A Public Policy Practice Note

Selecting and Documenting Mortality Assumptions for Measuring Pension Obligations

Revised January 2023

Developed by the Pension Committee

American Academy of Actuaries

Selecting and Documenting Mortality Assumptions for Measuring Pension Obligations[1]

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[1] Includes other post-retirement benefit plan obligations.

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 information to actuaries on current and emerging practices in the selection and documentation of the mortality assumptions for measuring obligations of defined benefit pension plans and other post-retirement benefits plans. The intended users of this practice note are the members of actuarial organizations governed by the ASOPs promulgated by the Actuarial Standards Board.

Measurements of defined benefit pension plan obligations include calculations that assign plan costs to time periods, actuarial present value calculations, and estimates of the magnitude of future plan obligations. This practice note does not apply to individual benefit calculations or individual benefit statement estimates. The application of the information contained herein is intended to cover U.S. tax-qualified and non-qualified plans, and governmental and non-governmental plans for which the actuary is subject to ASOP No. 35, *Selection of Demographic and Other Noneconomic Assumptions for Measuring Pension Obligations,* ASOP No. 41, *Actuarial Communications,* ASOP No. 51, *Assessment and Disclosure of Risk Associated with Measuring Pension Obligations and Determining Pension Plan Contributions,* ASOP No. 56, *Modeling* and ASOP No. 25, *Credibility Procedures*. This practice note reflects the changes in ASOP No. 35 that are effective for actuarial reports issued on or after August 1, 2021, and when the measurement date in such report is on or after August 1, 2021.

It is anticipated that this practice note may be helpful to pension actuaries when setting assumptions, providing advice on setting assumptions or assessing the reasonableness of assumptions, for funding (where permitted by law), and for financial accounting. In general, references to an actuary selecting assumptions also apply to an actuary giving advice on selecting assumptions. For example, the actuary may provide advice on selecting assumptions under U.S. GAAP standards even though another party is ultimately responsible for selecting those assumptions. However, this practice note is not an interpretation of the 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.

This practice note does not cover the discount rate, investment return, other economic, or non-mortality demographic assumptions. The investment return assumption (particularly when used as a discount rate) is covered in separate practice notes published by the Academy: *Selecting Investment Return Assumptions: Considerations When Using Arithmetic and Geometric Averages* (July 2019)[2] and *Forecasting Investment Returns and Expected Return Assumptions for Pension Actuaries* (February 2019).[3] Other

[2] https://www.actuary.org/sites/default/files/2019-07/ASOP_27_7312019.pdf

[3] https://www.actuary.org/sites/default/files/files/publications/Setting_Expected_Investment_Returns_2_27_2019.pdf.

economic or non-mortality demographic assumptions are discussed in *Selecting and Documenting Pension Assumptions Other than Discount Rate, Investment Return, and Mortality* (revised practice note forthcoming).

This practice note is intended to assist actuaries by describing some approaches for selecting (including giving advice on selecting), assessing the reasonableness of, and documenting mortality assumptions that the Committee believes could be employed to comply with ASOP No. 35. In addition, ASOP No. 4, *Measuring Pension Obligations and Determining Pension Plan Costs or Contributions*, and ASOP No. 6, *Measuring Retiree Group Benefits Obligations and Determining Retiree Group Benefits Program Periodic Costs or Actuarially Determined Contributions*, address broader measurement issues for pension and other post-retirement benefit plans and provide guidance for coordinating and integrating the elements of these measurements that are not addressed in this practice note.[4] Note that this practice note does not reflect the potential updates to ASOP No. 4 that will be effective in 2023 or 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 mortality.[5] In particular, ASOP No. 1, *Introductory Actuarial Standard of Practice*, provides useful guidance as to the general meaning of common terms used in ASOPs.[6]

This practice note replaces the June 2015 version and has been updated to reflect new information published by the Retirement Plans Experience Committee (RPEC) of the Society of Actuaries (SOA), updates to the ASOPs, and evolution of generally accepted practice since that time.

Actuaries are encouraged to read the publications of the SOA concerning pension mortality tables and mortality improvement scales. As of the publication date of this practice note, this material is available at https://www.soa.org/sections/retirement/pension-mortality-resources/.

This practice note is intended to be illustrative and spur professional discussion on this topic. Other reasonable selection and documentation methodologies currently exist, and new ones likely will evolve in the future.

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 emailing pensionanalyst@actuary.org.

[4] In the event of a conflict between the guidance provided in ASOP Nos. 4 or 6 and the guidance provided in ASOP No. 35, ASOP Nos. 4 and 6 govern.
[5] For example, ASOP No. 12, *Risk Classification (for All Practice Areas)*, and ASOP No. 23, *Data Quality*.
[6] 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. Mortality and Mortality Improvement Assumptions

General Requirements of ASOP No. 35

The Actuarial Standards Board (ASB) originally adopted ASOP No. 35 in 1999. The ASOP was most recently revised in June 2020 and is effective for actuarial reports issued on or after August 1, 2021, and when the measurement date in such report is on or after August 1, 2021.

ASOP No. 35 provides guidance to actuaries in selecting demographic assumptions for measuring obligations under defined benefit pension plans that are not social insurance programs (unless the ASOPs on social insurance programs specifically call for application of these standards). The measurements of obligations for this purpose include the assignment of plan costs to time periods (such as funding valuations), liability measurements or other actuarial present value calculations. It also includes cash flow projections and other estimates of the magnitude of future plan obligations. Measuring obligations for this purpose, however, does not generally include individual benefit calculations, individual benefit statement estimates, or nondiscrimination testing. When measuring pension obligations, actuaries should also consider the guidance on actuarial models in ASOP No. 56.

The practice note addresses assumptions selected by the actuary, as well as how to apply standards for prescribed assumptions, as defined in sections 2.6 and 2.7 of ASOP No. 35.

- A prescribed assumption set by another party is a specific assumption that is selected by another party, to the extent that law, regulation, or accounting standards give the other party responsibility for selecting such an assumption. For this purpose, an assumption selected by a governmental entity for a plan that such governmental entity or a political subdivision of that entity directly or indirectly sponsors is a prescribed assumption set by another party.
- A prescribed assumption set by law is a specific assumption that is mandated or selected from a specific range or set of assumptions that is deemed to be acceptable by applicable law. For this purpose, an assumption selected by a governmental entity for a plan that such governmental entity or a political subdivision of that entity directly or indirectly sponsors is not a prescribed assumption set by law.

ASOP No. 35, section 3.1 provides that an "actuary should use professional judgment to estimate possible future outcomes based on past experience and future expectations and select assumptions based upon application of that professional judgment."

ASOP No. 35 outlines a general process an actuary should follow for selecting demographic assumptions in section 3.2. The actuary does not need to follow this complete process at each measurement date for each assumption if previously selected

assumptions continue to be reasonable, in the actuary's professional judgment. The process includes:

- Identifying the types of assumptions (see discussion below);
- Considering an assumption universe relevant to each type of assumption identified (e.g., published tables, plan experience, published studies, future expectations, etc.);
- Selecting assumption formats (e.g., a table of rates or point estimate);
- Selecting the specific assumptions, taking into account factors such as the purpose and nature of the measurement, plan design features that may influence the assumption, plan specific or other relevant experience, and relevant factors that may affect future experience; and
- Selecting a reasonable assumption (see discussion below).

It may be appropriate to use different assumptions for different segments of the covered population. In all cases, the actuary should take into account the significance of each assumption selected, which may include the consequences of experience deviating significantly from the selected assumption.

When identifying the types of assumptions to use for a specific measurement, the actuary should take into account the following factors:

- The purpose of the measurement;
- The plan provisions or benefits and factors that will affect the timing and value of any potential benefit payments;
- The characteristics of the obligation to be measured, such as measurement period, pattern of plan payments over time, open or closed group, and volatility;
- The contingencies that give rise to benefits or result in loss of benefits;
- The materiality of each assumption to the measurement; and
- The characteristics of the covered group.

The actuary does not need to select a separate assumption for every contingency. For example, the actuary may use an assumption that combines several contingencies rather than selecting a separate assumption for each if a plan is expected to provide benefits of equal value to employees who voluntarily terminate employment or become disabled, retire, or die.

General considerations that should also be taken into account when applicable are identified in section 3.10 of ASOP No. 35, and include:

- Assessing whether adjustments are needed due to adverse deviation or plan provisions that are difficult to measure, depending on the purpose of the measurement, as discussed in ASOP No. 4;
- Using the actuary's professional judgment to provide the appropriate balance between refined assumptions and materiality;

- Determining the appropriate balance between refined assumptions and the cost of using refined assumptions;
- Ensuring that the combined effect of all assumptions selected by the actuary is expected to have no significant bias (i.e., it is not significantly optimistic or pessimistic) except when provisions for adverse deviation are included or when alternative assumptions are used for the assessment of risk, in accordance with ASOP No. 51;
- Reflecting changes in circumstances due to an event after the measurement date that the actuary learns about and believes is appropriate to use in determining the assumption as of the measurement date; and
- Incorporating the data and analyses from a variety of sources, including representatives of the plan sponsor and administrator, demographers, economists and other professionals, while still reflecting the actuary's professional judgement.

According to section 3.2.5 of ASOP No. 35, a reasonable assumption has the following characteristics:

- It is appropriate for the purpose of the measurement;
- It reflects the actuary's professional judgment;
- It takes into account historical and current data that is relevant to selecting the assumption for the measurement date (to the extent relevant data is reasonably available);
- It reflects the actuary's estimate of future experience, observation of estimates inherent in market data (if any), or a combination of both; and
- It is expected to have no significant bias (i.e., it is not significantly optimistic or pessimistic), except when provisions for adverse deviation or plan provisions that are difficult to measure are included and disclosed or when alternative assumptions are used for the assessment of risk.

