



ACTUARIAL STANDARDS BOARD

**Actuarial Standard
of Practice
No. 38**

Revised Edition

**Catastrophe Modeling
(for All Practice Areas)**

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

**Adopted by the
Actuarial Standards Board
July 2021**

Doc. No. 201

TABLE OF CONTENTS

Transmittal Memorandum	iv
Section 1. Purpose, Scope, Cross References, and Effective Date	1
1.1 Purpose	1
1.2 Scope	1
1.3 Cross References	2
1.4 Effective Date	2
Section 2. Definitions	2
2.1 Assumptions	2
2.2 Catastrophe Model	2
2.3 Data	2
2.4 Expert	2
2.5 Input	2
2.6 Intended Purpose	2
2.7 Model	3
2.8 Output	3
2.9 Parameter	3
Section 3. Analysis of Issues and Recommended Practices	3
3.1 Introduction	3
3.2 Catastrophe Models Developed by Experts	3
3.3 Understanding of the Catastrophe Model	4
3.3.1 Catastrophe Model Components	4
3.3.2 User Input	4
3.3.3 Catastrophe Model Output	4
3.4 Appropriateness of the Catastrophe Model for the Intended Purpose	4
3.4.1 Applicability of Historical Data	5
3.4.2 Developments in Relevant Fields	5
3.5 Output Validation	5
3.6 Appropriate Use of the Catastrophe Model and Output	5
3.7 Reliance on Another Actuary	5
3.8 Reliance on Data or Other Information Supplied by Others	6
3.9 Documentation	6
Section 4. Communications and Disclosures	6
4.1 Required Disclosures in an Actuarial Report	6
4.2 Additional Disclosures in an Actuarial Report	6
4.3 Confidential Information	7

APPENDIXES

Appendix 1—Background and Current Practices	8
Background	8

ASOP No. 38—Doc. No. 201

Current Practices	8
Appendix 2—Comments on the Exposure Draft and Responses	9

ASOP No. 38—Doc. No. 201

July 2021

TO: Members of Actuarial Organizations Governed by the Standards of Practice of the Actuarial Standards Board and Other Persons Interested in Catastrophe Modeling (for All Practice Areas)

FROM: Actuarial Standards Board (ASB)

SUBJ: Actuarial Standard of Practice (ASOP) No. 38

This document contains the revision of ASOP No. 38, *Catastrophe Modeling (for All Practice Areas)*.

History of the Standard

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 the actuary would have to rely on a model that was developed by professionals other than actuaries. As a result of this work, the ASB approved ASOP No. 38, *Using Models Outside the Actuary's Area of Expertise*, in June 2000 with the scope of the standard limited to the Property/Casualty area of practice. At the time, this was the only ASOP that specifically addresses modeling.

Over the ensuing years, 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 2012, a discussion draft titled *Modeling in Life Insurance and Annuities* was released. Nineteen comment letters were received.

Based upon this feedback and numerous other discussions on the topic of modeling, in December 2012 the ASB created two multidisciplinary 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 Task Force to consider expanding ASOP No. 38 to all practice areas while focusing exclusively on using catastrophe models.

An exposure draft titled *Modeling* was released in June 2013 with a scope that provides guidance to actuaries when selecting, designing, building, modifying, developing, or using models when performing actuarial services. ASOP No. 56, *Modeling*, was adopted by the ASB in December 2019. Changes have been made to this exposure draft of ASOP No. 38 to be consistent with ASOP No. 56 and other recent ASOPs.

The exposure draft of this revision of ASOP No. 38 was the work of the Catastrophe Modeling Task Force, whose membership has experience in life insurance, health insurance, property/casualty insurance, and enterprise risk management.

ASOP No. 38—Doc. No. 201

At the direction of the ASB, this standard was developed to apply to all practice areas and all forms of catastrophe models, including natural catastrophes such as hurricanes, earthquakes, and severe convective storms, and other catastrophes such as terrorist acts and pandemics.

Exposure Draft

The exposure draft was approved in September 2020 with a comment deadline of January 15, 2021. Four comment letters were received and considered in making changes that were reflected in the final ASOP.

