appropriate.
Response	The reviewers agree that the section was not clear and combined the guidance in sections 3.2.5(b) and 3.2.5(c) to make it clearer.
Comment	One commentator suggested the words "where applicable" need to be added when discussing the individual considerations, such as in section 3.2.5(d), which would only apply where stochastic approaches are available.
Response	The reviewers note that the list in this section does follow the words "where applicable" and made no change.
Comment	Several commentators asked for more clarity in section 3.2.5(e).
Response	The reviewers revised the language in this section to make it clearer.
Comment	One commentator was concerned that section 3.2.5(e) might seem to require the model to handle all possible choices and options.
Response	The reviewers agree and added the language "where the options could have a material effect."

Comment	One commentator suggested that section 3.2.5(e) should be expanded to explicitly state that if such options and choices could materially affect results, the ability of the model structure to reflect those options and choices and any other mitigating action that the entity could reasonably pursue should be evaluated.
Response	The reviewers agree in part and added the language "where the options could have a material effect."
Comment	One commentator indicated that section 3.2.5(e) is true for almost all situations and could be removed.
Response	The reviewers believe the guidance is appropriate and made no change.
Section 3.2.7, Assumptions and Parameters (now section 3.4.7)	
Comment	One commentator suggested that section 3.2.7 be combined with section 3.2.6, addressing only "inputs" and not specific reference to "assumptions" and "parameters."
Response	The reviewers believe that the guidance is appropriate and made no further change.
Comment	One commentator suggested that there should probably be more guidance with regard to the need to verify the relevance of actual experience when assumptions and parameters are based upon it.
Response	The reviewers believe that the guidance in section 3.2.7(a) is appropriate and that no additional guidance is necessary. Therefore, the reviewers made no change.
Comment	Two commentators suggested a definition of "margin" would be helpful.
Response	The reviewers believe that the use of "margin" is clear in the context of the examples given and do not believe defining "margin" would improve clarity. Therefore, the reviewers made no change.
Comment	One commentator suggested using alternative terms for "conservatism," "conservative," and "optimistic" in sections 3.2.7(b) and 3.4.4.
Response	The reviewers disagree and made no change.
Comment	One commentator expressed concern that section 3.2.7(b) gives the actuary authority to include a margin or not to include a margin based solely on their professional judgment and preference.
Response	The reviewers disagree and did not make a change in response to this comment.
Comment	Two commentators were concerned that the words "should determine" might require actuaries to investigate adding margins to assumptions, which they did not think was always necessary.
Response	The reviewers agree and changed "should determine" to "should consider."
Comment	One commentator suggested that margins could also be applied to data.
Response	The reviewers believe that the guidance does not prohibit adding margins to data in appropriate circumstances and, therefore, made no change.

Comment	One commentator noted that the specific statement "a margin might be included [because] the experience data are not fully credible" seems out of place in this ASOP since ASOP No. 25, *Credibility Procedures*, recommends many things one might use as "relevant experience" in the presence of data ("subject experience") that are not fully credible, but none of those things include a margin.
Response	The reviewers agree and modified the language to avoid confusion, replacing the reference to "credible" with "reliable."
Comment	One commentator suggested clarifying that "consistency" refers to a given "model run."
Response	The reviewers agree and modified the language.
Comment	One commentator suggested there was a need for guidance regarding consistency between the way assumptions are derived from experience studies and how the assumptions are used in the model.
Response	The reviewers believe such guidance would be beyond the scope of this standard.
Comment	One commentator suggested that section 3.2.7(d) would also need to be modified to treat parameters that are required by law to be "data" rather than "assumptions."
Response	The reviewers believe that the guidance is appropriate and, therefore, made no change, except to change "assumptions prescribed by applicable law" to "assumptions and parameters prescribed by applicable law."
Comment	One commentator noted that for complex models, it may be extremely difficult and/or time consuming to ascertain that there is no inconsistency across all the inputs, and suggested this section should require the actuary to take "reasonable and appropriate steps" to ensure consistency to the extent possible. Another commentator suggested the use of "not internally inconsistent," to be consistent with ASOP No. 43, *Property/Casualty Unpaid Claim Estimates*.
Response	The reviewers agree and modified the language to use the term "reasonably consistent" to better communicate the intended guidance.
Comment	One commentator suggested that the example in section 3.2.7(e) referring to "financial reporting" should delete the word "frequent" or should insert "for insurance companies," given that models used in financial reporting for pension plans "do not offer frequent opportunities to compare assumptions and parameters to emerging experience."
Response	The reviewers agree and modified the language.
Section 3.3, Mitigation of Model Risk (now section 3.5)	
Comment	One commentator suggested that the ASOP should state that the section on mitigation of model risk is not "very applicable" to the use of models developed by others.
Response	The reviewers disagree and made no change.
Comment	Two commentators suggested mentioning specific testing techniques such as out-of-sample testing.
Response	The reviewers note that there are many types of useful techniques for validating particular types of models, and made no change.