In selecting a reasonable assumption, the actuary may consider several different assumptions as reasonable for a given measurement. Also, due to differences in professional judgement, different actuaries may choose different reasonable assumptions. Therefore, it is possible for there to be a range of reasonable assumptions, both for an individual actuary and across actuarial practice, which is discussed in section 3.3 of ASOP No. 35. However, ASOP No. 35 no longer discusses a best-estimate range for purposes of selecting reasonable assumptions.[7] Section 3.8 of ASOP No. 35 requires the actuary to assess the reasonableness of assumptions not selected by the actuary (except for prescribed assumptions set by law or any assumption the actuary is unable to assess for reasonableness for the purpose of the measurement). In discussing the word "reasonable," section 2.10 of ASOP No. 1 says that "there will often be a range of reasonable methods and assumptions, and two actuaries could follow a particular ASOP,

[7] This change was made with the prior ASOP updates, which were effective for measurement dates on or after September 30, 2014.

both using reasonable methods and assumptions, and reach different but reasonable results."

Consistency in Assumptions

As provided in section 3.6 of ASOP No. 35, all demographic assumptions selected by the actuary should be reviewed for consistency with the other assumptions selected by the actuary (including economic assumptions, with respect to a particular measurement) unless the assumption, considered individually, is not material. For example, if a covered population has changed and has shifted from a blue- to white-collar workforce, then a mortality table change along with similar turnover and retirement assumption changes may be appropriate. Economic and demographic assumptions may be subject to common influences. Continuing the above example, if the employer's business is becoming more of a high-tech environment, it may also be appropriate to reflect that fact in the compensation increase assumption. In addition, the actuary should evaluate the assumptions for consistency with demographic assumptions used for measurements of different benefit plans covering the same covered group, if that information is available to the actuary. To the extent the actuary determines that inconsistencies exist, the actuary should determine whether those inconsistencies are reasonable and make adjustments where appropriate. The actuary is not required to select assumptions that are consistent with assumptions that are not selected by the actuary.

Generally, changes in mortality assumptions are not phased-in over multiple measurement dates. However, if a mortality assumption is phased-in, section 3.9 of ASOP No. 35 says that an actuary should determine the reasonableness of the assumption and its consistency with other assumptions as of the measurement date at which it is applied, without regard to planned assumption changes for future measurement dates.

The actuarial assumptions and the relationships among them should be reviewed and updated if appropriate at each measurement date, as stated in section 3.7 in ASOP No. 35.

Experience Analysis

Generally, actuaries do not need to undertake a complete assumption study at the time of each measurement. However, many actuaries conduct and document an analysis of actual plan experience and its effect on the plan's liability versus the assumed experience every three to five years for significant assumptions. Alternatively, some assumptions may be reviewed more frequently, but less rigorously, with a more thorough analysis conducted if the results of the basic analysis indicate that the experience may be deviating from the assumption. For example, assumptions may be tested against evolving experience by comparing the expected experience with the actual number of participants affected, calculating the plan's liability gain or loss by source, etc. The results for one year may not be indicative of a need to update the assumption, but a consistent trend over several years may indicate the need for a change. The analysis may be adjusted for any unusual events during the study period, such as an early retirement window, lump sum offer, or

workforce reduction. See the discussion below about coordination with ASOP No. 25 for more information about reflecting credibility.

In addition to the assumptions examined for recent experience, all assumptions may be examined with respect to changes, if any, in reasonable expectations of future experience or actual experience collected over a longer period of time. When assessing whether to use past experience in setting an assumption, the actuary may take into account whether the experience period is likely to be representative of the future, and "should not give undue weight to experience" that may be not relevant to future expectations. For small employer plans or other situations for which experience may not be sufficiently credible, a comparison of the assumptions to past experience may be less useful. However, even for these plans, a periodic review of assumptions based on current expectations for the employer's business and workforce is warranted.

Special events (e.g., pension plan changes, risk transfer transactions, retiree health plan changes, human resource policy changes, early retirement windows, pandemics, employer withdrawals from a plan, plan spin-offs or mergers, significant expansion or contraction of the workforce) may trigger a need for an additional review and documentation of the selection of actuarial assumptions. The actuary may consider whether the occurrence of the event could significantly alter the future experience of the plan and whether any assumption changes are warranted to better reflect that future experience.

ASOP No. 35 applies not just when an actuary selects an assumption, but also when an actuary gives advice on selecting an assumption; in general, this note refers to an actuary selecting assumptions, but also generally refers to when an actuary gives advice on selecting assumptions. Many sections of ASOP Nos. 35 and 4 do not apply to prescribed assumptions set by law (i.e., statutes, regulations, or other legally binding authority), such as assumptions prescribed in Internal Revenue Code Regulation 1.430(h)(3)-1; however, certain disclosures are required for prescribed assumptions set by law as described in section 4 of ASOP No. 4.

Coordination With ASOP No. 56

In addition to the requirements of ASOP No. 35, pension actuaries must comply with the requirements of ASOP No. 56, which generally covers all practice areas. Note that most of the guidance in ASOP No. 56 is consistent with the guidance in ASOP No. 35 but there are variations among the guidance for the actuary to consider. Specifically, the 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 ASOP No. 35) notes that the guidance on this topic is applicable only when the actuary takes responsibility for the assumption. The guidance in ASOP No. 35 is more robust while still consistent with the guidance on this topic in ASOP No. 56; therefore, the actuary should make sure to follow ASOP No. 35.

- *Range of assumptions.* Both 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 both ASOPs discuss consistency between all assumptions, ASOP No. 35 specifically states, "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." ASOP No. 35 does not require—but does 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 conflicts with or supplements ASOP No. 35.

  If inconsistent assumptions are used in modeling, disclosing the inconsistency and the reason for it would appear to satisfy ASOP Nos. 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 ASOP No. 35, but in that standard 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. ASOP No. 35 requires 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 satisfied.

  Note that the assessment under ASOP No. 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 the issue of consistency between assumptions 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.

Coordination with ASOP No. 25

ASOP No. 35 contains brief discussions of credibility and advises that the actuary should refer to ASOP No. 25, *Credibility Procedures*, for additional guidance. It is therefore important to understand when ASOP No. 25 applies, and how it may affect the assumption-setting process.

ASOP No. 25 applies to all actuarial areas and defines credibility as a measure of the predictive value the actuary attaches to a particular set of data. A credibility procedure is defined as a process that involves either "the evaluation of subject experience for potential use in setting assumptions without reference to other data" or as "the identification of relevant experience and the selection and implementation of a method for blending the relevant experience with the subject experience" for potential use in setting assumptions.

ASOP No. 25 applies to actuaries when performing actuarial services involving credibility procedures in the following situations:

- when the actuary is required by applicable law (statutes, regulations, and other legally binding authority) to evaluate credibility;
- when the actuary chooses to evaluate the credibility of subject experience, or states in any related actuarial communication that credibility has been evaluated in accordance with this ASOP;
- when the actuary is blending subject experience with other experience; or

- when the actuary represents the data being used as statistically or mathematically credible.

The first of these situations generally apply to pension actuaries only in limited situations. One example of when the actuary is legally required to evaluate credibility is when a plan that is subject to the single-employer funding rules under section 430 of the Internal Revenue Code (IRC) applies to use plan-specific mortality. In most situations, and for most assumptions, however, evaluating the credibility of an assumption is not legally required.

The second situation would apply if the actuary chooses to evaluate credibility (or is directed by a principal to evaluate credibility) and represents that credibility has been evaluated in accordance with ASOP No. 25. An actuary may choose to follow this approach if sufficiently credible data are available for a given assumption and the actuary represents that credibility procedures have been followed. This is very similar to the fourth situation noted above; however, in that situation the actuary may have a reason to represent that the data is credible without formal evaluation or may have been asked to evaluate the credibility by a principal.

The third situation—blending of subject experience (plan experience) with other relevant experience—is the one that is most likely to be relevant to a pension actuary. This will typically apply when there is other relevant experience that might also be used to set the assumption such as, for example, when blending plan mortality experience with a standard mortality table published by RPEC. When creating a custom mortality table, the plan experience may be blended with the standard table by utilizing statistical credibility procedures such as Bayesian credibility procedures or limited fluctuation model, when data are judged to be only partially credible.

ASOP No. 25 does not apply outside of these situations. For example, an actuary may conclude that there is no other relevant experience with which to blend the plan experience. In this situation the actuary may conclude that, despite a lack of credibility, plan experience is relevant in setting an assumption. An example might be the retirement assumption, for which standard assumptions generally do not exist.

ASOP No. 25 contains a more detailed discussion of the selection of other relevant experience with which to blend plan experience and notes that there may be a considerable element of actuarial judgment involved in deciding on the weight to give to each. When selecting relevant experience, with which to compare subject experience, ASOP No. 25 states that the relevant experience should have similar characteristics to the subject experience. The topic of risk characteristics is covered in ASOP No. 12, *Risk Classification (for All Practice Areas).*

ASOP No. 35 notes that "specific experience of the covered group or other groups with similar characteristics may be useful in forming a judgment about future expectations. However, the actuary should not give undue weight to experience that is not sufficiently credible." Whether experience is sufficiently credible may depend on whether there is other relevant experience that might be considered as an alternative in setting that assumption. Where other relevant experience does not exist, the actuary may apply a lower threshold for considering plan experience than would be the case if standard tables or an aggregation of experience for similar employers were available.

