

A PUBLIC POLICY PRACTICE NOTE

Modeling—for Pension Actuaries

Revised January 2023

Developed by the Pension Committee



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The American Academy of Actuaries is a 19,500+ member professional association whose mission is to serve the public and the U.S. actuarial profession. For more than 50 years, the Academy has assisted public policymakers on all levels by providing leadership, objective expertise, and actuarial advice on risk and financial security issues. The Academy also sets qualification, practice, and professionalism standards for actuaries in the United States.

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This practice note is not a promulgation of the Actuarial Standards Board (ASB), is not an actuarial standard of practice (ASOP) or an interpretation of an ASOP, and is not meant to be a definitive statement as to what constitutes generally accepted practice in the area under discussion. Actuaries are not in any way bound to comply with practice notes or to conform their work to the practices described in practice notes. Events occurring subsequent to the publication of this practice note may make the practices in the practice note irrelevant or obsolete.

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Introduction

This practice note was prepared by and reflects the views of the Pension Committee (Committee) of the American Academy of Actuaries (Academy). The purpose of this practice note is to provide background and ideas about how a pension actuary might comply with ASOP No. 56, *Modeling*, as well as to help with the evolution of ideas in this area. The intended users of this practice note are the members of the actuarial organizations governed by the ASOPs promulgated by the ASB.

It is anticipated that this practice note may be helpful to pension actuaries as they comply with ASOP No. 56, but it is not an interpretation of ASOPs and is not intended to be a codification of generally accepted actuarial practice. Actuaries are not in any way bound to comply with practice notes or to conform their work to the practices described in this or any other practice note.

While the Committee's current understanding of many typical issues is discussed in this practice note, other approaches and interpretations are possible, and it is likely that new approaches will evolve on this topic. Further, the applicable ASOPs should be referenced regarding any questions on the material covered in this practice note.

ASOP No. 56 was adopted in December 2019 and is effective for work performed on or after October 1, 2020. It is a general standard that applies to all practice areas and provides guidance to actuaries when performing actuarial services with respect to designing, developing, selecting, modifying, using, reviewing, or evaluating models. However, it does not apply to an actuary who is performing services with respect to individual 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*.

The standard only applies to the extent of the actuary's responsibilities, which may extend to an entire model or a small portion of a model. This practice note reviews several common responsibilities of pension actuaries as they relate to this standard, some of which may already be part of an actuary's current work process, but which will likely require additional disclosures in statements of actuarial opinion.

This standard applies to actuaries involved with a wide range of pension assignments, including annual actuarial valuations. The Committee believes this includes any actuary responsible for a valuation that was performed using parameter-driven actuarial valuation software, even for a basic pension plan with few or no coding changes from one year to the next.

There are several pension-specific ASOPs that apply to actuaries and provide some guidance with respect to models. These include but are not limited to ASOP No. 4; ASOP No. 27, *Selection of Economic Assumptions for Measuring Pension Obligations*;

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ASOP No. 35, *Selection of Demographic and Other Noneconomic Assumptions for Measuring Pension Obligations*; and ASOP No. 51, *Assessment and Disclosure of Risk Associated with Measuring Pension Obligations and Determining Pension Plan Contributions*. If guidance from any ASOPs conflicts with the guidance in ASOP No. 56, the guidance of the other ASOP will govern. Note that this practice note does not reflect any changes that are currently being contemplated to ASOP No. 41. In addition, there are several general ASOPs that apply to all practice areas and may provide useful guidance with respect to models.¹ In particular, ASOP No. 1, *Introductory Actuarial Standard of Practice*, provides useful guidance as to the general meaning of common terms used in ASOPs.²

All actuaries subject to the ASOPs are also required to follow the Code of Professional Conduct (“Code”). The first Precept of the Code requires an actuary to perform actuarial services “with skill and care.” This applies to any model that an actuary uses in performing actuarial services, whether it falls under the specific guidance of ASOP No. 56 or not.

The Committee welcomes any suggested improvements for future updates of this practice note. Suggestions may be sent to the pension policy analyst of the American Academy of Actuaries at 1850 M Street NW, Suite 300, Washington, DC 20036 or by email to pensionanalyst@actuary.org.

¹ For example, ASOP No. 12, *Risk Classification (for All Practice Areas)*, ASOP No. 23, *Data Quality*, and ASOP No. 25, *Credibility Procedures*.

² Such common terms include “must/should,” “may,” or “materiality”, to list a few. This practice note uses defined terms consistent with their definitions in ASOP No. 1.

I. What Is a Model?

Models are essential and indispensable tools in any scientific endeavor. An act of modeling is a scientific activity with a goal of understanding, defining, quantifying, visualizing, or simulating a feature or phenomenon of the real world. Actuarial modeling is ingrained in any actuary's daily activities. Yet, each actuary may give a different answer when asked to articulate what a model is. Despite these potential differences, individuals can find commonality in their conceptual understanding of modeling and what modeling means to actuarial science or any other science.

a) Model definition in ASOP No. 56

To understand whether ASOP No. 56 applies to a given modeling project, it might be helpful for the actuary to consider both the definition of a model and the scope of the standard.

These considerations encompass six elements: three components that comprise the model according to the definition within the standard (section 2.8)—namely input, processing, and output—as well as three criteria specified within the Scope (section 1.2)—namely actuarial aspect, materiality considerations, and specific exceptions.

Let's start with the definition of a model in the standard. Terms in bold are separately defined in section 2 of the standard.

“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.”

The ASOP No. 56 definition refers to a “simplified representation” of how real-world variables interact. Often the purpose of the model is to simplify complex real-world issues to fundamental relationships. Performing simple mathematical operations on numbers would not appear to meet the definition of modeling under the standard as it does not provide a simplified representation of any real-world phenomenon.

The ASOP definition includes the components of the model, but the definition itself does not refer to the purpose of the modeling project. However, the model's purpose is clearly relevant when evaluating whether a modeling project falls under the standard. So, the Scope section specifies that only models used for *actuarial services*

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are covered by the ASOP. This criterion is discussed in greater detail below, after reviewing the model components.

b) Components of the model

According to the ASOP No. 56 definition, a model has three components, detailed below.

i) An information input component. This component focuses on the delivery of data and assumptions to the model. Results from one model may become information input for another model. For example, in an ASC 715 accounting valuation for a pension plan, the high-quality corporate yield curve (or the corresponding effective rate) may be loaded into the pension valuation software, which then calculates pension-related liabilities at the measurement date. This yield curve or the corresponding effective discount rate may itself be an output from a yield curve construction model.

ii) A processing component. The processing component transforms inputs into outputs, using statistical, financial, economic, mathematical, non-quantitative, or other scientific concepts and equations.

A processing component—for example, an algorithm or a set of mathematical equations—does not on its own constitute a model subject to ASOP No. 56. For example, if an actuary is calculating a present value factor using a well-defined mathematical process, as well as prescribed mortality and interest rates, the Committee does not believe this activity falls under this standard.

iii) A results component. This component translates outputs into useful business information, enabling and facilitating an informed decision-making process. For example, a pension valuation system may produce detailed pension obligation outputs by individual, decrement, or plan provision, but the results component may show total amounts for the plan. Alternatively, a pension valuation system may show useful business information in the results, such as the plan's net periodic cost. In another example, for a discount rate model that uses a spot rate yield curve and plan-specific actuarial cash flows to create a plan-specific discount rate, the discount rate is the result, which could then be an input to an actuarial valuation model.

c) Criteria for applicability

i) Actuarial services

The scope of ASOP No. 56 (section 1.2) specifies that the standard applies to actuaries when performing *actuarial services*. ASOP No. 1 defines actuarial services as:

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“Professional services provided to a principal by an individual acting in the capacity of an actuary. Such services include the rendering of advice, recommendations, findings, or opinions based on actuarial considerations.”