Section 3.3.1, Validation (now section 3.5.1)	
Comment	One commentator believed that the degree of validation required for a new run of an existing model should be less than the degree of validation required for a new model, and asked whether the "set of model runs" might be understood to refer to thousands of rating runs, assuming appropriate governance and controls to maintain model integrity.
Response	The reviewers clarified the guidance by adding the word "reasonably" and by clarifying that a set of model runs can be done over time with repetitive use of the same model.
Comment	One commentator suggested validation should be addressed separately for the specifications, implementation and realization components of the model within this section. The commentator further discussed possible changes in the examples.
Response	The reviewers note the examples in sections 3.3.1(a)(1)-(3) are only meant to be illustrative.
Comment	One commentator noted the use of the word "data" in section 3.3.1(a) is inconsistent with the definition in section 2.2.
Response	The reviewers revised the definition of "data" in section 2.2 and replaced the word "data" in this section with "information."
Comment	One commentator noted in section 3.3.1(a) that requiring that "the model properly represents that which is being modeled" may not recognize that models will always be imperfect representations of reality. The commentator suggested using the words "the model represents the phenomenon being modeled with a degree of comparability that is sufficient given the intended purpose of the model."
Response	The reviewers clarified the language by replacing the word "properly" with "reasonably."
Comment	One commentator noted that there could be distinctions between "raw data" vs. "input data" or "ungrouped data" vs. "grouped data."
Response	The reviewers have clarified the definition of "data" in section 2.2 and believe the guidance is now clearer.
Comment	Most, but not all, commentators on section 3.3.1(a)(2) stated that guidance would be clearer if only "intended purpose" were used, instead of using both "intended application" and "project objective" for different phases of modeling.
Response	The reviewers agree and made the change.
Comment	One commentator suggested replacing "checking formulas, logic, and table references. The degree of checking…" with "validating model results. The degree of validation...."
Response	The reviewers disagree and note that this section focuses on "formula and logic" whereas section 3.3.1(a)(3) focuses on "model results."
Comment	One commentator suggested that the concept within section 3.3.1(a)(2) referring to the degree of checking that is appropriate be applied to all three aspects of 3.3.1(a), while adding that the degree of reconciliation, checking and testing will also depend on the available resources and the anticipated impact on the model results of a change in what is being validated.
Response	The reviewers agree with the broader application part of the suggestion, and revised the text accordingly, but did not agree with the additional items on which the degree of effort would be made dependent, and did not add such items.

Comment	One commentator on section 3.3.1(a)(2) suggested that "the context and nature of the model" was implicit in "intended purpose" and could be deleted.
Response	The reviewers disagree and, therefore, made no change.
Comment	One commentator on section 3.3.1(a)(3) noted that testing the model projection results against historical actual results is useful only if the inputs to the model are consistent with the conditions prevailing during the historical period under review. Additional model runs may be necessary for purposes of such a test.
Response	The reviewers agree and revised the wording.
Comment	One commentator suggested that "testing the model projection results" was an approach to "analyzing the output," and more properly belonged in section 3.3.1(b).
Response	The reviewers disagree and, therefore, did not change the text.
Comment	One commentator on section 3.3.1(a) suggested adding a statement as a new section 3.3.1(a)(4) in regards to convergence testing, such as: "where applicable, testing the model projection results for convergence, noting the sensitivity to the selection of the number of simulations."
Response	The reviewers believe the level of guidance is appropriate and made no change.
Comment	One commentator suggested that sections 3.3.1(b)(2) and 3.3.1(b)(3) could be viewed as examples covered by a broad reading of section 3.3.1(b)(1).
Response	The reviewers believe that the guidance in 3.3.1(b)(2) and (3) is helpful and distinct from 3.3.1(b)(1) and, therefore, did not delete these sections or combine them with 3.3.1(b)(1).
Comment	One commentator suggested that the guidance in section 3.3.1(b)(3) was not clear and suggested the sentence would be improved if the language "that the model has been used correctly, and " was deleted.
Response	The reviewers agree and made the change.
Comment	One commentator was concerned that the phrase in section 3.3.1(b)(4) could require that significant additional work might be appropriate to compare results of various models, which can be extremely labor intensive and expensive, and that this step should be qualified to be subject to limitations of the scope of the assignment or appropriateness in the actuary's professional judgment.
Response	The reviewers agree in part and added the words "where appropriate."
Comment	Two commentators suggested that the standard should describe the circumstances where peer review is critical to a professional work product and should state that peer review is required to generate a helpful result.
Response	The reviewers believe the guidance is appropriate and made no change.
Comment	One commentator suggested that in section 3.3.1(c) either "should consider" or "where practical and appropriate" be deleted.
Response	The reviewers agree in part and deleted the words "practical and."