ASOP No. 35 also advises that the actuary should not give undue weight to experience that may not be relevant to future expectations. The example cited in the ASOP is where recent rates of termination and retirement are largely attributable to a one-time workforce reduction. For many employers, experience during 2020 and 2021 will be heavily influenced by the COVID-19 pandemic and its aftermath and may similarly not be a particularly useful in setting future expectations.

Credibility Educational Resource for Pension Actuaries, published by the Society of Actuaries in 2017, is a useful resource.[8]

Published Tables

When choosing a reasonable mortality assumption, actuaries often reflect published mortality tables and mortality improvement scales, unlike when choosing other demographic assumptions. They will sometimes choose separate tables for different demographic groups or reflect the demographics of the entire covered group in selecting or adjusting a published table or other set of tables and/or published improvement scales. If the plan population has sufficient size to generate mortality experience data that are judged by the actuary to be statistically credible, use of its own mortality table or, in the case of partially credible data, using an adjustment to a published table to reflect this experience, may also be appropriate.

The Appendix contains descriptions of several pension mortality tables and mortality improvement scales published in the past 10 years. The inclusion of any particular table should not be considered an indication of current best practice.

Because standard mortality tables and mortality improvement scales are issued frequently, actuaries are encouraged to familiarize themselves with new data when they become available.

[8] https://www.soa.org/globalassets/assets/files/static-pages/sections/retirement/credibility-resource-pension.pdf.

General Framework of Mortality Assumptions

Selection of a mortality assumption generally involves a two-step process: (1) choosing an appropriate set of base mortality tables, and (2) selecting (past and future) mortality improvement rates.[9]

Selecting Base Mortality Assumptions

Section 3.4.3 of ASOP No. 35 provides guidance on the selection of the mortality assumption and generally states that the actuary should take into account factors such as:

- The characteristics of employees and retirees (for example, whether it may be reasonable to use different assumptions before and after retirement, especially given the differences found between employee and retiree mortality rates in recent studies)[10]
- The size of the covered population (for example, whether for a small plan it may be reasonable to assume no mortality before retirement);
- The characteristics of disabled lives, considering the plan's definition of disability and/or administration of disability provisions (for example, whether it may be appropriate to use a disabled mortality table or some other adjustment to healthy mortality); and
- The characteristics of different participant subgroups and beneficiaries (for example, whether it is appropriate to use different mortality tables for different groups, like white- and blue-collar participants).

In most cases, a mortality assumption is appropriate. However, the absence of a pre-retirement mortality assumption may be reasonable if the small size of the pension population does not justify the use of a mortality assumption for the period prior to assumed retirement. (See ASOP No. 35, section 3.4.3(b).) This approach can also be used to simplify the measurement when the use of a pre-retirement mortality table would not be expected to produce a materially different result (such as when a death benefit is provided that is equal to the actuarial reserve under the actuarial funding method).

Private Plan Published Base Mortality Tables (Including Multiemployer Plans)

The most recently published mortality tables for Private Retirement Plans are the Pri-2012 Tables (see the Appendix for more information). The Pri-2012 report indicates a difference between employee, annuitant, and disabled mortality (as did the RP-2014 and RP-2000 reports that preceded it). These differences may or may not be material in a given situation (depending on the assumed form of payment, small or large plan, etc.).

[9] Although rarely used in pension valuations, select and ultimate mortality tables may be appropriate in certain circumstances. Arguably, select and ultimate assumptions can be used for base tables and/or mortality improvement rates to reflect expected changes over time. See a brief section later in this practice note discussing this type of tables.

[10] For example, in the Pri-2012 family of mortality tables for the Total Dataset, mortality rates for retirees may be two to three times higher than employee rates at the same age.

In addition, the Pri-2012 report added new tables to use for Contingent Survivors (i.e., surviving beneficiaries of a former participant who is in receipt of a benefit) based on experience for beneficiaries *only after the primary participant's death.*[11] However, because of lack of complete data in some pension plans, the Pri-2012 report provided three different approaches that actuaries may consider in using these new tables when calculating joint-and-survivor annuities in the Pri-2012 environment, and acknowledged that other approaches could also be reasonable:[12]

1. Use retiree mortality for all beneficiaries, except use the rates applicable to the beneficiary's gender;
2. Use retiree mortality for the beneficiary (with beneficiary gender, as in Approach 1) while the primary participant is alive and the contingent survivor mortality rates for the beneficiary after the primary participant's death; and
3. Use contingent survivor mortality rates for the beneficiary both before and after the primary participant's death.

Collar is considered by some actuaries when selecting a mortality assumption. The collar effect was studied and discussed in preparation of the Pri-2012 mortality tables (see more about how collar was determined for these tables in the Appendix). The Pri-2012 Report says the following about plans when referencing the use of the White- or Blue-Collar Tables:

> "For plans whose covered populations meet either of these criteria, the corresponding collar-specific table may more accurately model the mortality patterns of the covered population than the "total population" table. For plans that do not meet these criteria, one option is to use the "total population" table. Another alternative would be to segment the population into Blue Collar and White Collar and apply the corresponding tables to those two subpopulations. A third alternative would be to apply a blended Blue/White Collar table to the population, where the proportions used in the blending are based upon the proportions of Blue Collar and White Collar data in the underlying population."[13]

In addition, the Pri-2012 Report indicated that participants in multiemployer plans did not exhibit significantly different mortality than participants in single employer plans, after "controlling for other factors, such as collar type and income level."[14] The Pri-2012 Report also indicated that, in general, the industry of the population was not found to be a useful predictor of mortality in the data collected. However, the report did not conclude

[11] When deciding how to reflect mortality for contingent survivors, actuaries may want to consider whether these conditional probabilities may be biased, as they reflect observed mortality rates contingent on another death event that could be highly correlated with the beneficiary's mortality. See, for example, the Committee's comment letter to IRS on updated mortality tables discussing this topic: https://www.actuary.org/sites/default/files/2020-03/AAA%20Comment%20Letter%20re%20IRS%20Notice%202019-67_Notice%202019-0053.pdf.
[12] Society of Actuaries, "Pri-2012 Private Retirement Plan Mortality Tables Report," page 59.
[13] Society of Actuaries, "Pri-2012 Mortality Tables Report," October 2019, section 12.2.2, page 55.
[14] Society of Actuaries, "Pri-2012 Mortality Tables Report," October 2019, section 1.3, page 7.

that industry was unimportant, just that the data collected for the study did not support the development of different tables by industry.[15] Regardless, in practice, some actuaries do reflect mortality differences by industries based on professional judgement and/or observed data.

Although the work in connection with Pri-2012 showed that salary level and benefit amounts are statistically significant indicators of differences in base mortality rates for nondisabled lives, the Pri-2012 Report does indicate several limitations with the income tables. These limitations include certain adjustments that were not made (e.g., form of payment, cost-of-living adjustments [COLAs] and generational issues) and a lack of information about frozen plans, etc.[16]

The Pri-2012 mortality rates were developed for both amount-weighted and headcount-weighted. In the report, RPEC indicated that they believe the use of amount-weighted mortality rates continues to be appropriate for the measurement of pension plan obligations. However, RPEC also indicated that the use of headcount-weighted mortality rates might be more appropriate for applications such as the measurement of obligations for retirement programs with benefit structures that are less directly correlated with income (such as many retiree medical plans).

Public Plan Published Base Mortality Tables

The recently published mortality tables for Public Retirement Plans are the Pub-2010 Tables (see the Appendix for more information). The Pub-2010 tables were released shortly before the Pri-2012 tables and have many of the same breakouts. The census information was gathered strictly from the experience of public sector pension plans; however, the Pub-2010 tables had several unique characteristics that are distinct from the Pri-2012 tables:

- For active employees, job category was shown to be a statistically significant predictor when looking separately at teachers, public safety, and general employees. As a result, separate tables by category were issued. No combined tables were published as the information provided did not allow for a balanced mix that could be looked at as representative of a public sector plan.
- For active employees, income quartile was generally the most significant explanatory variable when looking at region, quartile, year, and job category.[17]
- For annuitants, job category was similarly shown to be a statistically significant predictor. However, benefit quartile was generally the most significant explanatory variable when looking at region, quartile, year, and job category.[18]
- For disabled retirees, the only industry that was separated out was for public safety.

[15] Society of Actuaries, "Pri-2012 Mortality Tables Report," October 2019, section 4.3.4, page 26.
[16] Society of Actuaries, "Pri-2012 Mortality Tables Report," October 2019, section 12.2.3, page 56.
[17] Society of Actuaries, "Pub-2010 Mortality Tables Repot," January 2019, section 4.3, page 26.
[18] Society of Actuaries, "Pub-2010 Mortality Tables Repot," January 2019, section 4.4, page 27.

Selecting Mortality Improvement Assumptions

Section 3.4.4 of ASOP No. 35 also states, "the actuary should reflect the effect of mortality improvement (which may be positive, negative, or zero) both before and after the measurement date" and should do the following:

- *Pre-measurement date adjustment*: Adjust mortality rates to reflect mortality improvement before the measurement date. For example, when using a base mortality table that has an effective date before the measurement date, the base mortality table may need to be adjusted to reflect mortality improvement from the effective date to the measurement date. However, the published mortality table without improvement can be used if, in the actuary's professional judgment, it reflects expected mortality at the measurement date; and
- *Post-measurement date adjustment:* Include an assumption as to expected mortality improvement after the measurement date. The ASOP notes that an actuary's uncertainty about the occurrence or magnitude of future mortality improvement does not *by itself* mean that an assumption of no future mortality improvement is reasonable.