Therefore, one of the important factors in evaluating whether a model falls under the scope of ASOP No. 56 might be whether the associated project or services involve actuarial considerations.

While the term “actuarial considerations” is not defined in the U.S. Qualification Standards, some guidance provided regarding statements of actuarial opinion could be informative in this context. In particular, per the discussion in the Appendix to the Qualification Standards, a communication that contains data and other information but does not contain actuarial advice or an actuarial opinion is not a statement of actuarial opinion. Further, Appendix 1 of ASOP No. 56 states that actuaries use models “to analyze uncertain outcomes.”

Both of these discussions suggest that the presence of an element of uncertainty, inherent in actuarial services and considerations, is a part of the determination of whether a model is subject to the standard. Another indication of whether “actuarial considerations” are involved is if the model requires the actuary to exercise professional judgment.

Therefore, in evaluating whether a model falls under the standard, an actuary might want to consider whether it (a) meets the definition of a model within the standard, and (b) will be employed by an actuary using professional judgment to give actuarial advice or an actuarial opinion about matters that include an element of uncertainty.

ii) Materiality

Not every assignment involving a model, meeting the definition of the standard and performed as part of the actuarial services, is subject to ASOP No. 56. Section 1.2, Scope, specifies that the guidance in the standard applies “when, in the actuary’s professional judgment, reliance by the intended user on the model output has a *material effect* for the intended user” (emphasis added). Materiality should be assessed under the guidance of ASOP No. 1, section 2.6.

In relevant part, the definition of materiality in ASOP No. 1 states:

“An item or a combination of related items is material if its omission or misstatement could influence a decision of an intended user. When evaluating materiality, the actuary should consider the purposes of the

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actuary’s work and how the actuary anticipates it will be used by intended users. The actuary should evaluate materiality of the various aspects of the task using professional judgment and any applicable law (statutes, regulations, and other legally binding authority), standard, or guideline. In some circumstances, materiality will be determined by an external user, such as an auditor, based on information not known to the actuary.”

For additional discussion on concepts of materiality, please see *Materiality—Concepts on Professionalism*, a discussion paper published by the Task Force on Materiality of the Council on Professionalism of the Academy (2006).³

iii) Specific Exceptions

Section 1.2, Scope, provides some specific exceptions when the guidance in the standard does not apply:

“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*.”

d) Examples of models in the context of ASOP No. 56

Professional judgment plays a crucial role for actuaries when complying with any actuarial standard of practice. As is often the case with professional standards, no bright line or litmus test exists to determine when ASOP No. 56 applies and when it does not. To help the pension actuary evaluate whether ASOP No. 56 applies to a specific model, this practice note provides some examples of models that might generally fall or might generally not fall under ASOP No. 56. Furthermore, this practice note also provides some examples that, in the view of the Committee may or may not fall under the standard, depending on circumstances or conclusions based on the actuary’s professional judgment. Except for the examples taken directly from the standard, none of these illustrations are intended to be definitive statements of how ASOP No. 56 applies to a specific model, or how ASOP No. 56 will be found to apply in a disciplinary, legal, or regulatory proceeding. Further, and importantly, none reflect whether a given model would meet the materiality criteria mentioned above. Each actuary must consider the facts and circumstances specific to his or her particular situation.

³ https://www.actuary.org/sites/default/files/files/materiality_06.8.pdf/materiality_06.8.pdf

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i) Examples for which ASOP No. 56 might not apply

- *Mathematical or graphical manipulation of results.* This includes calculations that simply summarize or reformat results. For example, creating an exhibit with summary statistics such as sums, averages, etc. of a larger table of results. These are just summary facts, not simplified representations of real-world phenomenon, with no actuarial considerations or advice involved. It is possible that the information being summarized is the output of a model that is covered by the standard, but unless the summary itself is intended to be used in place of the model being summarized, the summary would not appear to be subject to ASOP No. 56.
- *Pension expense business unit allocation calculations.* The standard might not apply to such business unit allocation calculations when conducted under a specified methodology that allocates an already calculated pension expense using items that may or may not be outputs from another model covered by the standard.
- *Calculations in accordance with a prescribed methodology.* This includes calculations where the methodology requires no actuarial judgment, such as determining an Internal Revenue Code Section 415 limit for the current year.
- *Certain benefit statements.* Individual pension benefit statements that only communicate participants' current accrued benefits and do not include projected benefit amounts.

ii) Examples for which ASOP No. 56 might apply

- *Calculation of pension liabilities.* Measuring pension obligations for any purpose as of the current measurement date, including funding or accounting, even when some assumptions and methods are prescribed, falls under the standard.
- *Projections of pension metrics.* ASOP No. 56 applies when projecting actuarial results beyond the current measurement date. For example, the standard applies to projections of pension liabilities, normal costs, and assets to estimate future costs/contributions/Pension Benefit Guaranty Corp. premiums, either deterministically or stochastically. This includes certain projections to meet statutory requirements, such as actuarial certifications of multiemployer plan Zone Status and calculation of projected end of year liabilities to be disclosed on an Annual Funding Notice.
- *Bargaining, Funding Improvement Plans and Rehabilitation Plans.* For multiemployer plans, an actuarial analysis that is used for pension plan negotiations with a union and/or development of a Funding Improvement or Rehabilitation plan derived from a model would be subject to the standard.
- *Asset/liability modeling (ALM) studies.* The standard generally applies to ALM studies because the actuary uses actuarial judgment in evaluating the impact of stochastic modeling on both plan assets and liabilities.

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- *Economic scenario generators or capital market simulators.* These are very complex models that predict future economic conditions and capital markets behavior, either as deterministic future scenarios or stochastic simulations.
- *Yield curve developments.* This process requires both specific universe bond data and assumptions; for example, how to treat outliers and maturities where no observable market data exists. This also requires a mathematical methodology for extracting market signals.
- *Accounting discount rate derivations.* Development of an appropriate discount rate for ASC 715 accounting valuation generally requires a spot rates yield curve and projected plan-specific cash flows. Determination of the discount rate under GASB 67, 68, 74, or 75 may involve projections of future contributions intended to finance the benefits of current plan members as well as projected benefit payments.
- *Predictive models.* These models are specifically discussed in the standard. Predictive models are typically fit to a subset of relevant data using complex and sophisticated mathematical methodologies, such as generalized linear regression, machine learning, or neural networks. Once fit to the data, they can be used to predict outcomes given new data for the same phenomenon. For example, a relative mortality model, such as Cox proportional hazard model, can be fit to the past data with predictors such as smoking status, gender, age, geographic location, and other variables.
- *Deferred Retirement Option Plan (DROP) cost analysis.* A DROP is a benefit provision that allows an active employee to receive a benefit that mimics an in-service retirement benefit. For example, a participant who elects a three-year DROP would receive a lump sum of three years of benefits plus a lifetime retirement benefit based on their accrued benefit three years prior to retirement instead of receiving the current retirement benefit based on the accrued benefit at their actual retirement date. An analysis of the cost of the DROP (whether retroactive or prospective) would be a model under the standard.
- *Purchase service calculations.* Purchase service calculations occur frequently in public pension plans when a participant can buy additional service in a pension plan due to service with another governmental employer. The purchase price is usually determined as the present value of the participant's projected retirement benefit with and without the purchased service. Because the determination of the purchase price requires future assumptions about pay and retirement date, we believe it would be covered by the standard.
- *Spreadsheet liability calculations.* Excel-driven spreadsheets that calculate actuarial liabilities from data and assumptions input fall under the standard.

iii) Examples for which ASOP No. 56 may or may not apply

- *Experience studies.* Models of complex mortality experience studies where multivariate analysis, treatment of outliers, assumptions on older/younger ages,