Notable Changes from the Exposure Draft

Notable changes made to the exposure draft are summarized below. Additional changes were made to improve readability, clarity, or consistency.

1. Section 1.2, Scope, was revised to provide additional guidance to actuaries whose actuarial services involve reviewing or evaluating models.
2. In section 2, Definitions, the definition of “catastrophe model” was expanded to include a definition of model.
3. Section 3.2, Appropriate Reliance on Experts (now titled Catastrophe Models Developed by Experts), was revised to adopt language from ASOP No. 56, section 3.5(b).
4. An existing ASOP No. 38 example regarding validation to evaluate results derived from other models was reinserted into section 3.5.
5. A disclosure requirement for the extent of reliance on experts was added to section 4.1(b) and (c).

Notable Changes from the Existing ASOP

A cumulative summary of the notable changes from the existing ASOP are summarized below. Notable changes do not include additional changes made to improve readability, clarity, or consistency.

1. The ASOP was revised to apply to catastrophe models only and to all practice areas.
2. The scope was expanded to include the activities “selecting, reviewing, and evaluating” models in addition to the existing activity of “using” a model when performing actuarial services.
3. The scope was expanded to clarify that if the actuary determines that the guidance in the ASOP conflicts with the guidance in ASOP No. 56, the guidance of this ASOP will govern.

ASOP No. 38—Doc. No. 201

4. A new section specifically addressing reliance on data or other information supplied by others (section 3.8) was added.
5. The guidance on documentation (section 3.9) was updated and expanded to be consistent with current ASOPs.

The ASB thanks everyone who took the time to contribute comments and suggestions on the exposure draft.

The ASB would like to posthumously thank Martin M. Simons for his contribution to the ASOP No. 38 task force.

The ASB voted in July 2021 to adopt this standard.

ASOP No. 38—Doc. No. 201

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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.

ACTUARIAL STANDARD OF PRACTICE NO. 38

**CATASTROPHE MODELING
(FOR ALL PRACTICE AREAS)**

STANDARD OF PRACTICE

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

- 1.1 **Purpose**—This actuarial standard of practice (ASOP or standard) provides guidance to actuaries when performing actuarial services with respect to selecting, using, reviewing, or evaluating **catastrophe models**.
- 1.2 **Scope**—This ASOP applies to actuaries in any practice area when performing actuarial services with respect to selecting, using, reviewing, or evaluating **catastrophe models** to assess risk, including but not limited to **models** of hurricanes, earthquakes, severe convective storms, terrorist acts, and pandemics. This standard applies to the selection, use, review, or evaluation of **catastrophe models**, whether or not they are proprietary in nature.

If the actuary's actuarial services involve reviewing or evaluating **catastrophe models**, the reviewing or evaluating actuary should apply the guidance in this standard to the extent practicable within the scope of the actuary's assignment.

In addition to this standard, the actuary should follow the guidance in ASOP No. 56, *Modeling*, when selecting, using, reviewing, or evaluating **catastrophe models**. If the actuary determines that the guidance in this ASOP conflicts with the guidance in ASOP No. 56, the guidance of this ASOP will govern.

This standard does not apply to **models** of operational risks. This standard also does not apply to **models** of economic risks that deal with instances of extreme events such as hyperinflation or a stock market collapse.

This standard also does not apply when the actuary is only designing, developing, or modifying a **catastrophe model** (or a portion of a **catastrophe model**).

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. If a conflict exists between this standard and applicable law, the actuary should comply with applicable law.

ASOP No. 38—Doc. No. 201

- 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 standard is effective for work performed on or after December 1, 2021.

Section 2. Definitions

The terms below are defined for use in this actuarial standard of practice and appear in bold throughout the ASOP.