As with all assumptions, the mortality improvement assumption must be disclosed, and such disclosure should contain sufficient detail to permit another qualified actuary to understand any adjustments from the effective date of the base table to the measurement date and the provision made for the future mortality improvement. If the actuary concludes that it is reasonable to assume no future mortality improvement for a particular population or period of time, the actuary should state that no provision was made for future mortality improvement along with any required disclosures of the rationale for that assumption (see Section II below).

In practice, a single mortality improvement assumption may be selected and used for both periods, pre- and post-measurement date. But that does not have to be the case. The considerations for reflecting mortality improvement going forward from the measurement date may well be distinct and different from consideration for the pre-measurement date period.

Two-dimensional mortality improvement scales

Two-dimensional mortality improvement scales currently available are generally based on the three key concepts articulated in the MP-2014 report[19] (but also in other publications on associated scales):

1. Short-term mortality improvement rates are based on recent experience;
2. Long-term mortality improvement rates (LTR) are based on expert opinion; and

[19] Society of Actuaries, "Mortality Improvement Scale MP-2014 Report," October 2014, Section 1.1, page 3.

3. Short-term mortality improvement rates blend smoothly into the assumed long-term rates over an appropriate transition period.

Different approaches to these three basic concepts result in different mortality improvement scales.[20] RPEC used to update two different models annually that allow actuaries to change certain parameters to obtain customized scales, varying all three of the key concepts described above. RPEC_2014_v2020 and RPEC_O2_v2020 are the latest versions of two available tools[21] (see discussion of newer MIM model below). While RPEC-published scales use what is referred to as "committee-selected" assumption for the inputs, the RPEC models allow actuaries to exercise their professional judgment and select custom inputs.

Over the years, RPEC refined all three components from the MP-2014 to MP-2020 mortality improvement scales. For example, for LTR, the committee-selected assumption set in the MP-2014 Report favored uniform 1% improvement to age 85, with two linear segments decreasing it to 0.85% at age 95 and then, to 0% at 115.[22]

The LTR assumption was updated in the Scale MP-2020 Report based on recent experience. The LTR assumption was set to 1.35% through age 62, grading down to 1.10% at age 80, grading down to 0.40% at age 95, and finally grading linearly down to 0.00% at age 115.[23]

RPEC describes the committee-selected set of assumptions for their MP mortality improvement scales to be its best estimate, but the Committee is fully aware that selection of this assumption set involves a certain degree of subjectivity. As with any other future event assumption, the Committee understands that any number of future developments (e.g., medical breakthroughs, environmental changes, and societal factors) could result in actual future rates of mortality improvement varying significantly from projected levels.

In April 2021, the SOA published a report describing mortality improvement model, MIM-2021, and associated Excel-based tools. This model represents a single structure that practitioners can use to base their mortality improvement projections with consistency across a range of applications and SOA practice areas. The conceptual framework is modeled on RPEC's approach described above, while adding flexibility with additional user-defined inputs.[24]

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[20] Many mortality improvement models and scales use the same underlying framework. As an example, SSA publishes future mortality rates based on the same three concepts. See Actuarial Study No. 120, SSA Pub. No. 11-11536. Some pension actuaries utilize implied SSA mortality improvement scales in their work.

[21] https://www.soa.org/resources/experience-studies/2020/mortality-improvement-scale-mp-2020/.

[22] Society of Actuaries, "Mortality Improvement Scale MP-2014 Report," October 2014, Section 1.2, page 4.

[23] Society of Actuaries, "Mortality Improvement Scale MP-2020 Report," October 2020, Section 5, page 19.

[24] Society of Actuaries, "The Mortality Improvement Model, MIM-2021," https://www.soa.org/resources/research-reports/2021/mortality-improvement-model/.

Actuaries may conclude that alternative mortality improvement scales, including those developed from assumption sets, other than that selected by RPEC for the most recent MP Scale, lie within an appropriate assumptions' universe for modeling mortality improvement.

Resources available

Data from demographic and mortality studies can provide a good starting point for developing a mortality improvement assumption to use in lieu of, or to modify, an existing assumption. Resources include:

- In general, since October 2014, the RPEC has been publishing annual updates to the mortality improvement scales since it issued MP-2014, which was intended to replace both Scale AA and interim Scales BB and BB-2D. The most recent SOA mortality improvement scale was Scale MP-2021,[25] issued in October 2021. See the Appendix for more information. In lieu of issuing a new scale in 2022, the RPEC issued a 2022 Mortality Improvement Update (https://www.soa.org/4a9cd8/globalassets/assets/files/resources/research-report/2022/rpec-mortality-improvement.pdf) because of the impact of COVID-19 on the newest mortality data (2020) that would have been added to the model.
- The report for MP-2021 includes several references used in their analysis that may also provide useful information.[26]
- General population mortality experience from the Center for Disease Control and Prevention (CDC) and Social Security Administration (SSA)[27]
- Studies by other professionals, such as demographers, can also be helpful. While some experts expect a continued long-term trend of mortality improvements, others believe that rates of mortality improvement will ultimately decline, given factors such as obesity, sedentary lifestyles, drug-resistant bacteria, and the possibility of pandemic diseases. Some experts also point to the declining influence of factors that drove past mortality improvement (which included significant reductions in smoking, widespread use of antibiotics and statins, expansion of Medicare and Medicaid, etc.); however, other factors may emerge to drive future improvements.
- Other resources may be found on the SOA website https://www.soa.org/sections/retirement/pension-mortality-resources/, which is expected to be updated as new information becomes available.

[25] Society of Actuaries, "Mortality Improvement Scale MP-2021 Report," October 2021
[26] Society of Actuaries, "Mortality Improvement Scale MP-2021 Report," October 2021, References, page 39.
[27] For CDC Life Tables, including Excel spreadsheets with tables, see https://www.cdc.gov/nchs/products/life_tables.htm. For SSA past and future mortality rates, see https://www.ssa.gov/OACT/HistEst/DeathHome.html.

Other considerations

Past U.S. population mortality experience indicates that, in general, mortality rates consistently decreased, resulting in overall longevity improvement trends since the CDC and SSA began consistently tracking U.S. population mortality in 1900. The rate of such improvements has varied across different time periods,[28] and over the past decade this mortality improvement trend had stalled, and even reversed in some cases.

There are many unknowns causing ongoing debates among actuaries and demographers as to whether mortality improvements will continue, and if so, at what pace. Analyzing past trends and understanding their drivers is helpful in making future assumptions but realizing that new factors may emerge to replace the non-recurring causes of past mortality improvement is also critical.[29]

Estimating the level of future mortality improvement might involve consideration of specific demographic and other circumstances, such as:

- When the application of mortality improvement for some or all future years is precluded by law, or the purpose of the measurement calls for stated or mandated assumptions;
- When the characteristics of the plan population differ from those of the general population and how such differences might affect the projected rate of mortality improvement. Examples might include high-/low-paid populations or particular industries or occupations;
- When the plan's benefits primarily are paid in a lump sum form for which a future change in mortality basis may not need to be reflected (for example, IRS-mandated assumptions for pension funding where anticipated changes are not reflected in current year results, or where a plan specifies an alternative lump sum basis using a fixed table); and
- When the pre-retirement death benefit has roughly the same present value as the benefit payable under some other decrement(s) (e.g., turnover) such that the effect of mortality improvements may not be material.

Demographics and plan design may also impact the significance of the mortality improvement assumption increases, for example when:

- The plan provides benefits to a group that is predominately comprised of active lives who are not expected to elect a lump sum distribution of their benefit.

[28] Note that there is a notable exception in 1918 due to Spanish flu pandemic, but also acknowledge that although overall trend was positive improvement, there were ups and downs.

[29] For example, although some warned for years about a possibility of a global pandemic, the emergence of COVID-19 caught many by surprise. The impact of this pandemic on future U.S. mortality experience is currently unknown, both over the short and long term. Although some think this impact may be temporary and short-lived, uncertainty will remain for years to come.

- The plan provides benefits that increase over time (e.g., pension plans that grant automatic cost-of-living increases and post-retirement medical plans that do not have a cap on company cost increases).

Considerations for disabled participants

Health status of participants may or may not play into actuaries' judgment on whether mortality improvement assumption should be employed when valuing disabled participants. Prior to publication of MP-2014 in 2013, the SOA RPEC consistently observed that previous scales were based on non-disabled lives experience, and therefore should apply to non-disabled populations.[30] Upon the publication of MP-2014, the SOA RPEC recommended the use of the scale for disabled retirees mortality tables, as well as non-disabled mortality tables. The RPEC addressed the rationale for projection of disabled retiree mortality in MP-2014 report, section 6.2.[31] The RPEC reports for subsequent mortality improvement scales, published annually from 2014 to 2020, do not address this particular issue.

