ACTUARIAL STANDARDS BOARD

Actuarial Standard
of Practice
No. 56

Modeling

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

Adopted by the
Actuarial Standards Board
December 2019

Doc. No. 195

ASOP No. 56—Doc. No. 195

TABLE OF CONTENTS

APPENDIXES

ASOP No. 56—Doc. No. 195

ACTUARIAL STANDARD OF PRACTICE NO. 56

MODELING

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 designing, developing, selecting, modifying, using, reviewing, or evaluating **models**.

1.2 Scope—This standard applies to actuaries in any practice area when performing actuarial services with respect to designing, developing, selecting, modifying, or using all types of **models**. For example, an actuary using a **model** developed by others in which the actuary is responsible for the **model output** is subject to this standard.

If the actuary's actuarial services involve reviewing or evaluating **models**, the reviewing or evaluating actuary should be reasonably satisfied that the actuarial services were performed in accordance with this standard. The reviewing or evaluating actuary should apply the guidance in this standard to the extent practicable within the scope of the actuary's assignment.

The guidance in this ASOP applies to the actuary when, in the actuary's professional judgment, reliance by the **intended user** on the **model output** has a material effect for the **intended user**. This judgment should be made within the context of the use of the **model output** and the needs of the **intended user**, based on facts known by the actuary at the time the actuarial services are performed. For example, actuarial services performed in relation to pension plan contribution and cost projection **models**, insurance pricing **models**, predictive **models**, reserving **models**, and insurance company financial planning **models** may require application of the guidance in this ASOP. In assessing materiality, the actuary should be guided by ASOP No. 1, *Introductory Actuarial Standard of Practice*, section 2.6.

The guidance in this ASOP does not apply to the actuary when performing services with respect to individual pension benefit calculations and nondiscrimination testing, as described in section 1.2 of ASOP No. 4, *Measuring Pension Obligations and Determining Pension Plan Costs or Contributions.*

This standard only applies to the extent of the actuary's responsibilities. The actuary's responsibilities may extend to performing actuarial services related to an entire **model** or to only a small portion of a **model**.

Other ASOPs may provide guidance for actuarial services that involve **models**. If the actuary determines that the guidance from another ASOP conflicts with the guidance of this ASOP, the guidance of the other ASOP will govern.

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.

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 October 1, 2020.

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 **model** that is derived from **data**, represents possibilities based on professional judgment, or may be prescribed by law or by 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 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, benefit plan or policy provisions, or **output** from other **models**.

2.3 Governance and Controls—The application of a set of procedures and an organizational structure designed to reduce the risk that the **model output** is not reliably calculated or not utilized as intended.

2.4 Hold-out Data—A subset of **data** that is withheld intentionally when developing a predictive **model** so that the **model** may be validated later with **data** that were not used to develop the **model**.

2.5 Input—**Data** or **assumptions** used in a **model** to produce **output**.

2.6 Intended Purpose—The goal or question, whether generalized or specific, addressed by the **model** within the context of the assignment.

2.7 Intended User—Any person whom the actuary identifies as able to rely on the **model output**.

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

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 the risk of misuse or misinterpretation.

2.10 Model Run—The process of transforming a particular set of **input** to a particular set of **output** in a **model**. A **model run** could include the whole transformation process or part of the process, as applicable.

2.11 Output—The results of a **model** including, but not limited to, point estimates, likely or possible ranges, **data** or **assumptions** (as **input** for other **models**), behavioral expectations, or qualitative criteria on which decisions could be made.

2.12 Overfitting—A situation where a **model** fits the **data** used to develop the **model** so closely that prediction accuracy materially decreases when the **model** is applied to different **data**.

2.13 Parameter—A type of statistical, financial, economic, mathematical, or scientific value that is used as **input** to certain types of **models**. Examples of **parameters** include expected values in probability distributions and coefficients of formula variables. Some types of **models**, such as predictive or statistical **models**, produce estimates of **parameters** as **output**, which may be used as **input** to other **models**.