- 2.1 Assumption—A type of explicit **input** to a **catastrophe model** that is derived from **data**, represents possibilities based on professional judgment, or may be prescribed by law or others. When derived from **data**, an **assumption** may be statistical, financial, economic, mathematical, or scientific in nature, and may be described as a **parameter**.
- 2.2 Catastrophe Model—A **model** of low-frequency events with high-severity or widespread potential effects. **Catastrophe models** may be used to explain a system, to study effects of different components, or to derive estimates.
- 2.3 Data—Facts or information that are either direct **input** to a **catastrophe model** or inform the selection of **input**. **Data** may be collected from sources such as records, experience, experiments, surveys, observations, benefit plan or policy provisions, or **output** from other **models**.
- 2.4 Expert—One who is qualified by knowledge, skill, experience, training, or education to render an opinion concerning the matter at hand.
- 2.5 Input—**Data** or **assumptions** used in a **catastrophe model** to produce **output**.
- 2.6 Intended Purpose—The goal or question, whether generalized or specific, addressed by the **catastrophe model** within the context of the assignment.
- 2.7 Model—A simplified representation of relationships among real world variables, entities, or events using statistical, financial, economic, mathematical, non-quantitative, or scientific concepts and equations. A **model** consists of three components: an information **input** component, which delivers **data** and **assumptions** to the **model**; a processing

ASOP No. 38—Doc. No. 201

component, which transforms **input** into **output**; and a results component, which translates the **output** into useful business information.

- 2.8 Output—The results of the **catastrophe model** including, but not limited to, point estimates, likely or possible ranges, and **data** or **assumptions** (as **input** for other **models**), behavioral expectations, or qualitative criteria on which decisions could be based.
- 2.9 Parameter—A type of statistical, financial, economic, mathematical, or scientific value that is used as **input** to **catastrophe models**. Examples of **parameters** include expected values in probability distributions and coefficients of formula variables.

Section 3. Analysis of Issues and Recommended Practices

- 3.1 Introduction—In performing actuarial services, the actuary may find it appropriate to select, use, review, or evaluate **catastrophe models**. When selecting, using, reviewing or evaluating a **catastrophe model**, the actuary should do the following:
- a. determine the appropriate level of reliance on **experts**;
 - b. have a basic understanding of the **catastrophe model**;
 - c. evaluate whether the **catastrophe model** is appropriate for the **intended purpose**;
 - d. determine that appropriate validation of the **catastrophe model** and **output** has occurred; and
 - e. determine the appropriate use of the **catastrophe model** and **output**.

The actuary's level of effort in understanding and evaluating a **catastrophe model** should be consistent with the **intended purpose** and the **catastrophe model output's** materiality to the results of the actuarial analysis.

- 3.2 Catastrophe Models Developed by Experts—When selecting, using, reviewing, or evaluating a **catastrophe model** developed by **experts**, the actuary should take into account the following:
- a. whether the individual or individuals who developed the **catastrophe model** are **experts** in the applicable field;
 - b. the extent to which the **catastrophe model** has been reviewed or validated by **experts** in the applicable field, including known differences of opinion among

ASOP No. 38—Doc. No. 201

experts concerning aspects of the **catastrophe model** that could be material to the actuary's use of the **catastrophe model**; and

- c. whether there are industry or regulatory standards that apply to the **catastrophe model** or to the testing or validation of the **catastrophe model**, and whether the **catastrophe model** has been certified as having met such standards.

The actuary may rely on **experts** in the applicable field in the evaluation of items in section 3.2(a)-(c) and should disclose the extent of such reliance.

- 3.3 Understanding of the Catastrophe Model—The actuary should be familiar with the basic components of the **catastrophe model** and understand both the user **input** and the **catastrophe model output**, as discussed below.

- 3.3.1 Catastrophe Model Components—The actuary should be familiar with the basic components of the **catastrophe model** and have an understanding of how such components interrelate within the **catastrophe model**. In addition, the actuary should identify which fields of expertise were used in developing or updating the **catastrophe model** and should make a reasonable effort to determine if the **catastrophe model** is based on generally accepted practices within the applicable fields of expertise. The actuary should also be familiar with how the **catastrophe model** was tested or validated and the level of independent **expert** review and testing.