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- complex smoothing methodologies, etc. are employed, would likely fall under ASOP No. 56. At the other extreme, a simple tabulation of data that is used without adjustment to evaluate optional form election rates, might not if it does not include actuarial judgment and/or is not material.
- *Domestic Relations Order (DRO) calculations.* The calculation of a pension benefit as part of a DRO (whether a Qualified DRO [QDRO] or not) might fall under the exemption for benefit calculations. However, a calculation performed as part of the negotiation of a DRO might fall under the standard if methods and assumptions are not prescribed, for example estimating the present value of the benefits due to each party during the negotiation of the settlement.
 - *Relative value calculations.* The comparison actuarial basis is typically specified as part of the plan's administrative practice but is not included in the plan document. If these calculations are viewed as individual benefit calculations, this would fall under the specific exclusion of the standard. However, if an actuary picks an average employee who is intended to be representative of the employee group and is used in a simplified relative value disclosure, this might be considered as using a model that falls under the standard.
 - *Withdrawal liability calculations.* The unfunded vested benefits (UVB) is based on the actuary's best-estimate assumptions for the year, which are derived from a model under the standard. However, the allocation method may or may not be a model covered by the standard.
 - *Benefit statements with projected benefits.* Benefit projections for benefit statements purposes might not be covered by the standard when the formula is a flat dollar per year of service benefit, unless there is additional complexity around the projection of service that may cause the projection to be covered by this standard. Similarly, a projection of a benefit using a specified methodology, such as a level pay increase or no increase, and which does not reflect actuarial judgment as to what kind of pay increase assumption would be realistic, would likely not be covered by the standard due to the absence of actuarial judgment. However, projections of cash balance and final average pay benefits might be covered by this standard if they include actuarial judgment in setting the assumptions used in the projection, rather than a simplified specified methodology.
 - *Spreadsheets.* Spreadsheets used for actuarial calculations may or may not be covered by the standard. For example, a spreadsheet that calculates minimum contributions for five years based on assets and liabilities projected from current results using actuarial assumptions would be covered. But a spreadsheet that calculates current-year funding results prescribed by law (e.g., minimum required contribution, shortfall amortization amounts, Adjusted Funding Target Attainment Percentage [AFTAP], etc.) or accounting results would likely not be covered if the spreadsheet simply manipulates actuarial liabilities derived from another model that is subject to the standard.

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- *Funding policy calculations.* The determination of a pension contribution under a given funding policy might fall under the standard, depending on the methodology (e.g., does it require actuarial judgment?)
- *Cost-sharing allocation under GASB 68.* Cost-sharing allocations require an allocation of the GASB 68 pension liability by an employer’s long-term contribution effort. Many actuaries use actual contributions in the prior year to allocate the liability, which would not be a model covered by the standard unless it involves actuarial judgment. However, if the actuary projects the contributions by employer over a 10-year period to determine the long-term contribution effort, this would likely be a model covered by the standard.
- *Non-quantitative models.* Many non-quantitative models are not subject to the standard. However, an example of when the standard might apply is in utilizing theoretical considerations to derive an actuarial assumption before any empirical data for quantitative analysis is available. For example, in a pandemic environment, one may decide upon a future retirement pattern assumption to reflect the likely occurrence of increased retirements in the face of companies’ financial distress and/or uncertainty about workplace safety for vulnerable populations (for example, consider older teachers who decide to retire rather than risk exposure to COVID-19 in the classroom.)
- *Plan design studies.* There are several different steps that an actuary may take during a study to review different plan designs, some of which may involve models subject to this standard, including:
 - o Modeling future costs of the plan, such as the accounting cost or cash contribution impact of the change in plan design;
 - o Modeling future projected benefits for participants under various provisions, which could be to review the impact on sample employees or as part of drafting a 204(h) notice in connection with implementing the change; and
 - o “Winners/losers” analysis of the impact a plan design change may have on future projected benefits.

However, some benefit modeling may involve calculating only current accrued benefits, which might not be subject to this standard.

II. Actuarial Roles

Actuaries take on many different roles when doing actuarial work. Often their roles will vary depending on the project, client, etc. An actuary may take one or several roles when working with models, especially with a larger project or when a project spans a longer period of time, and there are an array of considerations and responsibilities for each of these roles. Also, a team of actuaries might make certain decisions collectively (e.g., selecting a model for a particular project), but this practice note uses the singular for this discussion.

Although the roles are listed below in a specific order, this does not imply actuaries will always perform these roles in this sequence; further, some roles may be performed multiple times. For example, a model may go through development and then review before being returned to development to address an issue uncovered during the review.

This section of the practice note presents a summary of the roles referred to in ASOP No. 56 and examples of how these roles relate to the day-to-day work performed by pension actuaries.

a) **Designing**

Actuaries may help design models in the initial phases of development or during later revisions. This work may include outlining the model's basic structure or processes, determining how much flexibility users have when using the model (e.g., which assumptions will be hardcoded and which can be changed), designing user interfaces and output protocols, determining the resources and associated skill levels of those resources to be involved in the development, etc.

b) **Evaluating**

An actuary may evaluate a new model to determine whether it is appropriate for a particular purpose, to determine the functionality of the model, limitations of the model, etc. An actuary may evaluate an existing model to determine whether it can be adapted to a new purpose or whether it remains appropriate for continued use, or to determine what changes may make it more appropriate for a particular purpose, more efficient, etc.

c) Selecting

Pursuant to the standard, when selecting a model for an actuarial assignment, an actuary must select a model that is consistent with the intended purpose of the measurement. Sometimes, this decision is made by others in the company and the actuary is relying on that decision—such as which actuarial valuation software package must be used. However, when multiple models are available, the actuary needs to select an appropriate one. Considerations might include choosing a model that is already licensed by the actuary’s employer, capabilities of each model, broad expertise with the model within the actuary’s company, expected efficiency, ease of use, long-term viability of the model, etc.

d) Developing

An actuary may develop the entire model or just a part of it. This process might include both programming and testing the programming prior to using or reviewing. This role may be performed by multiple teams. For instance, for an actuarial valuation, the development team that writes the software might include actuaries, whether they are employed directly by the actuarial firm or by an external vendor. But the task of developing is also performed by the actuary who uses the actuarial valuation software package to develop a version of the model specific to a client or project. That actuary may need to take a valuation software package used by their employer; complete the parameters or other coding to reflect the appropriate plan provisions, data, assumptions, and other features needed for that plan and measurement; and test that the parameters have been completed correctly prior to using or reviewing.

e) Using

An actuary will use the model to produce the model output. For example, an actuary who is using a client-specific version of an actuarial valuation software package may run the model to determine the liabilities and/or costs necessary for the intended purpose. Or an actuary may use a model developed in Excel to determine an output, such as a projection of pension liabilities.

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f) **Reviewing**

An actuary might perform several types of review with respect to a model. The complexity of this review may depend upon the complexity of the model itself and standard actuarial practice within the actuary's company. However, an actuary is always subject to the requirements in the ASOPs even if those requirements are not directly outlined in the actuary's company's standards.

i) **Detailed review**—review of the entire model. For an actuarial valuation program, this might include steps such as:

- a review of whether the data and assumptions are being read into the program correctly;
- a review of whether the parameters appropriately reflect the plan provisions that should be valued;
- a review of the individual results of specific test lives to assess whether all types of participants are being modeled correctly and/or to check the components of the results of the model for that participant and/or to analyze the components of the results of the model for that participant in comparison to the prior year.

ii) **Targeted review**—review of just a targeted portion of the model, while other actuaries are responsible for reviewing other portions of the model. For an actuarial valuation program, an example of a targeted review might be a review of the impact of a change in a plan provision.

iii) **High-level review**—general review of the model and its output. For an actuarial valuation program, this might include steps such as:

- a review of whether the liabilities produced by the program are reasonable in total, and/or by decrement, compared to the prior year, on an individual participant basis, for test lives and/or in total for the plan; and
- a review of whether changes in plan provisions, data, or assumptions produced reasonable changes to the results of the model.

iv) **Independent or peer review**—Review by an individual who has generally not been involved with the day-to-day model development process or use of the model. This may or may not be a detailed review of the model. A variety of things may be targeted as part of a peer review, such as that appropriate processes have been followed, appropriate technical checks have been performed, results are generally reasonable, etc.