In its recommendation in MP-2014 to apply general mortality improvement to disabled mortality base tables, RPEC relied on the 2012 OASDI Trustees Report that used this approach based on recommendation of 2011 SSA technical review panel. The SSA continues to use its approach for projections for Trustees Reports in subsequent years. For example, the 2020 report from Office of the Chief Actuary SSA on long-range disability assumption discloses the following assumptions:

> "In the first year of the projection period, the death rate is determined by fitting an exponential curve to historical death rates for disabled workers by age group and sex. For the rest of the projection period, death rate improvement factors are applied to the base probabilities of death to reflect the same rate of improvement as the general population for that age group and sex."[32]

Rationale for this approach is describe in the same report as follows:

> "The 2011 Technical Panel recommended a more rapid decline in disability mortality rates for both men and women from 2020 through 2030. The 2015 Technical Panel stated that they were comfortable with the Trustees' assumption. The 2019 Technical Panel did not address this assumption."[33]

[30] See for example, page 20, section 5.7 (in reference to BB) and also page 6, Section 2.2 (in reference to AA) of "Mortality Improvement Scale BB Report", Society of Actuaries, September 2012.
[31] Society of Actuaries, "Mortality Improvement Scale MP-2014 Report," page 21.
[32] "The Long-Range Disability Assumptions for the 2020 Trustees Report," April 22, 2020, page 7.
[33] Ibid.

Static vs. generational mortality improvement projections.

There are two distinct methodologies used to reflect future mortality improvement with a base mortality table post-measurement date. One is known as a static projection; the other is referred to as generational projection.

- Static projection—A static methodology projects all mortality rates as of the measurement date into the future using selected mortality improvement rates for a specified number of years. The resulting mortality rates for a given age do not change from one year to another when being applied to future benefits while measuring pension plan liabilities.

  For example, if a 15-year static projection is used, the mortality rate at age 65 is the age 65 rate from the base table with 15 years of projected mortality improvement applied. Similarly, the mortality rate at age 66 will be the age 66 rate from the base table, also with 15 years of projected improvement in mortality. These same age 65 and 66 rates will be applied to all participants when they reach ages 65 and 66, regardless of their current age.

- Generational projection—A generational projection generates a unique table for each year of birth cohort. For example, the mortality rate at age 65 for someone now age 40 will be the current age 65 rate with 25 years of projection applied. For the same person, the mortality rate at age 66 will be the current age 66 rate with 26 years of projection. By comparison, the mortality rate at age 65 for someone now age 50 will be the current age 65 rate with 15 years of projection applied.

Some theoretically posit that generational tables more accurately replicate the anticipated pattern of improvement in mortality rates but may also be somewhat more difficult to use than a statically projected table. Relative to a generational projection, a comparable static projection will overstate liability for some participants and understate it for others. For a large diverse group, an actuary may be able to use professional judgment to use a static projection that may produce a reasonable approximation of a more computationally complex generational projection methodology.

Also, in theory, generational tables do not need to be updated as frequently as static tables in order to keep up to date with mortality improvements. If a generational projection scale is expected to reasonably match actual rates of mortality improvement, the generational tables would not need to be updated. In practice, the base rates and mortality improvement scale will likely be updated periodically to account for new information that has become available since the last update.

In general, use of static tables was common in the past, perhaps partly due to technological limitations. General advances in computing power and technology, as well as in actuarial valuation systems' capabilities, make technical simplifications such as this less necessary. That said, in some cases a static table with sufficient projection may still be an appropriate choice. Even prescribed assumptions, such as minimum lump sum

applicable table under Internal Revenue Code Section 417(e), still utilize this methodology for ease of understanding and comparability when communicating with plan participants.

Select and ultimate assumptions

Select and ultimate assumptions, including mortality assumptions, are not uncommon across various actuarial practices.[34] These are used when a short-term assumption is expected to be significantly different from the ultimate assumption.

In pensions, select and ultimate assumptions may be appropriate when the rate of mortality is affected by the length of time after a particular event, such as disability. Disability mortality tables generally include a higher probability of death and a probability of recovery in the years immediately following the disability.[35] There may also be a return-to-work effect to be considered.

Another example of when select and ultimate assumptions may be appropriate is when a major demographic shift of the workforce is anticipated in the future. For example, an actuary is aware of an impending reduction in force in specific occupation/units, that have characteristics of lower (or higher) mortality than the rest of the plan participants.

An actuary may also want to reflect a different short-term and long-term mortality/mortality improvement assumption following a significant event, such as the recent COVID-19 pandemic. More on this can be found in https://www.actuary.org/sites/default/files/2020-09/ImpactOfCovidPension.pdf.

Forecast Assumptions

When performing forecasts of pension obligations or risk assessments (as described in ASOP No. 51[36]), an actuary may consider multiple sets of mortality assumptions, including different types of mortality assumptions.

A different set of valuation assumptions may be selected for each future date in the forecast period, depending on a variety of considerations. For example, current IRS minimum requirements for calculating lump sum benefits use a static projected mortality table. However, when projecting future lump sum amounts in future forecast periods, an actuary may consider using "dynamic" projected future static tables that use an additional year of mortality improvement from one year to the next.

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[34] For example, it is not uncommon, when underwriting life insurance, to identify lower risks that "wear out" over time.

[35] "RPEC's analysis of mortality by duration indicated that mortality rates in the early years of disability were considerably higher than those in subsequent years. However, because of the lack of data necessary to produce credible rates, RPEC decided against developing death rates that vary by duration." Society of Actuaries "RP-2014 Mortality Tables Report," revised November 2014, Section 4.4. See also section 4.6 of "Pri-2012 Private Retirement Plans Mortality Tables Report", Society of Actuaries, October 2019.

[36] Actuarial Standard of Practice No. 51, *Assessment and Disclosure of Risk Associated with Measuring Pension Obligations and Determining Pension Plan Contributions*, effective November 1, 2018.

In addition to a set of valuation assumptions for each future measurement date in the forecast period, other set(s) of assumptions may be necessary to appropriately project current data to future measurement periods or illustrate potential risk. This other entirely distinct set of assumptions, often called “experience” assumptions in the context of forecasting studies, is used to reflect projected “actual” experience of the plan’s population as it evolves from one future date to the next. For example, an assumption for an alternate mortality base table and mortality improvement may be selected to reasonably project participants to the forecast measurement date.

II. Disclosure and Documentation

Required disclosures about the assumptions in pension actuarial communications are described in ASOP Nos. 4, 12, 23, 25, 35, 41, 51 and 56, and generally include the following:

- **Assumptions Used**—Description of each significant assumption that was used in the measurement and, to the extent known, whether the assumption represents an estimate of future experience, an observation of estimates inherent in market data, or a combination thereof. The information should provide sufficient detail so that another qualified actuary reading the communication can make an assessment about the level and pattern of each assumption. The actuary should also disclose any explicit adjustment made for adverse deviation or for valuing plan provisions that are difficult to measure. In particular, the description should provide enough detail so that another qualified actuary can understand any adjustment to reflect mortality improvement. Even if the actuary utilizes zero mortality improvement for a particular population or period of time, that assumption must be disclosed.

- **Rationale for Assumptions**—Information about the rationale for assumptions that have a significant effect on the measurement, including:

  - For each assumption the actuary has selected, information and analysis used to support the actuary's determination that the assumption is reasonable, and
  - For each assumption the actuary has not selected, information and analysis used to support the actuary's determination that the assumption does not significantly conflict with what, in the actuary's professional judgment, is reasonable for the purpose of the measurement.[37]

  These disclosures may be brief, but they need to be pertinent to the plan's circumstances. They should also be based on the assumptions as of the measurement date and not reflect changes that may be planned for future measurement dates. If there was an explicit analysis of experience that was considered in developing the assumption, the actuary should also disclose the time period analyzed in that study and the date of the study. Also, if a mortality table is used that substantially predates a more recently published relevant and generally available mortality table, then the actuary should disclose the rationale for the use of such tables instead of the more recently published tables.

- **Changes in Assumptions**—Discussion of any changes in the significant assumptions from the previous measurement, including a description of the changes, their general effects, in words or numerically, as appropriate, and, for assumptions that are not prescribed, a brief explanation of the information and analysis that led to those changes. The general effects of changes of both

[37] This does not apply to prescribed assumptions set by law or an assumption that requires disclosure under "Assumptions not selected by the actuary (other than for prescribed assumptions set by law)" below.

demographic and economic assumptions made for the same measurement may be disclosed separately or combined, as appropriate. Disclosures may be brief, but they need to be pertinent to the plan's circumstances; also, disclosures may reference any explicit analysis of experience that was considered in developing the assumption, including the date of the study. Note that there may be different required disclosures for changes in assumptions in ASOP No. 35 (summarized here) when compared to the requirements that are currently and may in the future be described in ASOP No. 4 and the actuary should make sure to understand and comply with these provisions.

- **Assumptions Not Selected by the Actuary (general)—**Source of any assumption that the actuary has not selected. If the communication is silent about responsibility for the selection of an assumption, the actuary(ies) who signed the communication will be assumed to have taken responsibility for that assumption.

- **Assumptions Not Selected by the Actuary (other than for prescribed assumptions set by law)—**Identification of the following, if applicable:

  - Any assumption that significantly conflicts with what the actuary judges to be reasonable for the purpose of the measurement (note that for this purpose, a reasonable assumption is not limited to what the actuary would have selected), and
  - Any assumption set by another party that the actuary is unable to evaluate for reasonableness for the purpose of the measurement.

  If the assumption does not conflict significantly with what the actuary judges to be reasonable for the purpose of the measurement, there is no required disclosure.