- 3.3.2 User Input—The actuary should take reasonable steps to confirm that the precision and accuracy of the user **input** are consistent with the **intended purpose** and should refer, as applicable, to ASOP No. 23, *Data Quality*, when selecting, using, or evaluating **data** used in the **catastrophe model**. Certain user **input** may be required to produce **catastrophe model output** for the specific application. User **input** can include **assumptions** or **data**. If the **catastrophe model** requires user **input**, the actuary should evaluate the reasonableness of the user **input** and should have an understanding of the relationship between the user **input** and **catastrophe model output**.

- 3.3.3 Catastrophe Model Output—The actuary should determine that the **catastrophe model output** is consistent with the **intended purpose**.

- 3.4 Appropriateness of the Catastrophe Model for the Intended Purpose—The actuary should evaluate whether the **catastrophe model** is appropriate for the **intended purpose** and take into account the following:

ASOP No. 38—Doc. No. 201

- 3.4.1. **Applicability of Historical Data**—To the extent historical **data** are used in the development of the **catastrophe model** or the establishment of **catastrophe model parameters**, the actuary should take into account the adequacy of the historical **data** in representing the range of reasonably expected outcomes consistent with current knowledge about the phenomena being analyzed.
- 3.4.2. **Developments in Relevant Fields**—The actuary should make a reasonable effort to be aware of significant developments in relevant fields of expertise that are likely to materially affect the **catastrophe model**.
- 3.5 **Output Validation**— The actuary should validate that the **output** reasonably represents that which is being modeled. Depending on the **intended purpose**, **output** validation may include the following:
- a. comparing **output** to those of an alternative **model(s)**, where appropriate;
 - b. comparing the **output** produced by the **catastrophe model** with historical observations, if applicable;
 - c. comparing the consistency and reasonableness of relationships within the **output**; and
 - d. evaluating the reasonableness of changes in the **output** due to variations in the user **input**.
- 3.6 **Appropriate Use of the Catastrophe Model and Output**—The actuary should evaluate the reasonableness of the **catastrophe model output**, considering the **input** and the **intended purpose**. The actuary should take into account the limitations of the **catastrophe model** and use professional judgment to determine whether it is appropriate to use the **catastrophe model output**. The actuary should also use professional judgment to determine whether any adjustments to the **catastrophe model output** are needed to meet the **intended purpose**. The actuary should disclose any such adjustments in accordance with section 4.1.
- 3.7 **Reliance on Another Actuary**—The actuary may rely on another actuary who has selected, used, reviewed, or evaluated the **catastrophe model**. However, the relying actuary should be reasonably satisfied that the other actuary is qualified to select, use, review, or evaluate the **catastrophe model** in accordance with applicable ASOPs, and the **catastrophe model** is appropriate for the **intended purpose**. The actuary should disclose the extent of any such reliance.

ASOP No. 38—Doc. No. 201

- 3.8 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 No. 23 and ASOP No. 41, *Actuarial Communications*, for guidance.
- 3.9 Documentation—The actuary should consider preparing and retaining documentation to support compliance with the requirements of section 3 and the disclosure requirements of section 4. If preparing documentation, the actuary should prepare such documentation in a form such that another actuary qualified in the same practice area could assess the reasonableness of the actuary's work and should document the steps taken to comply with this standard in light of proprietary aspects of the **catastrophe model**, if any. The degree of such documentation should be based on the professional judgment of the actuary and may vary with the complexity and purpose of the actuarial services. In addition, the actuary should refer to ASOP No. 41 for guidance related to the retention of file material other than that which is to be disclosed under section 4.

