Society of Actuaries

RP-2014 Mortality Tables Report

October 2014 (Revised November 2014)

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Preface: Substantive Revisions Made to this Report Subsequent to 10/27/14 Release

November 2014 Updates

1. **Employee collar- and quartile-specific rates corrected**

As summarized in subsection 7.3, the methodology used to develop the individual collar- and quartile-specific Employee mortality rates was based on applying an appropriate scaling factor to the gender-specific Total Employee tables. Each of these scaling factors was based on the ratio of (a) the actual number of deaths for the specific Employee subgroup to (b) the expected number of deaths based on the Total Employee rates applied to the subgroup exposures.

Since the denominators of the scaling factors are based on mortality rates as of 2014, the numerators should also be adjusted to 2014. The revised collar- and quartile-specific tables included in this revised report reflect this adjustment (based on Scale MP-2014) to the numerators. **This correction does not affect the Total Employee rates, any (Total, collar- or quartile-specific) Healthy Annuitant rates, Disabled Retiree rates or Juvenile rates.**

The following parts of the RP-2014 report have been updated to take into account the corrected rates.

- Subsection 7.3; the last paragraph in ***"Construction of the Collar- and Quartile-Based Rates Between Ages 18 and 65"*** has been updated as follows:

  Prior wording:
  "For example, the sum of actual amount-weighted deaths between ages 18 and 65 for White Collar males between the ages of 18 and 65 was approximately $77.7 million, and the expected number of amount-weighted deaths based on the unadjusted male Total Employee table between ages 18 and 65 was approximately $99.5 million. Therefore, the constant scaling factor used to construct the White Collar male rates between ages 18 and 65 was approximately 0.78."

  New wording:
  "For example, the sum of actual amount-weighted deaths between ages 18 and 65 for White Collar males between the ages of 18 and 65 was approximately $77.7 million, but approximately $69.8 million when adjusted for improvement to 2014 with Scale MP-2014. The expected number of amount-weighted deaths based on the unadjusted male Total Employee table between ages 18 and 65 was approximately $99.5 million. Therefore, the constant scaling factor used to construct the White Collar male rates between ages 18 and 65 was approximately 0.70."

- Subsection 7.3; the last paragraph in ***"Extension Between Ages 65 and 80"*** has been updated to reflect revised numbers:

Prior wording:
"For example, the age-65 mortality rate for a female White Collar Employee is 0.003382, and the age-90 mortality rate for a female White Collar Healthy Annuitant is 0.100207. The constant factor that when applied to 0.003382 for 25 years produces a value of 0.0501035 (i.e., 50 percent of 0.100207) is 1.11385. Hence, the female White Collar Employee mortality rate for each of the ages 66 through 80 was calculated as 1.11385 times the rate at the preceding age."

New wording:
"For example, the age-65 mortality rate for a female White Collar Employee is 0.003119, and the age-90 mortality rate for a female White Collar Healthy Annuitant is 0.100207. The constant factor that when applied to 0.003119 for 25 years produces a value of 0.0501035 (i.e., 50 percent of 0.100207) is 1.117465. Hence, the female White Collar Employee mortality rate for each of the ages 66 through 80 was calculated as 1.117465 times the rate at the preceding age."

- Subsection 10.5; Figures 10.5(M), 10.5(F), 10.6(M), 10.6(F) have been updated.

- Subsection 12.2; Table 12.3 has been updated.

- Appendix A; Collar- and quartile-specific Employee rates have been updated.

2. Headcount-weighted mortality tables

In subsection 13.5, RPEC introduces the concept that headcount-weighted mortality rates might be more appropriate than amount-weighted rates for certain applications. Rather than describing how actuaries might be able to construct "reasonable estimates" of headcount-weighted versions of the RP-2014 tables, RPEC has developed these headcount-weighted tables, denoted RPH-2014 (for Retirement Plans Headcount-weighted), using the same underlying datasets and method used to construct the RP-2014 tables.