- **Assumptions Not Selected by the Actuary (reliance on other sources)—** Statement when the actuary relied on other sources (other than prescribed by law) and thereby disclaims responsibility for a material assumption, including:

  - That the assumption that was set by another party
  - The party who set the assumption
  - The reason the party rather than the actuary set the assumption, and
  - That either (i) the assumption significantly conflicts with what, in the actuary's professional judgment, would be reasonable for the purpose of the measurement, or (ii) the actuary was unable to judge the reasonableness of the assumption without performing a substantial amount of additional work beyond the scope of the assignment and did not do so, or the actuary was not qualified to judge the reasonableness of the assumption. (Note that, although there may be different requirements in the new ASOP No. 35 than are in section 4.3(d)(2) of ASOP No. 41, the pension actuary should still comply with the new requirements of ASOP No. 35. Also, these differences may be resolved when a new ASOP No. 41 is adopted.)

- **Assumptions Prescribed by Law**—Summary of the applicable law (statues, regulations, and other legally binding authority) under which the report was prepared, the assumptions that are prescribed by that law and disclosure that the report was prepared in accordance with that law. This disclosure is required regardless of whether the actuary believes the assumption is appropriate for the purpose of the communication.

- **Subsequent Events**—Discussion of any relevant event that meets the following conditions:

  - It becomes known to the actuary after the latest information date (the date through which data or other information has been considered in developing the findings included in the report).
  - It becomes known to the actuary before the actuary's report is issued.
  - It may have a material effect on the actuarial findings if it were reflected in the actuarial findings, and
  - It is impractical to revise the report before it is issued.

  Also, if the actuary learns of changes to data or other information (on or before the information date) after some findings have been communicated but before the report is completed, the actuary should communicate those changes and their implications to any intended user to whom the actuary has communicated findings.

- **Deviation From ASOP Guidance—**Discussion of any material deviation from the guidance in an applicable ASOP (other than as described above under "Assumptions Not Selected by the Actuary (reliance on other sources)" or "Assumptions Prescribed by Law"), including the nature, rationale, and effect of the deviation.

- **Material Inconsistencies—**Disclosure of any material inconsistencies among assumptions, and known reasons for such inconsistencies.

Although this is a summary of disclosures related to assumptions, ASOP Nos. 4 and 41 include other items required to be disclosed in an actuarial communication. The actuary should refer to those ASOPs to ensure inclusion of all required disclosures.

Nothing in ASOP Nos. 4 or 35 is intended to require the actuary to disclose confidential information.

If the form and content of an actuarial communication is in a prescribed form that does not accommodate these disclosures (such as for a required government form), sections 4.2 and 4.3 of ASOP No. 41 states that the "actuary should make these disclosures in a separate communication (such as a cover letter to the principal), requesting that both communications be disseminated together where practicable."

The actuary may also want to document the assumption selection in internal workpapers to support compliance with the requirements of section 3.11 of ASOP No. 35. The actuary may use professional judgment to determine the degree of the documentation and may want to consider the complexity and purpose of the actuarial services. This documentation may describe the assumptions selected for the analysis and the rationale for the assumption selection, including the basis for selecting these assumptions, the process used to review them, and the results of any experience or gain/loss analysis; the effect of any special events; and the effect of any assumption changes.

Appendix

Recently Published Mortality Tables and Mortality Improvement Scales

The following is a summary of materials published by actuarial task forces and committees in the last 10 years. For more details on each table, refer to the reports for each table.

Actuaries are encouraged to read the publications of the SOA concerning pension mortality tables and mortality improvement scales. As of the publication date of this practice note, this material is available at https://www.soa.org/sections/retirement/pension-mortality-resources/.

Table Name: Pri-2012 Private Retirement Plans Mortality Tables

Background, date published and table location: The SOA's current intention is to review both private- and public-sector retirement plan mortality on a cycle of approximately every five years. Consistent with this intention, in October 2019, the RPEC published results of the mortality experience study for private-sector plans initiated in 2016. In October 2019, the RPEC published a family of tables named Pri-2012 ("Pri" stands for Private Pension Plans, while 2012 denotes the central year of the experience data underlying construction of this family of tables).

The "as-of-date" of the Pri-2012 tables was determined by RPEC as January 1, 2012. This means the mortality rates at age x in the tables should be interpreted as one-year probabilities of death at age x on January 1, 2012.

The report and tables can be found at:

> https://www.soa.org/resources/experience-studies/2019/pri-2012-private-mortality-tables/

Common Naming Conventions: The family of tables developed in this study were published under the Pri-2012 name. All tables were developed both on headcount-weighted and amount-weighted bases.

Amount-weighted tables are named Pri-2012, while headcount-weighted tables are named Pri.H-2012. Separate tables were created for Total population, Blue Collar, White Collar, Bottom Quartile, and Top Quartile, separated by gender and status, (i.e., employee, disabled, and healthy annuitants), with annuitant mortality further broken into retirees or primary annuitants and contingent beneficiaries.

Breaking the healthy annuitants' group into subgroups for retiree and surviving beneficiaries was a departure from prior RPEC methodologies (e.g., those underlying

construction of RP-2006 and RP-2000). It was first introduced in the Pub-2010 mortality experience study published for public sector pension plans a few months earlier in 2019.

Where applicable, Blue Collar or White Collar, as well as Bottom Quartile or Top Quartile are designated by "BC," "WC," "BQ," or "TQ," respectively, following the name of the table. For example, Pri.H-2012(BC) designates headcount-weighted, Blue Collar tables that contain separate gender-specific rates for employees, healthy retirees and contingent survivors.

Data used to develop the table: Data collection was initiated by RPEC in 2016, and the final dataset contained approximately 16.1 million life-years of exposure and 343,000 deaths from private-sector pension plans across the United States for years 2010 through 2014, inclusive. Data were received from 18 different entities that submitted information on 402 plans. The final data set after the data validation process included all except approximately 8% of the data processed.

The Pri-2012 dataset includes significantly more multiemployer plans data (compared to RP-2006 which reflected a minimal amount of such data). The multiemployer plans' data comprised approximately 41% of the Total dataset, and 70% of the Blue Collar dataset.

Total life-year exposures and death counts for Blue Collar, White Collar and Unknown Collar are as follows: approximately 9 million exposures and 199,000 deaths in the Blue Collar dataset, a little under 3 million exposures and 54,000 deaths in the White Collar dataset, and 4 million exposures and 89,000 deaths in the dataset with unknown collar designation.

Variations of the tables and other considerations: As mentioned in the naming convention section, separate tables were developed by gender, by health status (healthy versus disabled), by collar (total, blue collar and white collar), by amount (top quartile and bottom quartile), and by status (employee, primary retiree, and contingent beneficiary). In addition, each table was developed on both headcount-weighted and amount-weighted basis. The following is a brief discussion of factors to consider about these different variations.

- *Collar category*—As in previous studies, collar type was determined (via multivariate analysis) to be significantly correlated with mortality. In this study, a substantial portion of the data was categorized as unknown, and relative mortality of this set was close to that of the white-collar dataset. RPEC notes significant correlation between the collar type and income quartile. It should be noted that there was a difference in methodology in designating collar type from prior studies. Blue-collar plans had previously been consistently defined as those comprising 70% or more participants being either hourly or union, while white-collar plans had been defined as those where 70% of plan participants are both salaried and non-union. In the Pri-2012 study, in addition to designating collar type on a plan basis according to this definition, RPEC also requested participant-level designations of the collar category and incorporated it, if available. For

example, the blue-collar dataset contained participants of the plans designated as blue collar and not individually identified as white collar, and all individual participants identified as blue collar on a participant-level basis.

- *Income Quartile*—According to RPEC report, multivariate analysis indicated that, after controlling for age and gender, the income (annualized salary for employees and benefit amounts for annuitants) quartile was the most predictive variable for employees. RPEC selected a quartile approach versus "above- or below-median" approach "with an eye toward applications" and for consistency with the prior RP-2006 and RP-2014 studies. RPEC notes that top quartile tables, in particular, have been found useful for valuing nonqualified plans offered to highly compensated employees.
- *Disabled versus healthy retirees*—As in previous mortality studies, RPEC created separate tables for healthy retirees and disabled retirees. Developing separate tables for disabled retirees always presents special challenges, including with accurately tracking disabled retiree experience, as retiring participants are often reclassified as healthy Retirees upon attaining some fixed age, and also the subjective nature of disability retirement eligibility criteria—particularly for plans that do not follow Social Security's definition of disability. RPEC worked with contributors to correct the data to reflect "disabled" status in these cases. Based on the amount of available data and considerations of sufficiency, disabled retiree rates were produced only by gender on the total population of the study.
- *Retirees versus Contingent Survivor*—Historically, gender-distinct annuitant mortality tables were constructed on a combined basis for all relevant sub-populations in the study receiving benefits from pension plans. For this study, however, data on annuitants was separated by status (primary member or retiree versus contingent beneficiary or survivor), and mortality rates were derived separately for each category. It should be noted that contingent survivor mortality rates are only known for those who outlived the primary member, because experience for this group is generally tracked on a consistent basis only after death of the primary member. Another note is that these tables were created for the Total population on a gender specific basis using headcount-weighting, due to credibility issues and the fact that amount-weighted rates were higher than the headcount-weighted rates (the reverse of what is normally seen in pension plan data). RPEC suggests that these contingent survivor mortality rates could be appropriate for measuring liabilities of current contingent annuitants in plan populations. The report discusses various approaches that may be utilized when the primary member is alive on the valuation date and is receiving benefits in the form of a joint and survivor annuity (see discussion above). These are the same three approaches discussed in the Pub-2010 report and described below. While the report describes three possible approaches, the RPEC does not endorse any particular methodology and acknowledges that other approaches may be reasonable.