When performing the reviewer role, an actuary may want to think about the scope of the review and the actuary's expertise in the area of the model relative to that of the other team members whose work is being reviewed.

g) Modifying

Models may be in use for many years and may be updated periodically for emerging experience data, corrections, enhancements, new laws or regulations, etc. For example, an actuarial valuation program may be modified and rerun to produce the next year's valuation results or to determine the impact on the model output of change(s) in the assumption(s) and/or plan provision(s). When the model is modified, actuaries may take on roles similar to the other roles described in this section. However, when testing and reviewing the modifications, the actuary may want to consider also testing and reviewing other parts of the model to uncover potential unintended consequences of the modifications.

III. Actuarial Responsibilities

Actuaries have a variety of responsibilities when using models. ASOP No. 56 sorts these responsibilities into seven broad categories, each of which contains several different tasks:

- Confirming the model meets its intended purpose
- Understanding the model
- Relying on data and information supplied by others
- Relying on models developed by others
- Relying on experts
- Evaluating and mitigating model risk
- Documenting compliance with the ASOP

The applicable tasks for any particular assignment will depend on the actuary's role(s) for the assignment, for example, developing, using, or reviewing the model (see the previous section of this practice note for a complete list of roles). Not every role will require the actuary to assume every responsibility listed below, but most projects will involve multiple responsibilities.

a) Confirming the model meets its intended purpose

In accordance with the standard, whenever an actuarial assignment involves a model, the actuary must confirm the model meets its intended purpose. This requires the actuary to understand that intended purpose, which the standard defines as “the goal or question, whether generalized or specific, addressed by the model within the context of the assignment.”

The standard does not preclude an actuary from using the model for another purpose, but the actuary should still understand what the *intended* purpose of the model is, so that the actuary can assess how it might differ from the actuary's own purpose for using the model. For instance, an actuary might consider using an annual funding valuation program to calculate accrued benefits for a replacement ratio analysis or to generate cash flows for an asset/liability modeling study. The actuary should fully understand the model's intended purposes before concluding that the output—in the first example, the accrued benefits—are appropriate for these other uses.

i) Model assessment overview

Having ascertained the intended purpose of the model, the standard requires that the actuary next confirm whether the model reasonably meets that purpose. All actuaries should make this assessment, but the steps differ depending on the actuary's role in the assignment. The standard separates the actions into three categories, each with their own tasks.

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A) Designing, developing, or modifying the model

When the actuary is building the model, either in theory as part of a design team or in practice, and whether the work is on the underlying model code or in completing the parameters of a specific model for a particular purpose, the standard requires the actuary to confirm that the model's capability is consistent with its intended purpose. This refers to the model's ability to answer the question for which it was designed.

When making this assessment, the actuary should consider several things (if applicable), including but not limited to the level of detail built into the model, the dependencies recognized within the model (such as when assumptions are not mutually independent—for example, correlations among expected returns for various asset classes), and the model's ability to identify possible volatility (such as around expected values). For example, an Excel spreadsheet originally designed to develop a one-year projection of minimum required contributions using current interest rates may be perfectly suited to its original purpose but may not be sufficiently sophisticated or flexible to provide a longer-term projection.

B) Selecting, reviewing, or evaluating the model

Even when the actuary is not responsible for directly developing or using a model, the actuary should use professional judgment to confirm that the model reasonably meets the intended purpose. The standard gives no details on what this might mean; presumably, the actuary is expected to use professional judgment to determine what actions would be appropriate. For instance, an actuary purchasing a model for widespread use by the actuary's firm would likely do a thorough review of all documentation provided by the vendor, whereas an actuary reviewing valuation results prepared by a team of colleagues might rely heavily on documentation of their firm's standardized valuation process.

C) Using the model

The standard's requirements are most expansive for actuaries actually using models. An actuary using a model should make reasonable efforts to confirm that its structure, data, assumptions, governance and controls, and model testing and output validation are all consistent with the model's intended purpose.

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ii) Model assessment in practice

The standard provides detail on each of the tasks the actuary might undertake as part of the assessment of the model's structure, data, and assumptions used as input (as opposed to assumptions inherent in the underlying model itself).

A) Model structure

When assessing whether the model's structure is appropriate for the intended purpose, the actuary should consider the following, as applicable:

- Whether all material provisions and risks specific to a business segment, contract, or plan (or segments of the plan) or interactions more broadly have been included in the model
- Whether the model's form (e.g., deterministic or stochastic, statistical, or predictive) is appropriate
- Whether the level of detail required as input and provided as output is appropriate
- Whether there is a material risk of overfitting the data
- Whether any options that could reasonably be expected to have a material effect on the model's output have been included (e.g., call options on fixed income assets, early retirement options)

B) Data

The actuary should confirm that the data used by the model (either directly or as the basis for assumptions input into the model) are appropriate. For instance, if a model uses a long-term inflation assumption, the actuary should confirm that the data used to develop that assumption is appropriate for the model's intended purpose. As another example, when a model uses gender-specific mortality, the actuary should confirm that gender is a field on the data. For specific guidance on data, ASOP No. 56 directs the actuary to ASOP No. 23, *Data Quality*.

C) Assumptions Used as Input

As part of understanding whether a model meets its intended purpose, the actuary should confirm that any assumptions used as input to the model are appropriate.

In addition to the requirements of this standard, which applies to all practice areas, pension actuaries must follow guidance from ASOP No. 27 for the selection and use of economic assumptions and ASOP No. 35 for the selection and use of demographic and other non-economic assumptions. Note that most of the guidance in ASOP No. 56 is consistent with the guidance in ASOPs No. 27 and 35 but there are variations among the guidance for the

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actuary to consider. Specifically, all three ASOPs cover the following areas but with some differences in the guidance:

- *Information or data to consider when setting the assumption.* ASOP No. 56 (consistent with ASOPs Nos. 27 and 35) notes that the guidance on this topic is applicable only when the actuary takes responsibility for the assumption. The guidance in ASOPs Nos. 27 and 35 is more robust and consistent with the guidance on this topic in ASOP No. 56; therefore, the actuary should make sure to follow ASOPs Nos. 27 and 35.
- *Range of assumptions.* All three ASOPs acknowledge there may be a range of assumptions that are reasonable. In addition, ASOP No. 56 suggests the actuary can consider multiple model runs using that range of assumptions. In this context, note that assumptions used to assess risk may have some bias or other aspect that may mean it is acceptable under ASOP No. 56 but may be considered unreasonable for other purposes.
- *Consistency between assumptions.* While all three ASOPs discuss consistency between all assumptions, ASOPs Nos. 27 and 35 specifically state, “The actuary is not required to select assumptions that are consistent with assumptions not selected by the actuary.” ASOP No. 56 states, “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.” Consequently, one might conclude that ASOP No. 56 requires all assumptions be consistent “where appropriate,” whether selected by the actuary or not.

For two reasons, some pension actuaries find the ASOP No. 56 requirement regarding additional assessment of consistency for assumptions not selected by the actuary a gray area. The first is the terminology “where appropriate,” which acknowledges the potential for circumstances in which inconsistency would be acceptable. But this does not establish whether use of assumptions not set by the actuary represents such a scenario.