The final paragraph of subsection 13.5 has been updated as follows:

Prior wording:
"Although RPEC has not included any headcount-weighted tables in the final RP-2014 report, RPEC believes that reasonable estimates of headcount-weighted mortality rates could be constructed by comparing the "Death Rates Based on: Number" and "Death Rates Based on: Amount" columns shown in the Appendix C tables."

New wording:
Sets of headcount-weighted mortality tables, denoted RPH-2014 (for Retirement Plans Headcount-weighted), are presented in the Supplement to the RP-2014 Mortality Tables Report, which is available here.

Section 1. Executive Summary

1.1 Purpose of the SOA's Pension Mortality Study

As part of its periodic review of retirement plan mortality assumptions, the Society of Actuaries' (SOA's) Retirement Plans Experience Committee (RPEC or "the Committee") initiated a Pension Mortality Study in 2009. The primary focus of this study was a comprehensive review of recent mortality experience of uninsured private[1] retirement plans in the United States. The ultimate objectives of the study were the following:

1. Propose an updated set of mortality assumptions that would supersede both the RP-2000 base tables and mortality projection Scales AA, BB, and BB-2D
2. Provide new insights into the composition of gender-specific pension mortality by factors such as type of employment (e.g., collar), salary/benefit amount, health status (i.e., healthy or disabled), and duration since event

The RP-2014[2] mortality tables presented in this report and the mortality improvement Scale MP-2014 presented in the accompanying report form a new basis for the measurement of retirement program obligations in the United States [14].[3] With the exception of the mortality rates at the youngest and oldest ages, the participant data underlying the RP-2014 tables reflect mortality experience of retirement plans subject to the funding rules of the Pension Protection Act of 2006 (PPA).

The mortality assumptions for nondisabled participants currently mandated by the Internal Revenue Service (IRS) for minimum funding purposes are based on RP-2000 tables projected with mortality improvement Scale AA.[4] Certain Pension Benefit Guaranty Corporation (PBGC) measures, including the determination of the PBGC variable rate premium, rely on the mortality basis applicable to minimum funding valuations. Section 430(h)(3) of the Internal Revenue Code (IRC) requires periodic review of the mortality assumptions used for PPA funding requirements, and RPEC anticipates that the RP-2014 tables presented in this report will be considered in the next IRS review process.

1.2 Overview of the Data

The final dataset upon which this study has been based reflects approximately 10.5 million life-years of exposure and more than 220,000 deaths, all from uninsured private pension plans subject

[1] While RPEC collected (and analyzed) the mortality data from a number of large public and federal pension plans, only the data collected on uninsured private plans were used in the development of the RP-2014 mortality tables.
[2] The abbreviations "RP" and "MP" stand for Retirement Plans and Mortality Projection, respectively.
[3] Numbers in square brackets refer to items listed in the References section at the end of this report.
[4] Most U.S. pension actuaries use IRS-published static tables (based on Scale AA projection) for minimum funding purposes, despite the fact that generational projection with Scale AA is permitted. Some larger plans use plan-specific "substitute" mortality assumptions for minimum funding purposes.

to PPA funding rules. Data were submitted for a total of 123 private and public/federal[5] pension plans[6] in response to RPEC's request for plan experience covering the years 2004 through 2008.[7] For purposes of characterizing plans as blue collar or white collar, RPEC used the same criteria as were described in the RP-2000 study.