- *Amount- and headcount-weighted tables*—The Pri-2012 report includes both versions of each table. Per ASOP No. 35, the actuary should select a mortality assumption that is appropriate for the purpose of measurement. As examples, the report discusses that generally amount-weighted tables are more appropriate for measuring pension obligations, while the headcount-weighted counterpart may be more appropriate for measuring postretirement medical obligations with a flat benefit structure. Thus, it may not be inappropriate or inconsistent to use two different weighting schemes for valuing different obligations even for an identical population.
- *Other variations considered*—RPEC considered variations by lump sum availability, by industry category, by duration, and by plan type (multiemployer versus other). After conducting multivariate analysis for these factors, RPEC concluded that either statistical significance of indicators was not overwhelming (such as lump sum availability) or if category had some statistical significance, data was skewed (as in industry category).

Relationship to other tables: The report contains extensive sections where comparisons with RP-2006 are explored for both mortality rates and annuities. In these sections, Pri-2012 tables are compared with RP-2006 tables, as adjusted by mortality improvement scale MP-2018. Mortality rates are compared using ratios by age, and annuity-factor comparisons use deferred to 62 annuities at 4% interest (with additional comparisons at 0% and 6% interest included in the Appendix D).

When comparing mortality rates or annuities, RPEC notes that the differences between the two mortality experience datasets should be kept in mind. The two sets have significantly different collar concentration, as well as potential different collar definition, and considerably different—and generally lower—quartile breakpoints. The differences complicate direct comparison of certain tables of Pri-2012 and RP-2006.

Table Name: Pub-2010 Public Retirement Plans Mortality Tables

Background, date published and table location: Following comments that RP-2014 tables did not include experience for public-sector plans, RPEC decided to perform a mortality study with the following objectives:

1. Develop mortality tables based exclusively on the public-sector pension plan experience.
2. Provide new insights into the composition of gender-specific pension mortality by factors such as job category, salary/benefit amount, health status, geographic region, and duration since event.

The SOA's current intention is to review both private- and public-sector retirement plan mortality on a cycle of approximately every five years. Consistent with this intention, in January 2019, the RPEC published results of the mortality experience study for public-sector plans initiated in 2015, In January of 2019, RPEC published a family of tables named Pub-2010 ("Pub" stands for Public Retirement Plans, while 2010 denotes the central year of the experience data underlying construction of this family of tables).

The "as-of-date" of the Pub-2010 tables was determined by RPEC as July 1, 2010. This means the mortality rates at age x in the tables should be interpreted as one-year probabilities of death at age x on July 1, 2010. Some practitioners may want to adjust the rates with reference to this date. However, RPEC also believe that these tables could represent reasonable benchmarks for mortality rates for any date within calendar year 2010.

The report and tables can be found at:

https://www.soa.org/resources/research-reports/2019/pub-2010-retirement-plans/

Common Naming Conventions: The family of tables developed in this study were published under the Pub-2010 name. All tables were developed both on headcount-weighted and amount-weighted bases.

Amount weighted tables are named Pub-2010, while headcount-weighted tables are named Pub.H-2020. Separate employee and healthy retiree tables were created for three job categories (Teachers, Public Safety, and General Employees), separated by gender and income (Total, Above-Median, and Below-Median). Annuitant mortality was further broken into retirees or primary annuitants and contingent beneficiaries, but the contingent beneficiary tables are not separated into job categories. Separate disabled retiree tables were created for two job categories (Public Safety and Non-Safety), separated by gender. Where applicable, Teachers, Public Safety, General, and Non-Safety Employees are designated by "PubT," "PubS," "PubG," and "PubNS," respectively. Wherever applicable, the above-median and below-median versions are designated by the letter "(A)" or "(B)," respectively. For example, Pub.G-2010(A) is the name for amount-weighted Above-Median General Employees table.

Data used to develop the table: Data collection was initiated by RPEC in 2015, and the final dataset contained approximately 46 million life-years of exposure and 580,000 deaths from public-sector pension systems across the United States for years 2008 through 2013, inclusive. Data were received from 35 different public pension systems that submitted information on 78 plans and the vast majority of the collected data was included in the study. Contributors were asked to identify plan members as teachers, public safety personnel, or general employees.

Total life-year exposures and death counts by job category are as follows: approximately 12 million exposures and 108,000 deaths in the Teachers dataset, approximately 4 million exposures and 31,000 deaths in the Public Safety dataset, and approximately 31 million exposures and 440,000 deaths in the General Employees dataset.

Variations of the tables and other considerations: As mentioned in the naming convention section, separate tables were developed by gender, health status (healthy versus disabled), by job category (teachers, public safety, general employees), by amount (above-median and below-median), and by status (employee, primary retiree, and contingent beneficiary). In addition, each table was developed on both headcount-weighted and amount-weighted basis. The following is a brief discussion of factors to consider about these different variations.

- *Job category*—In early stages of the study, multivariate analysis of data revealed that certain types of public-sector employment exhibited overall mortality patterns different from other categories of jobs. Separate tables for job category were created as a result of this finding. Ultimately, RPEC elected not to publish a combined table due to statistically significant differences in mortality patterns and due to the unequal proportion of different categories in the total dataset. Another consideration was RPEC's recognition that most public-sector systems or plans cover populations with very different blends of job categories that would have resulted from a total dataset, as well as the use of separate plans to sometimes cover these distinct job category populations. RPEC concluded that "it would be better for the actuary with knowledge of specific member demographics to either segregate the populations or construct a custom combined table."
- *Above- and Below-Median Tables*—Income (annualized salary for employees and benefit amounts for annuitants) was found to be a significant predictor in mortality, and multivariate analysis on the study data revealed significant difference between mortality at above-median and below-median income levels. This difference was more stable than that between top and bottom quartiles for this population. In addition, practitioners have reported difficulties in using quartile-based tables. For these reasons, above- and below-median tables were developed instead of using quartiles, as were used for RP-2014. Data with missing income amounts were excluded from development of these tables.
- *Disabled versus healthy retirees*—As in previous mortality studies, RPEC created separate tables for healthy retirees and disabled retirees. Developing separate

tables for disabled retirees always presents special challenges, including with accurately tracking disabled retiree experience, as retiring participants are often reclassified as healthy retirees upon attaining some fixed age, and also the subjective nature of disability retirement eligibility criteria. This last issue was particularly significant in this study due to disparity between Safety and non-Safety members. Multivariate analysis revealed significantly lower mortality rates for disabled retirees who were Safety members compared to Teachers and General members. RPEC believes that this is "likely due to less restrictive definitions of disability, consistent with the demands of Safety occupations." Accordingly, disabled retirees were separated into Safety and non-Safety subgroups and separate tables were constructed with gender and weighting-specific rates for these subgroups.

- *Retirees versus Contingent Annuitants*—Historically, gender-distinct annuitant mortality tables were constructed on a combined basis for all relevant sub-populations in the study receiving benefits from pension plans. For this study, however, data on annuitants was separated by status (primary member or retiree versus contingent beneficiary or survivor), and mortality rates were derived separately for each category. It should be noted that contingent beneficiary mortality rates are only known for those who survived the primary member, because experience for this group is generally tracked on a consistent basis only after death of the primary member. RPEC suggests that these contingent survivor mortality rates could be appropriate for measuring liabilities of current contingent annuitants in plan populations. The report discusses various approaches that may be utilized when the primary member is alive on the valuation date and is receiving benefits in the form of a joint and survivor annuity (see discussion above). While the report describes three possible approaches, the RPEC does not endorse any particular methodology and acknowledges that other approaches may be reasonable.
- *Amount- and headcount-weighted tables*—The Pub-2010 report includes both versions of each table. Per ASOP No. 35, the actuary should select a mortality assumption that is appropriate for the purpose of measurement. As examples, the report discusses that generally amount-weighted tables are more appropriate for measuring pension obligations, while the headcount-weighted counterpart may be more appropriate for measuring postretirement medical obligations with a flat benefit structure. Thus, it may not be inappropriate or inconsistent to use two different weighting schemes for valuing different obligations even for an identical population.
- *Geographic region*—Experience data for the study was collected from across the country, so RPEC had an opportunity to investigate whether geographic region is an effective predictor of relative mortality experience. However, results from multivariate analysis showed that the explanatory power of geography was considerably lower than that of job category or income. In addition, notably, the data submitted for the study was not uniformly distributed across geographies, so

it was difficult to evaluate systematic longevity differences between regions. Therefore, this variable was not used in development of Pub-2010 mortality tables.

Relationship to other tables: The report contains extensive sections where comparisons between Pub-2010 tables and tables commonly used by public sector plans from previous SOA RPEC studies, such as the RP-2000 and RP-2006 families with appropriate application of available mortality improvement scales applied generationally. Comparisons are performed using pre-retirement discount rate of 7% and a spread of 2%, representing average cost-of-living adjustment increases in retirement, resulting in a net post retirement rate of 5%. Deferred to 62 annuities are compared under previously available tables and Pub-2010 tables. For example, the amount-weighted Teachers table is compared with RP-2006 white collar (RP-2006 WC) table, both projected generationally with MP-2017, starting with the appropriate baseline year. In this case, PubT-2010 tables produce more than 4% higher annuity values for females and approximately 3% higher for males. Public Safely table PubS-2010 is compared to RP-2006 and RP-2006 WC (all projected generationally with MP-2017). PubS-2010 produces annuity values that fell between those developed using these two previously available tables—RP-2006 WC and total version of RP-2006.

The closest match for female General members was the RP-2006 WC table, which produced deferred annuity values that were generally about 0.5% to 1.0% lower. For male General members, PubG-2010 produced annuity values greater than RP-2006 by approximately 3% but lower than RP-2006 WC, by about 2%.