Comment	One commentator asked, with respect to section 3.3.1(c), whether the guidance regarding peer review should be in ASOP No. 1, in a generic ASOP, or in nearly all ASOPs.
Response	The reviewers note that because ASOP No. 1 does not currently discuss peer review, the guidance in this standard was retained.
Section 3.4, Presentation of Results (now section 3.6)	
Comment	One commentator suggested expanding "…since the most recent comparable model results were communicated." to "…since the most recent comparable model results communicated by or provided to the actuary for review."
Response	The reviewers disagree and made no change in response to this comment.
Comment	Several commentators suggested that this section is overly onerous, noting that requiring the actuary to explain methodology, assumptions and parameters (i.e. inputs), limitations, and material changes whenever the actuary presents model results is unrealistic in some situations. One commentator also noted that ASOP No. 41 already addresses communication.
Response	The reviewers clarified the guidance and added a reference to ASOP No. 41.
Section 3.4.1, Explanation of Limitations of Models (now section 3.6.1)	
Comment	Several commentators suggested inserting the word "known" before "material limitations."
Response	The reviewers agree and made the change.
Section 3.4.2, Discussion of Models (now section 3.6.2)	
Comment	One commentator thought describing "any uncertainty in model results" is far too broad and ambiguous.
Response	The reviewers agree and added "significant" before "uncertainty."
Comment	One commentator thought this section belonged in section 4.
Response	The reviewers believe that the placement of the guidance is appropriate and made a reference to this section in section 4.
Section 3.4.3, Reconciliation (now section 3.6.3, Comparison to Prior Reports)	
Comment	One commentator suggested adding "as applicable depending on the type of the model."
Response	The reviewers agree and modified the language.
Section 3.4.4, Description of Conservatism or Optimism (now section 3.6.4)	
Comment	One commentator suggested adding "as applicable depending on the type of the model."
Response	The reviewers agree and modified the language.
Comment	Two commentators suggested terms such as "conservative" and "optimistic" are undefined and can lead to confusion.
Response	The reviewers believe this is addressed in the guidance and made no change.
Comment	One commentator believes this paragraph implies the actuary has the authority to add conservatism even when not consistent with the project objective.
Response	The reviewers disagree and believe the guidance is clear, and made no change.

Comment	One commentator thought the last sentence is unclear if applicable law specifies some but not all of the model inputs or methodology.
Response	The reviewers agree and modified the guidance.
Section 3.5, Reliance on Data or Other Information Supplied by Others (now section 3.7)	
Comment	One commentator noted that this paragraph appears to suggest that relying on projections or analyses supplied by others (or using a model developed by others that is outside their expertise) is equivalent to relying on data provided by others, thus potentially requiring a rewrite of ASOP No. 23, *Data Quality*, and reference in section 3.1.2.
Response	The reviewers clarified the guidance by replacing "projections or supporting analysis" with "outputs from other models."
Section 3.6, Documentation (now section 3.8)	
Comment	One commentator suggested that documentation of material assumptions and parameters seems inappropriate when using a model supplied by others, believing users would be satisfied with just identification of the model used plus the switches applied in running the model (with an example being vendor, version, and one switch). Another commentator suggested adding a documentation requirement of vendor and version when relying on a vendor model.
Response	The reviewers believe the guidance is appropriate, and made no change except to add the sentence, "The actuary may consider documenting items mentioned in sections 3.1-3.7 that the actuary believes may be helpful to subsequent users."
Comment	One commentator stated that, while this section focuses on documentation needed when model results are used in actuarial communications, with a further consideration of sections 3.4.1 and 3.4.2, even when no report is written, the ASOP should also address documenting that the model is suited to its intended purpose, including what work was done to validate the model and mitigate model risk. Another commentator believes the guidance regarding documentation in section 3.6 should be more robust and broader to include the other aspects of section 3.
Response	The reviewers believe that guidance that suggests that the actuary "may consider" other documentation is appropriate, and made no change except to add the sentence, "The actuary may consider documenting items mentioned in sections 3.1-3.7 that the actuary believes may be helpful to subsequent users."
Section 3.7, Relation to Other ASOPs (now section 3.9)	
Comment	One commentator noted that meaningful guidance on modeling is already provided in other ASOPs and that this standard is, therefore, not necessary.
Response	The reviewers agree that guidance regarding aspects of modeling is also included in other ASOPs. However, this ASOP provides guidance regarding aspects of modeling that are not addressed in other ASOPs.

Comment	One commentator noted that to the extent this ASOP adds guidance supplementary to existing standards, the supplementary guidance may require the actuary only to make a "reasonable attempt" in the context of section 3.1.2.
Response	The reviewers believe the guidance is clear that the ASOP applies only to the extent it does not conflict with existing more specific standards, and made no change.
Comment	One commentator asked if ASOP No. 1 duplicates section 3.7.
Response	The reviewers believe the guidance is clear and appropriate, and made no change.
SECTION 4. COMMUNICATIONS AND DISCLOSURES	
Section 4.1.2, Inconsistent Assumptions and Parameters (now section 4.2.3)	
Comment	Two commentators were concerned that requiring disclosure of unknown inconsistencies would not be appropriate or feasible.
Response	The reviewers modified section 3.2.7(d) and, therefore, believe the guidance in section 4.1.2 is appropriate and made no change.
Comment	Two commentators suggested that disclosing material inconsistencies or limitations in the model to nontechnical audiences may cause more harm than benefit, and that the section should be modified to clarify that the amount of disclosure should depend upon the intended audience.
Response	The reviewers believe that the guidance is appropriate and, therefore, made no change.