1.3 Development of RP-2014 Mortality Tables

RPEC first projected the raw mortality rates from their central year (2006) to 2014 using the Scale MP-2014 mortality improvement rates. Those projected rates were then graduated using Whittaker-Henderson-Lowrie methodology,[8] and subsequently extended to extreme (very old or very young) ages using a variety of standard actuarial techniques. The final result was a set of 11 gender-specific amount-weighted tables with base year of 2014:

- *Employee Tables* (ages 18 through 80)
    - Total (all nondisabled data)
    - Blue Collar
    - White Collar
    - Bottom Quartile (based on salary)
    - Top Quartile (based on salary)
- *Healthy Annuitant*[9] *Tables* (ages 50 through 120)
    - Total (all nondisabled data)
    - Blue Collar
    - White Collar
    - Bottom Quartile (based on benefit amount)
    - Top Quartile (based on benefit amount)
- *Disabled Retiree Table* (ages 18 through 120)

For completeness, the Committee also developed gender-specific Juvenile tables covering ages 0 through 17.

As a test of consistency with the RP-2000 mortality tables, the Committee compared each of the "Total" RP-2014 rates to the corresponding RP-2000 rates projected to 2014 using both Scale AA and Scale MP-2014. The results of the comparison indicated that, for Healthy Annuitants (the group that has the greatest financial impact), the RP-2014 rates were generally very close to the RP-2000 rates projected to 2014 with Scale MP-2014.

This RP-2014 report does not include mortality tables analogous to the "Combined Healthy" tables in the RP-2000 report. Actuaries who wish to develop Combined Healthy tables are encouraged to

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[5] For the remainder of this report, the term "public plans" should be understood to include both public and federal pension plans.
[6] The final RP-2014 dataset included data from 38 private plans.
[7] Because of the length of the data collection/validation process and RPEC's desire to maximize study exposures, the final dataset includes some private plan mortality experience that extended into the 2009 calendar year.
[8] See Section 5 for details.
[9] The term "Healthy Annuitants" refers to the combined populations of Healthy Retirees and Beneficiaries.

blend appropriately selected RP-2014 Employee and Healthy Annuitant tables, taking plan-specific demographic information into account.

1.4 Estimated Financial Impact

Most current pension-related[10] applications in the United States involve projection of RP-2000 (or possibly UP-94) base mortality rates using either Scale AA or Scale BB. RPEC believes that it will be considerably more meaningful for users to assess the combined effects of adopting RP-2014 tables projected with Scale MP-2014, rather than trying to isolate the impact of adopting one without the other. The financial impact of the combined change is expected to vary substantially based on the starting mortality assumptions; for example, the impact of switching from a static projection using Scale AA will typically be much more significant than the impact of switching from a generational projection using Scale BB.

Table 1.1 presents a comparison of 2014 monthly deferred-to-age-62 annuity due values (at an annual interest rate of 6.0 percent) based on a number of different sets of base mortality rates and generational projection scales, along with the corresponding percentage increases of moving to RP-2014 base rates[11] projected generationally with Scale MP-2014.

		Monthly Deferred-to-62 Annuity Due Values Generational @ 2014					*Percentage Change of Moving to RP-2014 (with MP-2014) from:*			
	Base Rates	UP-94	RP-2000	RP-2000	RP-2000	RP-2014	UP-94	RP-2000	RP-2000	RP-2000
	Proj. Scale	AA	AA	BB	MP-2014	MP-2014	AA	AA	BB	MP-2014
	Age									
Males	25	1.3944	1.4029	1.4135	1.4324	**1.4379**	*3.1%*	*2.5%*	*1.7%*	*0.4%*
	35	2.4577	2.4688	2.4881	2.5259	**2.5363**	*3.2%*	*2.7%*	*1.9%*	*0.4%*
	45	4.3316	4.3569	4.3963	4.4662	**4.4770**	*3.4%*	*2.8%*	*1.8%*	*0.2%*
	55	7.6981	7.7400	7.8408	7.9735	**7.9755**	*3.6%*	*3.0%*	*1.7%*	*0.0%*
	65	11.0033	10.9891	11.2209	11.5053	**11.4735**	*4.3%*	*4.4%*	*2.3%*	*-0.3%*
	75	8.0551	7.8708	8.2088	8.5842	**8.6994**	*8.0%*	*10.5%*	*6.0%*	*1.3%*
	85	4.9888	4.6687	5.0048	5.2978	**5.4797**	*9.8%*	*17.4%*	*9.5%*	*3.4%*
Females	25	1.4336	1.4060	1.4816	1.5097	**1.5195**	*6.0%*	*8.1%*	*2.6%*	*0.6%*
	35	2.5465	2.4931	2.6145	2.6666	**2.6853**	*5.5%*	*7.7%*	*2.7%*	*0.7%*
	45	4.5337	4.4340	4.6264	4.7198	**4.7497**	*4.8%*	*7.1%*	*2.7%*	*0.6%*
	55	8.1245	7.9541	8.2532	8.4373	**8.4544**	*4.1%*	*6.3%*	*2.4%*	*0.2%*
	65	11.7294	11.4644	11.8344	12.1437	**12.0932**	*3.1%*	*5.5%*	*2.2%*	*-0.4%*
	75	8.9849	8.6971	9.0649	9.4045	**9.3996**	*4.6%*	*8.1%*	*3.7%*	*-0.1%*
	85	5.7375	5.5923	5.9525	6.2910	**6.1785**	*7.7%*	*10.5%*	*3.8%*	*-1.8%*