Section 3. Analysis of Issues and Recommended Practices

3.1 Model Meeting the Intended Purpose—The actuary should understand the **model's intended purpose**.

3.1.1 Designing, Developing, or Modifying the Model—When the actuary designs, develops, or modifies the **model,** the actuary should confirm, in the actuary's professional judgment, that the capability of the **model** is consistent with the **intended purpose**. Items the actuary should consider, if applicable, include but are not limited to the following:

a. the level of detail built into a **model**;

b. the dependencies recognized; and

c. the **model's** ability to identify possible volatility of **output**, such as volatility around expected values.

3.1.2 Selecting, Reviewing, or Evaluating the Model—When selecting, reviewing, or evaluating the **model**, the actuary should confirm that, in the actuary's professional judgment, the **model** reasonably meets the **intended purpose**.

3.1.3 Using the Model—When using the **model**, the actuary should make reasonable efforts to confirm that the model structure, **data**, **assumptions**, **governance and controls**, and **model** testing and **output** validation are consistent with the **intended purpose**.

3.1.4 Model Structure—The actuary should assess whether the structure of the **model** (including judgments reflected in the **model**) is appropriate for the **intended purpose**. The actuary should consider the following, as applicable, for a particular **model**:

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

b. whether the form of the **model** is appropriate, such as a projection **model** (deterministic or stochastic), statistical **model**, or predictive **model**;

c. whether the use of the **model** dictates a particular level of detail, for example, whether grouping **inputs** will produce reasonable **output**, or whether a certain level of detail in the **output** is needed to meet the **intended purpose**;

d. whether there is a material risk of the **model overfitting** the **data**; and

e. whether the **model** appropriately represents options, if any, that could be reasonably expected to have a material effect on the **output** of the **model**. Examples include call options on fixed income assets, policyholder surrender options, and early retirement options.

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

3.1.6 Assumptions Used As Input—For **models** that use **assumptions** as **input**, the actuary should use, or confirm use of, **assumptions** that are appropriate given the

model's intended purpose. The following guidance applies for **models** that use **assumptions** as **input**:

a. Setting Assumptions—When setting **assumptions** for which the actuary is taking responsibility, the actuary should consider using the following **data** or information:

   1. actual experience properly modified to reflect the circumstances being modeled, to the extent actual experience 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, relevant, or sufficiently reliable;

   3. future expectations or estimates, including those derived from market **data**, when available and appropriate; and

   4. other relevant sources of **data** or information.

b. Range of Assumptions—The actuary may consider using a range of **assumptions** and, if so, whether the number of **model runs** analyzed reflects a set of conditions consistent with the **intended purpose**.

c. Consistency—Where appropriate, the actuary should use, or confirm use of, **assumptions** for the **model** that are reasonably consistent with one another for a given **model run**.

   If the actuary is aware of material inconsistencies among **assumptions** used by the actuary in the **model**, the actuary should disclose the inconsistencies and known reasons for the inconsistencies. In the case of **assumptions** prescribed by applicable law, the actuary's disclosure may be limited to identifying the possibility of an inconsistency with other **assumptions**.

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

e. Reasonable Model in the Aggregate—The actuary should assess the reasonability of the **model output** when determining whether the **assumptions** are reasonable in the aggregate. While **assumptions** might

appear to be reasonable individually, conservativism or optimism in multiple **assumptions** may result in unreasonable **output**.

3.2 Understanding the Model—When expressing an opinion on or communicating results of the **model**, the actuary should understand the following:

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

b. known weaknesses in **assumptions** used as **input**, known weaknesses in methods or other known limitations of the **model** that have material implications; and

c. limitations of **data** or information, time constraints, or other practical considerations that could materially impact the **model's** ability to meet its **intended purpose**.

3.3 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.

3.4 Reliance on Models Developed by Others—If the actuary relies on a **model** designed, developed, or modified by others, such as a vendor or colleague, and the actuary has a limited ability either to obtain information about the **model** or to understand the underlying workings of the **model**, the actuary should disclose the extent of such reliance. In addition, the actuary should make a reasonable attempt to have a basic understanding of the **model**, including the following, as appropriate:

a. the designer's or developer'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**.

When relying on **models** developed by others, the actuary should make practical efforts to comply with other applicable sections of this standard.