Section 4. Communications and Disclosures

- 4.1 Required Disclosures in an Actuarial Report—When issuing an actuarial report to which this standard applies, the actuary should refer to ASOP Nos. 23, 41, and 56. In addition, the actuary should disclose the following in such actuarial reports, as appropriate:
- a. the **catastrophe model** used and the **intended purpose**;
 - b. the methodology used to validate the **catastrophe model** developed by **experts** (see section 3.2);
 - c. the extent of reliance on **experts** (see section 3.2);
 - d. a description of the user **input** that was incorporated into the **catastrophe model** (see section 3.3.2);
 - e. a description of adjustments made to the **catastrophe model output** (see section 3.6); and
 - f. the extent of any reliance placed upon the work of another actuary (see section 3.7).
- 4.2 Additional Disclosures in an Actuarial Report—The actuary also should include disclosures in accordance with ASOP No. 41 in an actuarial report for the following circumstances:
- a. if any material **assumption** or method was prescribed by applicable law;

ASOP No. 38—Doc. No. 201

- b. if the actuary states reliance on other sources and thereby disclaims responsibility for any material **assumption** or method selected by a party other than the actuary; and
 - c. if in the actuary's professional judgment, the actuary has deviated materially from the guidance of this ASOP.
- 4.3 Confidential Information—Nothing in this ASOP is intended to require the actuary to disclose confidential information.

ASOP No. 38—Doc. No. 201

Appendix 1

Background and Current Practices

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

Background

Hurricane Andrew in 1992 and the Northridge Earthquake in 1994 led actuaries involved in evaluating hurricane and earthquake exposures to recognize the severe inadequacy of the traditional, empirical actuarial methods used for ratemaking for these exposures. Recognizing the need to replace these methods, many actuaries began using stochastic computer simulation models for their actuarial analysis of hurricane and earthquake exposure. Computer simulation models had been commonly used for some time by actuaries and others for the purpose of evaluating probable maximum loss but had not been widely used for ratemaking.

Over time, the output from catastrophe models became commonly used by property/casualty actuaries in developing rates for catastrophic perils as well as many other risk management purposes.

Current Practices

Catastrophe models are now widely used by actuaries in all practice areas for risk management analyses and calculating expected losses due to hurricanes, earthquakes, and terrorist acts. More recently, catastrophe models have also been developed to simulate wildfires, severe convective storms, tsunamis, and pandemics.

In addition, due to changes in regulations and financial reporting requirements, the number and importance of modeling applications in actuarial science has increased, with the results of actuarial models often entering financial statements directly.

Lastly, due to the evolution of enterprise risk management (ERM) practices and regulations, there has been increased use of catastrophe modeling as part of insurer stress testing and risk management across all practice areas. This trend is likely to continue to evolve and heighten in light of the emergence of the novel coronavirus and the COVID-19 pandemic.

ASOP No. 38—Doc. No. 201

Appendix 2

Comments on the Exposure Draft and Responses

The exposure draft of the proposed revision of ASOP No. 38, *Catastrophe Modeling (for All Practice Areas)*, was issued in September 2020 with a comment deadline of January 15, 2021. Four 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. The ASOP No. 38 Task Force carefully considered all comments received, and the ASB reviewed (and modified, where appropriate) the changes proposed by the ASOP No. 38 Task Force and the ASB General Committee.

Summarized below are the significant issues and questions contained in the comment letters and the responses. Minor wording or punctuation changes that were suggested but not significant are not reflected in the appendix, although they may have been adopted.

The term “reviewers” in appendix 2 includes the ASOP No. 38 Task Force, the ASB General Committee, and the ASB. Also, the section numbers and titles used in appendix 2 refer to those in the exposure draft, which are then cross referenced with those in the final ASOP.

SECTION 1. PURPOSE, SCOPE, CROSS REFERENCES, AND EFFECTIVE DATE	
Section 1.2, Scope	
Comment	One commentator requested a clearer definition of what is excluded from the scope of ASOP No. 38, noting that catastrophe models can be used to infer economic impacts beyond direct claims and that novel catastrophic perils may fall into a gray area in which ASOP No. 38 may or may not apply.
Response	The reviewers believe the guidance is appropriate and made no change in response to this comment. The reviewers note that section 1.2 does not limit the reason why a catastrophe model is used to perform actuarial services or whether the catastrophe model is a mature or novel catastrophe model.
Comment	One commentator suggested that section 1.2 should state that the guidance in the standard applies to the extent practicable within the scope of the actuary’s assignment when the actuary is reviewing or evaluating a catastrophe model.
Response	The reviewers agree and made the change.
Comment	One commentator suggested that “review or evaluation” be removed from the scope of the standard or alternatively that the scope be changed to exclude an actuary performing a regulatory review.
Response	The reviewers believe the revised guidance is appropriate and made no change in response to this comment.