Second, the scope of ASOP No. 56 states that, “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.” ASOPs No. 27 and 35 do not require—but do not forbid—an assessment of consistency with assumptions not selected by the actuary. Accordingly, the actuary should use professional judgment to determine whether the ASOP No. 56 requirement for such an assessment is in conflict with ASOPs Nos. 27 and 35.

An example of when this additional assessment of consistency could come into play is when the plan sponsor sets the expected rate of return

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and the actuary sets the salary scale assumption. Both assumptions have an underlying inflation component. Under ASOP No. 56 the actuary should make sure the two assumptions are consistent, but ASOP No. 27 permits the two to be inconsistent.

If inconsistent assumptions are used in modeling, disclosing the inconsistency and the reason for it would appear to satisfy ASOPs Nos. 27, 35, and 56. ASOP No. 56 specifically says in Section 3.1.6(c) that “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.”

- *Appropriateness of existing assumptions.* ASOP No. 56 requires the actuary to consider whether all assumptions in the model, when reusing the model, are appropriate or should be changed, when practical and appropriate. This is similar to the requirement in ASOPs Nos. 27 and 35, but in those standards the actuary must only consider the appropriateness of assumptions previously selected by the actuary.
- *Combined effect of assumptions/reasonability in the aggregate.* ASOP No. 56 discusses ensuring that assumptions in the aggregate produce reasonable output. ASOPs Nos. 27 and 35 require that the combined effect of assumptions has no significant bias (in addition to selecting an assumption that is reasonable). These requirements are slightly different and both need to be followed.

Note that the assessment under ASOPs Nos. 27 and 35 is only for assumptions selected by the actuary. ASOP No. 56 does not treat assumptions set by the actuary any differently than assumptions that are not set by the actuary. Similar to consistency noted above, this could be a gray area requiring professional judgment.

Under section 4.1(c) of ASOP No. 56, the actuary must disclose if the output may be unreasonable due to the aggregate effect of otherwise reasonable assumptions.

b) Understanding the model

The standard specifies that the actuary should understand the following when expressing an opinion on or communicating the results of the model:

- The important aspects of the model, including (but not limited to) the model’s basic operations, its important dependencies and major sensitivities;

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- Known weaknesses in assumptions used as input and methods, or any other known weaknesses that have material implications; and
- Limitations of data, information and time constraints, or other practical considerations with a material effect on the model’s ability to meet its intended purpose.

For models developed by other people, the actuary can get this understanding through a variety of sources. For instance, the actuary might review the usage documentation provided by the model’s developer or discuss the model with the developer or with other people who have used the model for a similar intended purpose. Even when the actuary is the developer of the model, reviewing these aspects of the model will often be beneficial.

c) Reliance

Actuaries working with models will almost invariably rely on other people. The ASOP identifies three types of reliance: on data and other information, on models developed by others, and on experts.

i) Reliance on data and other information.

When the reliance is strictly for data or other information supplied by others, ASOP No. 56 simply directs the actuary to ASOPs Nos. 23 and 41 for guidance.

ii) Reliance on models designed, developed, or modified by others

Frequently, the actuary will be using a model designed, developed, or modified by someone else—for example, a colleague, a technical group within the actuary’s firm, or a third-party vendor. In this case, the actuary should make a reasonable attempt to understand basic information about the model, as appropriate, including the model’s original intended purpose, its general operation, major sensitivities and dependencies, and its key strengths and limitations.

If the actuary has a limited ability to get information about the model or gain an understanding of the underlying workings of the model, the actuary should disclose the extent of the reliance on the model. It appears no disclosure is necessary if the actuary has full access to information about the model and can understand its underlying workings.

Section 1.2, Scope, states that a reviewing or evaluating actuary should apply the guidance in the standard to the extent practicable and only to the extent of the actuary’s responsibilities. Similarly, the actuary relying on models developed by others should “make practical efforts” to comply with other sections of the standard. What sort of efforts are “practical” will depend on the circumstances of

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the actuary's reliance. For instance, an actuary relying on valuation software chosen by the actuary's firm may not have access to documentation for the software itself but should have access to documentation for the particular plan-specific valuation.

iii) Reliance on experts

Often, a model may encompass information or methodology stemming from a field in which the actuary is not an expert. For example, an actuary may use a portfolio return calculator to determine an expected rate of return on assets, even if the actuary is unfamiliar with the construction of that tool. Similarly, an actuary may set an inflation assumption with reference to a capital markets outlook developed by investment consultants. Other times, the actuary may be an expert, but the assignment includes reliance on other sources. For instance, when setting a retirement assumption, the actuary may be asked to rely on an experience study performed by a prior actuary; similarly, an actuary may perform only a high-level peer review of the output when relying on the inputs and results of a model developed by a team.

The actuary must assess how much reliance is appropriate; that is, can the actuary simply accept the expert's information without additional verification, or must the actuary attempt to independently confirm that information? When making this determination, the standard suggests the actuary may consider the following factors:

- Whether the individuals supplying the information are experts in the field;
- Whether the model has been appropriately reviewed and whether there are known material differences of opinion among experts concerning any aspects of the model that could be material to the actuary's use of the model;
- Whether the model is subject to any industry or regulatory standards, and if so, whether the model has been appropriately certified as having met those standards; and
- Whether the "science underlying the expertise" is likely to produce useful models consistent with the model's intended purpose.

The standard does not differentiate between models developed by internal experts within the actuary's own firm and external experts. The actuary should consider to what extent an assessment of a third party's expertise performed by another person (or team) within the actuary's own firm can be relied upon. The actuary should disclose the extent of any such reliance.

d) Evaluating and mitigating model risk

The standard requires the actuary to evaluate model risk—that is, the risk of negative consequences from relying on a model that does not adequately represent what is

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being modeled, or the risk that the model will be misused or misinterpreted. These are two very different risks, the first of which might be considered as more under the actuary's control. The actuary must also take reasonable and appropriate measures to mitigate model risk. To mitigate possible misuse or misinterpretation, section 3.6.5 refers the actuary to the guidance in ASOP No. 41 (in particular sections 3.4.1 and 3.7).

But for the risk arising from relying on an inadequate model, the standard contains specific guidance on how to evaluate and mitigate the risk. The determination of how much model risk mitigation is reasonable and appropriate depends on:

- The model's intended purpose
- The nature and complexity of the model
- The operating environment, governance, and controls related to the model
- Any changes to the model or its operating environment
- The balance between the cost of risk mitigation and the resulting risk reduction

To evaluate model risk, the standard requires actuaries to use three techniques, where appropriate—model testing, model output validation, and reasonable governance and controls. In addition, the standard notes that the actuary may also consider obtaining a review by another professional.

i) Model testing

As defined by ASOP No. 56, actuaries undertake model testing to confirm whether the model “reasonably represents that which is intended to be modeled.” This test evaluates whether the model was created correctly (rather than whether it is producing correct output). The exact evaluation procedure will necessarily depend on the model structure itself; for example, testing a simple Excel spreadsheet will be a different exercise than testing a complex valuation system. However, the standard says that model testing may include:

- Reconciling input values to the relevant system, study, or other source of information (for instance, confirming that decrement tables are being properly incorporated by a valuation program, or that the correct yield curve values are entered into a spreadsheet) and addressing and documenting the differences, if material
- Checking formulas, logic, and table references
- Confirming that changes in key assumptions produce consistent changes in output, for example, that lower interest rates produce higher pension obligations (as applicable, and to an expected degree)
- When a model has been updated from a previous version or run, that the changes in the output are consistent with expectations, given changes in data, assumptions, formulas, or other aspects of the model