Table Name: RP-2014 and RPH-2014 (and RP-2006 and RPH-2006) Mortality Tables

Background, date published and table location: In October 2014, the SOA RPEC published the RP-2014 mortality tables. The underlying experience mortality data covered the period 2004-2008, with central year of 2006. However, the experience mortality rates were projected by the RPEC to the year of publication (2014) by applying the simultaneously published mortality improvement scale MP-2014. At that time the RPEC described the process of backing out mortality improvement from the base rate to obtain the rates as of the central year of experience.

The RP-2014 and RPH-2014 tables, as well as the RP-2006 and RPH-2006 tables and reports, can be found here.

https://www.soa.org/resources/experience-studies/2014/research-2014-rp/

With publication of new mortality improvement scales reflecting more recent historical mortality data, and the resulting complication of having to back out the MP-2014 projection before substituting in the revised projection scale, the actuarial community requested that the SOA publish baseline mortality tables underlying RP-2014 without embedded effects of Scale MP-2014, for clarity. The SOA published a set of factors (in 2015) that actuaries could use to back out mortality improvement 2007–2014 to base year of study data of 2006, and many actuaries did, in fact, use this approach.

In July 2018, the SOA RPEC published RP-2006 (amount-weighted rates) and RPH-2006 (headcount-weighted rates), which are based on the mortality experience data underlying construction of RP-2014 and RPH-2014, with mortality rates as of the central year of the study data of 2006. This was an addition to the RP-2014 tables (published in October 2014), which allowed actuaries to use the table without the impact of the imbedded inclusion of the MP-2014 improvement scale.[38]

Common naming conventions: As of July 2018, RP-2006 and RPH-2006. Previously used names include RP-2014 Base Year 2006, Adjusted RP-2014 (2006), RP-2014 @ 2006 (and similar headcount-weighted counterparts).

Data used to develop the table: Approximately 10.5 million life-years of exposure and over 220,000 deaths, all from uninsured private pension plans subject to the funding rules of the Pension Protection Act of 2006. The experience is for calendar years 2004 through 2008. In the RP-2014 version, data were projected to 2014 based on Scale MP-2014 mortality improvement rates. Public plan experience was excluded in developing the table.

[38] In 2014, many actuaries used the process described by the RPEC to obtain a version of RP-2006 table to be used with potentially different improvement scale than MP-2014. The publication of official tables RP-2006 and RPH-2006 resolved potential naming and other confusion.

Different variations of tables: Separate tables were developed by gender for employees, healthy annuitants (including retirees and beneficiaries, combined), and disabled retirees. The study also looked at the effect of collar and size of annuity/salary. The following is a brief discussion of factors to consider about these different variations:

- *Employees vs. Annuitants*—The report recommends separate tables be used for employees and annuitants. The report does not include a "combined" table as was present in the RP-2000 report and instead encourages actuaries "to blend appropriately selected Employee and Annuitant tables, taking plan-specific demographic information into account."[39]
- *Healthy vs. Disabled Retirees*—Use of the table for healthy annuitants may overstate liabilities if used for healthy and disabled retirees; the disability mortality table includes all disabled retirees, regardless of whether they are eligible for Social Security. Thus, the disabled life table may not be appropriate if valuing a group of disabled participants with a different definition of disability. Also, although the analysis determined that mortality rates in the early years of disability were considerably higher than those in subsequent years, the RP-2006 disability mortality rates do not vary by duration because of lack of credible data. "RPEC performed a number of logistic regressions on the final Disabled Retiree dataset. Although some variations in mortality by collar and amount were identified, those variations were significantly less pronounced than those found in the nondisabled populations."[40]
- *White vs. Blue vs. Mixed Collar*—Collar is a significant predictor of mortality in this data. As for the RP-2000 table, collar was set to blue if more than 70 percent of participants were hourly and/or union and to white if more than 70 percent of participants were both salaried and non-union. All others were defined as mixed collar. The RP-2006 standard (no collar) table reflects the data for all three groups.
- *Amount*—Size of annuity/salary is a significant predictor of mortality in these data. The study analyzed quartile-based mortality trends for both Employees and Annuitants based on annual salary and annual retirement benefit amount, respectively. The quartile breakpoints were developed based on gender-specific "head count" exposure, and not based on exposure weighted by either salary or benefit amount. Some participants, such as terminated vested participants, have lower benefit amounts due to short service or other factors rather than due to income level. Also benefit levels tend to decrease in real value over time because few plans provide automatic cost-of-living adjustments.
- *Combined Effect of Collar and Amount*—Combined tables were not produced because the RPEC decided the extra complexity was not warranted given the high degree of correlation between collar and amount. Although the work in connection with RP-2014 confirmed that both collar and amount quartile are

[39] Society of Actuaries, "RP-2014 Mortality Tables Report," revised November 2014, Section 1.3.
[40] Society of Actuaries, "RP-2014 Mortality Tables Report," revised November 2014, Section 4.4.

statistically significant indicators of differences in base mortality rates for nondisabled lives, the RPEC believed that the use of collar-based tables will generally be more practical that the use of amount-based tables.

- *Other*—Industry (SIC) code was not analyzed in this study.

Projection Scale: The RP-2014 Table Report recommends Scale MP-2014 for generationally projecting rates beyond 2014 or an appropriately parameterized version of the RPEC_2014 model. The report also recommends the use of the same improvement scale for disabled lives.

Approximation based on a static projection of mortality rates to a specific duration: RPEC did not provide any recommendations in this regard.

Relationship to Other Tables:[41] The RP-2014 table with Scale MP-2014 produces a deferred to 62 annuity due values with a discount rate of 6.0 percent of between 3.0 percent (age 55) and 4.4 percent (age 65) percent higher for males, and between 6.3 percent (age 55) and 5.5 percent (age 65) higher for females than RP-2000 with generational mortality improvement projection using Scale AA based on individuals at these ages in 2014.

[41] Society of Actuaries, "RP-2014 Mortality Tables Report," revised November 2014, section 12.2.

Mortality Improvement Scale Name: MP-2014, MP-2015, MP-2016, MP-2017, MP-2018, MP-2019, MP-2020, and MP-2021

Background and scale location: These mortality improvement scales were issued by the RPEC in October of the year indicated by the name of the scale and can be found following appropriate links ("Mortality Improvement Scale MP-20XX") at the following location:

https://www.soa.org/research/topics/pension-exp-study-list/

The MP mortality improvement scales are used to project base mortality rates forward and have been updated annually by the RPEC, since 2014, to reflect more recently available US mortality data. Some modifications were made in certain committee-selected assumptions, starting in 2016, with further modifications added in 2020.

Data used to develop scales: These mortality improvement scales were developed by smoothing the most recent U.S. historical mortality data available and extrapolating trends into the future according to an RPEC-developed methodology. Prior to 2016, the data was obtained from historical data published annually by the SSA. This data as published by SSA can be found at the following location:

https://www.ssa.gov/oact/HistEst/DeathHome.html

As noted in the MP-2014 report, the historical data reflected was available to 2009. The 2015 version of the model included two additional years (2010 and 2011). The 2016 version of the model reflects three additional years (2012–2014), with the 2014 data reflecting preliminary estimates developed from the same data sources as SSA rates by the RPEC (so-called "SSA-style" rates). Starting with the 2016 version, the scales incorporated not only published SSA historical data but included additional historical information, developed by the SOA based on data obtained from CDC, Centers for Medicare and Medicaid Services (CMS), and the U.S. Census Bureau. Similar methodology has been employed for 2017–2021. For MP-2017, SSA historical data was available through 2014 with supplemental CDC, CMS and Census Bureau information used for 2015. One additional year of data from each of these sources was used to develop the MP-2018 table, and again in developing the 2019 tables. For the 2020 version of the scale, RPEC utilized data from SSA-published rates to 2015 and developed "SSA-style" rates from CDC, Census, and CMS data. For the 2021 version of the scale, RPEC utilized data from SSA-published rates to 2016 and developed "SSA-style" rates from CDC, Census, and CMS data.

Scale development: The MP mortality improvement family of scales were developed by utilizing the model RPEC_2014, also available on the SOA website. The model is updated annually to reflect all available historical data and allows for custom selection of several parameters to create custom versions of the mortality improvement scales. Each version contains the year of update in the name (e.g., RPEC_2014_v2018 for the 2018 update). The MP scales are produced by utilizing "committee-selected" assumptions. The

committee-selected set of assumptions was revised in 2016 to shorten the age/period convergence to the long-term rate assumption from 20 to 10 years. In addition, they discontinued reflecting trend in mortality improvement derived from the recent historical data. Both methodological changes were made to improve stability from year to year. Another revision was introduced in 2020 as a change to the committee-selected assumption for the long-term rate of mortality improvement. This change reflected additional analysis of historical mortality improvement by age bracket and refined the assumption to better reflect the age-graded nature of long-term mortality improvement trend.

In 2018, RPEC published another version of the mortality improvement model, where underlying historical data was graduated using a much smoother version of the graduation methodology. The model was named RPEC_O2_v2018, where “O2” refers to technical description of the graduation methodology, namely “order 2” parameter(s) applied to both dimensions in Whittaker-Henderson graduation. This alternative model is updated annually; updated versions of the model are included in MP-2019 through MP-2021 releases.

Expected future updates: In October from 2014 to 2021, RPEC published a new iteration of the pension mortality improvement scales. These updates incorporated the latest available historical data, as well as the occasional revision of the methodological elements.