ASOP No. 38—Doc. No. 201

Comment	One commentator recommended that section 1.2 should state that the application of the standard be based on the actuary's professional judgement as to the materiality of the model output for the intended user.
Response	The reviewers believe the guidance is appropriate and made no change in response to this comment. The reviewers note that section 3.1 addresses materiality.
Comment	One commentator recommended that section 1.2 should state that the guidance in the standard applies only to the extent of the actuary's responsibilities and adopt the language from ASOP No. 56 section 1.2.
Response	The reviewers believe the guidance is appropriate and made no change in response to this comment.
Comment	One commentator suggested that the scope of the standard be expanded to include elements similar to ASOP No. 56.
Response	The reviewers believe the revised guidance is appropriate and made no change in response to this comment.
Comment	Several commentators questioned what constituted a conflict between ASOP No. 38 and ASOP No. 56 versus what constituted a difference and asked how potential conflicts are meant to be resolved.
Response	The reviewers believe the revised guidance is appropriate and made no change in response to this comment. The reviewers note that ASOP No. 1, <i>Introductory Standard of Practice</i> , section 4.4, states, "When an actuary believes that multiple ASOPs have conflicting provisions when applied to a specific situation and none provide explicit guidance concerning which governs, the actuary should apply professional judgment and may wish to contact the ABCD for confidential guidance on appropriate practice."
SECTION 2. DEFINITIONS	
Section 2.2, Catastrophe Model	
Comment	Two commentators suggested clarifying the definition of catastrophe model.
Response	The reviewers agree and made changes similar to those suggested by the commentators to improve clarity.
Comment	One commentator suggested a definition for "model" be added to ASOP No. 38.
Response	The reviewers agree and made the change.
SECTION 3. ANALYSIS OF ISSUES AND RECOMMENDED PRACTICES	
Section 3.1, Introduction	
Comment	One commentator suggested that the use of the term "validation" used in sections 3.1(d) and 3.5 be clarified to distinguish if the terms are being used differently.
Response	The reviewers believe the guidance is appropriate and made no change in response to this comment. The reviewers note section 3.1 introduces validation and section 3.5 provides details on the validation of catastrophe model output.

ASOP No. 38—Doc. No. 201

Section 3.2, Appropriate Reliance on Experts (now titled Catastrophe Models Developed by Experts)	
Comment	One commentator recommended changing “should consider” to “may consider” regarding the appropriate level of reliance on experts to be consistent with the corresponding language in ASOP No. 56, section 3.5.
Response	The reviewers believe the guidance is appropriate and made no change in response to this comment.
Comment	One commentator recommended changing the language in section 3.2(b) to mirror ASOP No. 56, section 3.5(b).
Response	The reviewers agree and made the change.
Comment	One commentator noted that this section, does not include the language of ASOP No. 56, section 3.5(d), which considers whether the science underlying the expertise is likely to produce useful models for the intended purpose.
Response	The reviewers believe the guidance is appropriate and made no change in response to this comment.
Comment	One commentator recommended that ASOP No. 38 be expanded to require disclosure of reliance on experts.
Response	The reviewers agree and made the change.
Comment	One commentator suggested that the ASOP be expanded to explicitly allow reliance on an expert to select, use, review, or evaluate the catastrophe model.
Response	The reviewers believe the guidance is appropriate and consistent with the suggestion, and made no change in response to this comment.
Section 3.5, Appropriate Validation (now titled Output Validation)	
Comment	One commentator requested that results derived from alternate models or methods, where available and appropriate, which is part of current ASOP No. 38, be added.
Response	The reviewers partially agree and modified the language.
Section 3.7, Reliance on Another Actuary	
Comment	One commentator suggested that ASOP No. 56 be added to the requirements for reliance on another actuary.
Response	The reviewers believe the revised guidance is appropriate and made no change in response to this comment.