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The above list can be expansively interpreted to include many routine activities. For instance, model testing of an actuarial valuation will often include a review of test lives (also often referred to as sample lives) where several individual plan participants are run through the model. Depending on the circumstances, checking test lives might be a very detailed review of these sample participants, involving activities such as ensuring the input data is correct; that decrement and other assumptions are being applied appropriately; that benefits are correctly calculated; and that liability factors reflect the correct forms of payment, mortality, and interest rates. Checking test lives might also include a review of the results for specific individuals compared to the prior year. Test life review is a fundamental part of most valuation checking and may take place during the model checking and/or model output validation phases.

ii) Model output validation

Output validation is checking that the output reasonably represents that which is being modeled. This is different from model testing, which is more of a theoretical assessment of the model's overall appropriateness, rather than a practical assessment of the model's results. The standard notes that model output validation may include:

- Checking current output against historical output
- Evaluating whether the model applied to hold-out data produces output that is consistent to model output from the data set without the hold-out data
- Performing statistical or analytical tests for reasonableness
- Running tests of changes in output due to variations in key assumptions that are inputs to the model
- Comparing model output to the output from alternative models, if appropriate

An example of model output validation might be confirming that valuation liabilities properly reflect an updated mortality and interest rate basis. An actuary might also independently review the impact of the change in liabilities through rule-of-thumb calculations, such as using the duration to check the reasonability of a change in interest rates. For pension valuations, model output validation may often include checking test lives, described in more detail in the model testing section above.

iii) Review by another professional

In certain circumstances, the actuary may rely on another qualified professional to review the model. An actuary might do this for simple models (for instance, having a junior actuary review a few assumption changes in a well-reviewed model) or complex models, where a colleague may be more familiar with the

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workings of the model. In either case, the actuary should confirm that the reviewing actuary is competent to do the review.

iv) Reasonable governance and controls

The standard defines governance and controls as “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 utilized as intended.” Actuaries should make sure to use reasonable governance and controls to mitigate model risk.

In some situations, actuaries may find it appropriate to rely on others for reasonable governance and controls. For instance, an actuarial firm using valuation software from a third-party vendor might rely on the vendor’s governance and controls to ensure that the inner workings of the model are properly maintained and tested. In addition, an actuarial firm may have its own governance and controls to ensure that the application of the valuation software to a particular pension plan is properly implemented and checked. Unlike some other forms of reliance, this reliance on others for governance and controls does not need to be disclosed.

Appendix 1 of ASOP No. 56 lists several examples of appropriate governance and controls, including such items as limitations on access to the model, and confirmation that model output is reproducible. Additional examples of governance and controls include:

- Instructions for the model’s use and documentation of the model’s intended use
- Protection against accidental editing, for instance by only allowing users to input data into certain fields or introducing drop menus in input fields, limiting potential input choices
- Error messages when inputs are out of range, or in an unexpected format
- Using functions or named variables to pull inputs into the model rather than a specific cell reference that could be mistakenly changed, where appropriate
- Hard-coding constants within a cell’s formula, when appropriate
- Identification of changes made to the model since the previous iteration

IV. Disclosure and Documentation

a) General model documentation

ASOP No. 56 states that the actuary should consider preparing and retaining documentation to support compliance with the requirements of the standard. This documentation is not required by the standard, so some actuaries may choose not to prepare it. However, if documentation is created, it should be sufficient for another actuary to assess the reasonability of the actuary's work (but that documentation is not required to be disclosed).

The degree of any such documentation should be based on the professional judgment of the actuary and may vary with the complexity and purpose of the actuarial services. For example, a simple model that calculates the liabilities for a few retired participants may not need the level of documentation that a sophisticated valuation system for a large number of different types of participants may warrant. The standard specifically points to ASOP No. 41, section 3.8, for guidance related to the retention of file material other than required disclosures. This section of ASOP No. 41 refers to documentation that may not be required to be disclosed in a work product but would be useful if another actuary needs to take over the assignment.

Documentation might cover the intended use, model structure, understanding of the model, evaluation and mitigation of model risk and reliance on others. For some regularly used models, the actuary may have standing documentation that is updated each time the model is revised or used. This documentation will likely include a summary, and/or the location, of the data and assumptions used in the model.

In some cases, the actuary's documentation of certain elements of the model, such as the evaluation and mitigation of model risk, could refer to separate documentation prepared by the expert who developed the model. This may be the case if the actuary purchases a model from another firm or developed by a separate group within the same firm.

b) Actuarial report disclosure

ASOP No. 56 requires six specific disclosures when issuing an actuarial report that is covered by this standard:

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- i) *The intended purpose of the model.* The actuary is required to disclose the intended purpose of the model, as discussed in the Section 3-a. of the practice note.
- ii) *Material inconsistencies, if any, among assumptions, and known reasons for such inconsistencies.* There may be reasons an actuary would intentionally choose assumptions that are not consistent with each other—for example, in projections illustrating the impact of a single variable without adjusting other related variables. In other situations, the inconsistency may be due to assumptions prescribed by another party. In these cases, if the actuary is aware of material inconsistencies among assumptions used by the model, the inconsistency and the known reason for the inconsistency should be disclosed. If the inconsistency is due to an assumption prescribed by law, the disclosure is limited to noting there is a possibility of inconsistencies.
- iii) *Unreasonable output resulting from the aggregation of assumptions, if material.* Assumptions that seem reasonable individually may, when combined with other assumptions, unintentionally produce output that is skewed optimistically or pessimistically. Conversely, it is possible an actuary may choose assumptions for the model that are for illustration purposes only and may intentionally result in output that is known not to be the best estimate. When there are known inconsistencies from the aggregation of assumptions, the actuary should also note if the resulting output is unreasonable.
- iv) *Material limitations and known weaknesses.* A model might use estimation techniques or may not be able to handle all known variables that could influence the output. For example, if significantly incomplete data is used in the model or if methods are overly simplified, those limitations should be disclosed. The actuary should disclose these known weaknesses or any material limitations of the model.
- v) *Extent of reliance on models developed by others, if any.* If the model was not designed, developed, or modified by the actuary and the actuary has a limited ability either to obtain information about the model or to understand its underlying workings, the actuary should disclose the extent to which the model was relied upon by the actuary.
- vi) *Extent of reliance on experts, if any.* If the actuary issuing the report relied on experts in the fields of knowledge used in the development of the model, as discussed in the section above, the extent of this reliance should be disclosed.

Actuaries may encounter situations in which the actuary issuing the report may have worked with many other actuaries on a team that used the model for the analysis being disclosed. In these cases, the actuary issuing the report should disclose the information noted above even if the actuary was not directly responsible for identifying or evaluating the specific item to be disclosed.

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Although all of ASOP No. 41 is applicable to actuarial reports, ASOP No. 56 also points out certain sections of ASOP No. 41 that are required disclosures in actuarial reports that use models:

- i) **Section 4.2**—if any material assumption or method was prescribed by applicable law;
- ii) **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
- iii) **Section 4.4**—if, in the actuary’s professional judgment, the actuary has otherwise deviated materially from the guidance of this standard.

However, none of the disclosures in this standard requires the actuary to disclose information that is confidential.