Table 1.1

[10] The word "pension" used in the terms "pension actuary", "pension actuaries", or "pension-related" in this report should be understood to include both "pension" and "other postemployment benefits (OPEB)."

[11] Total Employee mortality rates through age 61 and Total Healthy Annuitant mortality rates at ages 62 and older.

1.5 RPEC Recommended Application and Adoption of RP-2014 Tables

The Committee encourages all pension actuaries in the United States to carefully review the findings presented in this report and the companion Scale MP-2014 report. RPEC maintains that, as of their release date, the RP-2014 tables presented in this report represent the most current and complete benchmarks of U.S. private pension plan mortality experience, and the Committee recommends consideration of their use for the measurement of private pension plan obligations, effective immediately. The Committee also recommends generational projection of mortality rates using Scale MP-2014, or an appropriately parameterized version of the RPEC_2014 model.

RPEC recommends that the individual characteristics and experience of the covered group be considered in the selection of an appropriate set of base mortality rates. While statistical analyses summarized in this report continue to confirm that both collar and amount quartile are statistically significant indicators of differences in base mortality rates for nondisabled lives, RPEC believes that the use of collar-based tables will generally be more practical than the use of amount-based tables.

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Special Recognition of Others Not Formally on RPEC

First and foremost, the Committee would like to express its sincere and profound appreciation for the support provided throughout the project from the following team of Swiss Re employees:

Curtis Burgener
JJ Carroll
Steven Ekblad
Dr. Brian Ivanovic
Allen Pinkham

It is difficult to overstate the importance of the work performed by the Swiss Re team in the successful completion of this report. In addition to expending a great deal of effort ensuring the accuracy of the final dataset, the Swiss Re team produced a vast number of univariate and multivariate analyses that were critical to the construction of the RP-2014 tables.

The Mortality Improvement subcommittee would also like to thank Stephen Goss, Alice Wade, Michael Morris, Karen Glenn, and Johanna P. Maleh, all from the Office of the Chief Actuary at the Social Security Administration (SSA), for the valuable comments and information they have provided throughout the study. RPEC would especially like to acknowledge the assistance it received from Michael Morris, who was the Committee's main point of contact with respect to SSA mortality data and methodology.

The Committee would like to thank Greg Schlappich at Pacific Pension Actuarial who was extremely helpful in developing Excel-based software for the Whittaker-Henderson-Lowrie graduation described in Section 5.