3.5 Reliance on Experts—The actuary may rely on experts in the fields of knowledge used in the development of the **model**. In determining the appropriate level of reliance, the actuary may consider the following:

a. whether the individual or individuals upon whom the actuary is relying are experts in the applicable field;

b. the extent to which the **model** has been reviewed or validated by experts in the applicable field, including known material differences of opinion among experts concerning aspects of the **model** that could be material to the actuary's use of the **model**;

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

d. whether the science underlying the expertise is likely to produce useful **models** for the **intended purpose**.

When relying on experts, the actuary should disclose the extent of such reliance.

3.6 Evaluation and Mitigation of Model Risk—The actuary should evaluate **model risk** and, if appropriate, take reasonable steps to mitigate **model risk**. The type and degree of **model risk** mitigation that is reasonable and appropriate may depend on the following:

a. the **model's intended purpose**;

b. the nature and complexity of the **model**;

c. the operating environment and **governance and controls** related to the **model**;

d. whether there have been changes to the **model** or its operating environment; and

e. the balance between the cost of the mitigation efforts and the reduction in potential **model risk**.

3.6.1 Model Testing—For a **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 perform sufficient testing to ensure that the **model** reasonably represents that which is intended to be modeled. **Model** testing may include the following:

a. reconciling relevant **input** values to the relevant system, study, or other source of information, addressing and documenting the differences appearing in the reconciliation, if material;

b. checking formulas, logic, and table references;

c. running tests of variations on key **assumptions** used as **input** to test that changes in the **output** are consistent with expectations given the changes in the **input** (i.e., sensitivity testing); and

d. reconciling the **output** of a **model run** to prior **model runs**, given changes in **data**, **assumptions**, formulas, or other aspects of the **model** since the prior **model run**.

3.6.2 Model Output Validation—The actuary should validate that the **model output** reasonably represents that which is being modeled. Depending on the **intended purpose**, **model output** validation may include the following:

a. testing, where applicable, preliminary **model output** against historical actual results to verify that modeled **output** would bear a reasonable relationship to actual results over a given time period if **input** to the **model** were set to be consistent with the conditions prevailing during such period;

b. evaluating whether the **model** applied to **hold-out data** produces **model output** that is reasonably consistent with **model output** developed without the **hold-out data**, as may be used for predictive **models**;

c. performing statistical or analytical tests on **model output** to assess their reasonableness;

d. running tests of variations on key **assumptions** to test that changes in the **output** are consistent with the expectations given the changes in the **input**; and

e. comparing **model output** to those of an alternative **model**(s), where appropriate.

3.6.3 Review by Another Professional—The actuary may consider obtaining a review by another qualified professional, depending upon the nature and complexity of the **model**.

3.6.4 Reasonable Governance and Controls—The actuary should use, or, if appropriate, may rely on others to use, reasonable **governance and controls** to mitigate **model risk**.

3.6.5 Mitigating Misuse and Misinterpretation—The actuary should refer to the guidance in ASOP No. 41, in particular sections 3.4.1 and 3.7, to mitigate possible misuse and misinterpretation of the **model**.

3.7 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. 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, section 3.8, 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 under this standard, the actuary should refer to ASOP Nos. 23 and 41. In addition, the actuary should disclose the following in such actuarial reports:

a. the **intended purpose** of the **model**, as discussed in section 3.1;

b. material inconsistencies, if any, among **assumptions**, and known reasons for such inconsistencies, as discussed in section 3.1.6(c);

c. unreasonable **output** resulting from the aggregation of **assumptions**, if material, as discussed in section 3.1.6(e);

d. material limitations and known weaknesses, as discussed in section 3.2;

e. extent of reliance on **models** developed by others, if any, as discussed in section 3.4; and

f. extent of reliance on experts, if any, as discussed in section 3.5.

4.2 Additional Disclosures in an Actuarial Report—The actuary should include the following, as applicable, in an actuarial report:

a. the disclosure in ASOP No. 41, section 4.2, if any material **assumption** or method was prescribed by applicable law;

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** 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.

4.3 Confidential Information—Nothing in this ASOP is intended to require the actuary to disclose confidential information.