V. Other Considerations

a) Effective date

The standard is effective for “work performed on or after October 1, 2020.” To discern at what point in the performance of the actuarial work, particularly a large project, this standard begins to apply, the actuary may want to consider the point when their individual involvement with the model began. For example, actuaries use a model in the valuation of pension liabilities. Actuarial valuation software is a model, and typically is developed, reviewed, and documented by a person other than the actuary responsible for the valuation results. Data, assumptions, methods, and provisions are input into the actuarial valuation software. The actuarial valuation software produces results, which can be reviewed and tested by the actuary. The actuary communicates the results of the valuation. In this scenario, the actuary’s “work” may begin and end at any point in this process, and the actuary’s work would be subject to ASOP No. 56 when it is being done on or after October 1, 2020. An actuarial project, such as an actuarial report or AFTAP, may arguably not be subject to the standard if the modeling was completed and signed off by the actuary before this date, even if the report or other statement of actuarial opinion was not issued until later. This is due to the fact that the actuary’s “work” involving the model was completed before the standard was in effect.

b) Intended user

ASOP No. 56 applies to an actuary when the actuary believes the model output will have a material effect for the intended user. An intended user is “any person whom the actuary identifies as able to rely on the model output.” (This is essentially identical to the definition of the term in ASOP No. 41.) Some actuaries have expressed concern that this definition is unclear: In its broadest sense, an intended user could be any person the actuary thinks might theoretically rely on the model output—for example, an individual who relies on a financial report containing a pension plan’s annual expense.

However, a plain reading of the definition of “intended user” is more limited. That is, an intended user is anyone the actuary indicates as permitted to rely on the report. Given the ambiguity, cautious actuaries might want to consider carefully defining the intended user for each actuarial communication.

Appendix: Case Studies

The valuation of defined benefit pension plan liabilities is likely the most common example of a model pension actuaries will encounter. These case studies intend to discuss the various actuarial roles and responsibilities in this particular project from start to finish, as well as discuss where other experts may be involved and need to be considered as being relied on for purposes of ASOP No. 56.

Performing a pension valuation using an actuarial valuation software program

a) The “off-the-shelf” software package

Many actuaries use a computer software package to calculate pension liabilities, either a third-party-developed and purchased software or an internally controlled company-designed software. The package itself will not be specifically designed for a particular client, plan, or year, but be a customizable model often with pre-programmed common plan design structure alternatives and the option to customize to a more granular level. The following areas of the ASOP No. 56 apply and actuaries may encounter some or all of these components.

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i) **Design**—The process of creating the actuarial valuation software and its structure, user interfaces, and presentation of results will likely be done by a professional computer software designer and may or may not also involve actuaries providing output to specific clients. If the designers are actuaries, they are required under the ASOP to confirm the model is capable of meeting the intended purpose—in this case, valuing pension liabilities. However, as the software is typically designed explicitly for that purpose, this should be an easily attainable goal.

ii) **Evaluate and select**—Many actuaries will not be responsible for selecting the actuarial software they use to value pension liabilities; that choice will be made for them by someone else at their company. Actuaries selecting the package, however, should thoroughly evaluate the available options for appropriateness for their intended purpose before selecting a model accordingly. For example, the selecting actuary might consider the following: ease of use, reasonable controls to prevent inadvertent mistakes, reasonable processing time to produce results, product lifetime, and ability to provide useful and customizable reports.

iii) **Governance documentation**—Professional valuation software packages will typically have documentation (in the form of a manual or user guide) describing how the software works. The documentation may also cover known limitations and intended use of the software. There will often also be version documentation, where updates and programming fixes are communicated to the user. These items, in addition to the controls below, would seem to be a comprehensive set of procedures and structure to meet the requirements of the governance in the standard.

iv) **Controls**—Professional valuation software packages typically prevent users from making changes to the underlying code. The user interface is often designed to allow specific structure of coding—for example, a final average pay plan structure may allow a range of x% of salary, various common salary averaging options, and certain common offsets like Social Security benefits or covered compensation. Some software may also include warnings or error messages.

v) **Reliance and disclosure**—Ideally, the actuary who relies on the model will gain a basic understanding of the model’s operation, strengths, and limitations. If the actuary does have this understanding of the model and detailed documentation is available for the model, disclosure may not be required.

b) Developing the plan-specific model

Although the “off-the-shelf” software package is a complex model on its own, the actuary cannot use the model to value a specific pension plan without further customization. The following areas of the standard apply, and actuaries may encounter some or all of these components.

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- i) **Develop**—The most substantial customization of the software package for a particular pension plan will usually take place when the plan is first valued by a particular actuarial firm—for example, during the transition process for a new client. The software will be updated to reflect the plan’s provisions, assumptions, and methods used to value liabilities. As when designing a software package, the actuary is required under the standard to ensure that the developed model meets the intended purpose of valuation of the specific pension plan’s liabilities.
- ii) **Review and testing**—Once the model is customized, the inputs should be checked to confirm they were entered correctly (e.g., no typos) and output reviewed to ensure the inputs are being used in the processing component as intended. This may be referred to as reviewing “test cases” or “sample lives.” The accuracy of this first version of the model, particularly when transitioning a new client, would typically be reviewed by also incorporating the most recent data and assumptions. This would generally be tested to ensure that the prior actuary’s results at the same measurement date are consistent with the model’s results within industry acceptable thresholds. This review can be done by the actuary developing the model or another actuary.
- iii) **Modify**—The development of the customized client model will be ongoing as a result of yearly review, data updates, assumption changes, plan amendments, law changes, or changes to the underlying valuation package. The same responsibilities to developing will apply, just on a smaller and more targeted scale.
- iv) **Reliance on models developed by others**—The actuary relying on the customized version of the model should make a reasonable attempt to gain a basic understanding of its operation, strengths, and limitations. If information regarding the workings of the model is available in enough detail that the actuary can gain understanding of it, including detail on the plan-specific coding, reliance does not need to be disclosed. Whether the actuary must disclose reliance on the developer of the valuation model is a matter of professional judgment as to whether the criteria are met.
- v) **Reliance on experts**—Reliance on experts may need to be disclosed—for example, when using capital market assumptions provided by an expert in the process of modeling a discount rate assumption.

c) Using the model to calculate pension liabilities

Probably the most common application for actuaries will be using the plan-specific model to calculate pension liabilities. The following areas of the standard apply, and actuaries may encounter some or all of these components.

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- i) **Develop**—Further development of the model may be required to ensure the provisions, data, assumptions, and methods are appropriate for a particular measurement date, e.g., annually changing actuarial equivalence, or new plan amendments.
- ii) **Model inputs**—Preparing the census data and assumption inputs for a particular valuation cycle will likely be done at least annually and will be input into the system. The actuary should confirm the data is appropriate for the model. For example, if the deferred vested coding refers to a specific field with an age 65 benefit, that field should be populated and reasonable for all deferred vested participants. Or if assumptions vary by a coded field, that coded field should be available on the data. The actuary should also go through the process of selecting and evaluating assumptions as pension actuaries are used to doing for compliance with ASOPs Nos. 27 and 35. There may be additional evaluation of prescribed assumptions.
- iii) **Testing**—Ensuring the plan-specific model is working as expected, an actuary may use some or all of the following tests per the standard:
- Checking input values are appropriately being reflected.
 - An initial run of liabilities using the new data with prior year assumptions can be reviewed and checked for consistency against prior year liabilities for expected and unexpected changes.
 - Confirming the assumptions and provisions are being used correctly, and if any have changed, that those changes produce expected changes in results, both in direction and magnitude.
 - Checking of varied sample or test lives for data, plan provisions (e.g., benefits calculated, early retirement factors applied), and assumptions (e.g., withdrawal decrement tables applied, discount rates applied).
- iv) **Documentation of the model**—Although documentation of the model is not a requirement of the standard, internal documentation is nonetheless helpful for the actuary to communicate model details to other actuaries. Such documentation may include any changes made to the model as a result of annual updates, new developments, etc.

d) Reviewing results without directly using model

Senior actuaries may rarely come into contact with the model itself and may review only the model output, or even the results from the output in another format, such as the annual valuation report. The following discusses the roles and responsibilities in this situation.

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i) **Review and testing (in model output format, or in another format)**—Ensuring the results coming out of the model are appropriate, an actuary might do a higher-level review, based on those outlined in section 3.6.2 of the ASOP:

- Testing the results of the model are consistent with historical results, e.g., the changes in liability are reasonable given changes in assumptions or plan provision.
- Performing tests to assess reasonableness; e.g., comparing to a simple liability rollforward.
- Comparing output to results from another model; e.g., comparing the liability to results from a projection model.

ii) **Review by another professional**—In the case of an actuary performing only a high-level review, typically another professional will undertake a more detailed review. In a team of actuaries, this is a typical scenario. The actuary responsible for the project deliverable should confirm those team members who are responsible for detailed reviewing are competent to do the work.

iii) **Reliance on models developed by others**—The actuary who is relying on a broader team or other actuaries to meet the standard may need to disclose the reliance if they do not have access to sufficient information about the model.

iv) **Reliance on experts**—The development of the model may have relied on inputs from experts that need to be disclosed.

v) **Disclosure**—The standard does require disclosures in an actuarial valuation report or associated model documentation about the model, and reliance. Even if the actuary signing the report did not personally assess the model, these disclosures need to be included and reliance documented.

e) **Summary of disclosures for a valuation report**

Regardless of the actuary's role in the preparation of a valuation report or deliverable, the following disclosures are required, if applicable:

- i) **The intended purpose of the model**—Document the intended purpose for all models used in the report.
- ii) **Material inconsistencies, if any, among assumptions, and known reasons for such inconsistencies**—Document any known inconsistencies. For assumptions prescribed by law, such as stabilized valuation interest rates, disclosure is limited to noting a possibility of inconsistency.
- iii) **Unreasonable output resulting from the aggregation of assumptions, if material**—Document if applicable.
- iv) **Material limitations and known weaknesses**—Document if applicable.

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- v) **Extent of reliance on models developed by others**—As discussed in “Developing the plan-specific model,” the inclusion of this reliance depends on the actuary’s access to information about the model.
- vi) **Extent of reliance on experts**—The development of the model may have relied on inputs from experts that need to be disclosed.

Performing a liability calculation for retirees in a spreadsheet

a) Model designed and developed by the actuary

For less complicated valuations of liabilities, the actuary may create a model specifically to meet the intended purpose. The following areas of the standard may apply, and actuaries may encounter some or all of these components.

- i) **Design**—The actuary should design the model so that it meets the intended purpose—in this case, valuing pension liabilities. The actuary might consider the level of detail built into the model and potential dependencies; for example, whether the model reflects contingent mortality for beneficiaries after the primary beneficiary’s death. The actuary might also consider the model’s ability to identify possible volatility and the ease of modeling that volatility, such as the impact of changes in the mortality table or discount rate changes.
- ii) **Evaluate and select**—If the actuary is designing the model, this may not be applicable, but if an actuary leverages the model another actuary designed, they should evaluate the model to determine whether it is appropriate for the intended purpose. For example, if the retirees’ benefits being valued have cost-of-living increases, the actuary would want to confirm that the model accommodates this feature.
- iii) **Governance documentation**—The actuary might consider adding notes about the model to the spreadsheet for documentation purposes, such as instructions for use, limitations of the model, and when the model was last modified and tested.
- iv) **Controls**—The actuary might build in features to the model, such as referencing a named cell for regularly changed assumptions (e.g., discount rate). The actuary might also add restrictions to cell entries, such as not allowing the discount rate to be negative or higher than 10%.
- vi) **Review and testing**—Once the model is developed, the inputs are typically checked to confirm they were entered correctly (no typos) and output reviewed to ensure the inputs are being used in the processing component as intended. This may be referred to as reviewing “test cases” or “sample lives.” This review can be done by the actuary developing the model or another actuary.
- vii) **Modify**—Each year the model may be updated for data updates, assumption changes, plan amendments, or law changes. The same responsibilities to developing will apply, just on a smaller and more targeted scale.
- viii) **Reliance and disclosure**—If the actuary communicating the results in the report has a full understanding of the model’s operation, strengths, and

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limitations, disclosure may not be required. However, if the actuary is relying on a model developed and tested by other team members, a disclosure may be needed indicating reliance on a model developed by others if they do not have understanding of the model.

b) Using the model to calculate pension liabilities

i) **Develop**—Further development of the model may be required to ensure the provisions, assumptions, and methods are appropriate for a particular measurement date; e.g., updates to discount rate and/or mortality table.

ii) **Model inputs**—Preparing the census data and assumptions inputs for a particular year will likely be done at least annually and will be input into the system. The actuary should confirm the data is appropriate for the model (for example, confirming the contingent annuitant's birth date available). The actuary should also go through the process of selecting and evaluating assumptions as pension actuaries are used to doing for compliance with ASOPs Nos. 27 and 35. The actuary may perform additional evaluation of prescribed assumptions.

iii) **Testing**—Ensuring the plan-specific model is working as expected, an actuary may use some or all of the following tests per the standard:

- Checking input values are appropriately being reflected.
- Checking for consistency against prior year liabilities for expected and unexpected changes.
- Confirming the assumptions and provisions are being used correctly, and if any have changed, that those changes produce expected changes in results, both in direction and magnitude.
- Checking of varied sample or test lives for data, plan provisions, and assumptions.

iv) **Documentation of the model**—The actuary may want to note any changes made to the model as a result of annual updates to data or new developments to the model. Although documentation may not be a requirement, internal documentation for the actuary to communicate to other actuaries regarding details of the models is encouraged.

c) Reviewing results without directly using model

Senior actuaries may rarely come into contact with the model itself and may review only the model output, or even the results from the output in another format, such as the annual valuation report. The following discusses the roles and responsibilities in this situation.

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i) **Review and testing (in model output format, or in another format)**—In order to ensure that the results coming out of the model are appropriate, an actuary may do a higher-level review, based on those outlined in section 3.6.2 of the standard:

- Testing the results of the model are consistent with historical results; e.g., the changes in liability are reasonable given changes in assumptions or plan provisions.
- Performing tests to assess reasonableness; e.g., comparing to a simple liability rollforward.
- Comparing output to results from another model; e.g., comparing the liability to results from a projection model.

ii) **Review by another professional**—In the case of an actuary performing only a high-level review, typically another professional will undertake a more detailed review. In a team of actuaries this is a typical scenario. The actuary responsible for the project deliverable typically confirms that those reviewing are competent to do the work.

iii) **Reliance on models developed by others**—The actuary who is relying on a broader team or other actuaries to meet the standard may need to disclose the reliance if they do not have access to appropriate information about the model.

iv) **Reliance on experts**—The development of the model may have relied on inputs from experts that need to be disclosed.

v) **Disclosure**—The standard does require disclosures in an actuarial valuation report or associated model documentation about the model, and reliance. Even if the actuary signing the report did not personally assess the model, these disclosures need to be included and reliance documented.

d) Summary of disclosures for a valuation report

Regardless of the actuary's role in the preparation of a valuation report or deliverable, the following disclosures are required, if applicable:

- i) **The intended purpose of the model**—Document the intended purpose for all models used in the report.
- ii) **Material inconsistencies, if any, among assumptions, and known reasons for such inconsistencies**—Document any known inconsistencies. For those assumptions prescribed by law, such as stabilized valuation interest rates, disclosure is limited to noting a possibility of inconsistency.
- iii) **Unreasonable output resulting from the aggregation of assumptions, if material**—Document if applicable.
- iv) **Material limitations and known weaknesses**—Document if applicable.

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- v) **Extent of reliance on models developed by others**—As discussed in “Model designed and developed by the actuary,” the inclusion of this reliance depends on the actuary’s access to information about the model.
- vi) **Extent of reliance on experts**—The development of the model may have relied on inputs from experts that need to be disclosed.