Finally, the current RPEC members and SOA staff would like express their sincere gratitude to Lindsay Malkiewich and Diane Storm. Lindsay retired in May 2014 and Diane will step down from RPEC after the publication of the RP-2014 and MP-2014 reports. Lindsay and Diane have each contributed 22 years of volunteer service on the Committee. RPEC thanks Lindsay for the valuable input he provided on the development of Scale BB and both of the RP-2014 and Scale MP-2014 exposure drafts and Diane for all the valuable work she did in connection with the development of Scale BB, the RP-2014 and Scale MP-2014 exposure drafts, the RP-2014 and Scale MP-2014 reports and RP-2014 and Scale MP-2014 Response to Comments documents.

Reliance and Limitations

The RP-2014 mortality tables have been developed from private pension mortality experience in the United States and are intended for use in connection with actuarial calculations related to pension and other postemployment benefit (OPEB) programs. No assessment has been made concerning the applicability of these tables to other purposes.

Section 2. Background and Process

2.1 Reason for New Study

The mortality assumptions currently used to value most retirement programs in North America were developed from data that are more than 20 years old. The two most commonly used pension-related mortality tables are UP-94 and RP-2000, which were based on mortality experience with central years of 1987 and 1992, respectively [11, 12]. Prior to the SOA's release of the Scale BB Report in September 2012, the only mortality projection scale generally available to North American pension actuaries was Scale AA, which was based on mortality improvement experience between 1977 and 1993.

The Retirement Plans Experience Committee (RPEC) initiated a Pension Mortality Study in 2009 with the ultimate objective of developing updated base mortality rates and mortality improvement scales for use with pension and other postretirement programs in the United States and Canada. After RPEC became aware that the Canadian Institute of Actuaries was planning to undertake a similar study of pension-related mortality experience in Canada, the Committee decided to limit the scope of the SOA project to U.S. retirement programs.

An important motivation for this study is the requirement in IRC Section 430(h)(3) for the Secretary of the Treasury to review at least every 10 years "applicable mortality rates" for various qualified plan funding requirements. Since the RP-2014 mortality tables are based on the mortality experience of uninsured private pension plans[12] in the United States, RPEC believes they should be considered as potential replacements for the current mortality basis (generally RP-2000 rates projected with Scale AA) that is mandated for a number of Department of the Treasury and PBGC applications.

The requirements of the IRS and PBGC notwithstanding, U.S. pension actuaries need to have available a variety of up-to-date mortality tables to accurately measure pension and other postretirement benefit obligations. The Committee is hopeful that future studies of pension-related mortality assumptions will be performed on a more frequent basis.

RPEC encourages all members of the U.S. pension actuarial community to carefully review the base tables described in this report—in conjunction with the new mortality projection methodology described in the companion Scale MP-2014 report—as part of their ongoing review of pension-related mortality assumptions.

2.2 RPEC's Process

RPEC generally met two times a month, with almost all of those meetings taking place via conference call. These meetings were not open to the public. Status updates of the Committee's progress were shared periodically (approximately quarterly) with representatives of the IRS and

[12] In addition to the raw pension plan data collected, RPEC made use of Social Security data for juvenile mortality rates as well as 2008 VBT (individual life insurance) mortality rates in the development of final RP-2014 rates; see Sections 6 through 9 for details.

the PBGC. The Committee also had numerous helpful interactions with the Office of the Chief Actuary at the SSA. Timothy Geddes, an RPEC member, and Andrew Peterson, SOA Staff Fellow–Retirement, were responsible for keeping appropriate groups within the American Academy of Actuaries apprised of RPEC's progress.

One of RPEC's first decisions was to create a number of subteams, each of which would focus on a particular fundamental component of the mortality table construction process. This allowed the group to work on key aspects of the RP-2014 project simultaneously rather than sequentially. The following is a list of those subgroups and the names of the respective team members; subteam leaders are denoted with asterisks, and Swiss Re employees are denoted with plus signs:

- *Data Processing and Validation (the "Data" subteam):* Ed Hustead*, Curtis Burgener+, Andy Eisner, Allen Pinkham+, and Bart Prien
- *Graduation Methodology (the "Graduation" subteam):* David Kausch*, Bob Howard, and Larry Pinzur
- *Univariate and Multivariate Analyses (the "Statistical Analysis" subteam):* Larry Pinzur*, Steve Ekblad+, Brian Ivanovic+, Allen Pinkham+, and Bill Roberts
- *Disabled Life Mortality (the "Disability" subteam):* Paul Dunlap*, Pete Zouras*, David Kausch, Pat Pruitt, and Bob Pryor
- *Extension to Extreme Ages (the "Table Extension" subteam):* Ed Hustead*, Paul Dunlap, Andy Eisner, Bob Howard, David Kausch, and Pete Zouras

In addition to these RP-2014 subteams, a separate subcommittee (composed of Larry Pinzur*, Bob Howard, Brian Ivanovic+, Paul Dunlap, Allen Pinkham+, Bob Pryor, and Bill Roberts) was formed to study U.S. mortality improvement trends and develop the new RPEC_2014 projection model and the associated Scale MP-2014 [14].

2.3 Designation of Various Participant Subgroups

The following list summarizes the official names used by RPEC throughout this report to describe various subgroups of plan participants and the description of the participants covered by that designation:

- *Employee:* A nondisabled participant who is actively employed[13] (including those in plans that no longer have ongoing benefit accruals).
- *Healthy Annuitant:* A formerly active participant in benefit receipt who was not deemed disabled at the date of retirement (a "*Healthy Retiree*") or the surviving beneficiary of a formerly active participant who is older than age 17 and in benefit receipt (a "*Beneficiary*"[14]).

[13] Terminated vested participants not yet in payment status were excluded from the study due to insufficient data.
[14] Since exposures and deaths were only counted after the death of the primary annuitant, the term "Beneficiary" should always be understood to mean "surviving Beneficiary" throughout this report.

- *Disabled Retiree:* A retired participant in benefit receipt who was deemed disabled as of the date of retirement.
- *Juvenile*: A participant's beneficiary who is under the age of 18.

The term *Annuitant* is sometimes used when it is not necessary to distinguish between a Healthy Retiree, a Beneficiary or a Disabled Retiree.

Section 3. Data Collection and Validation

3.1 Data Processing Overview

The following list outlines the phases involved in the development of the final dataset from which the raw mortality rates for this study were produced:

1. Data collection
2. Preliminary review for reasonableness and completeness
3. Record-specific data consolidation and validation
4. In-depth actual-to-expected ("A/E") ratio[15] analysis.

Each of these phases, which were performed in accordance with ASOP 23, is discussed in more detail in the remainder of this section.

3.2 Data Collection

The data collection process started in October 2009, with RPEC sending data request letters to the largest actuarial consulting firms and a number of large public pension plans.[16] The formal request package consisted of the following three documents, which are reproduced in Appendix E:

1. A cover letter outlining the goals of the study, an approximate timetable, and preferred file formats
2. A "Participant Information" summary, detailing the requested individual data elements for calendar years 2004 through 2008
3. A "Plan Information" summary, requesting plan-specific information such as type of pension formula and eligibility criteria for disability benefits

Organizations that were sent the data request packages were requested to confirm their intent to provide data to the study by October 30, 2009. The due date originally requested for the submission of data was December 31, 2009, but that was subsequently extended to June 30, 2010, after it became clear that certain firms would not be able to submit accurate data until that later date.

At the request of RPEC, SOA staff later requested that firms provide information regarding the "collar type" of each plan for which data was submitted. The collar criteria used in the current study were the same as those used in the RP-2000 study; that is, the type was classified as Blue Collar if at least 70 percent of the plan participants were (either) hourly or union, and the type was classified as White Collar if at least 70 percent of the plan participants were (both) salaried and non-union. Plans whose participants failed to satisfy either of those two conditions were to be classified as Mixed Collar.

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[15] The ratio of the actual number of deaths to the expected number of deaths.

[16] The final dataset used by RPEC to develop the RP-2014 tables did not include any public plan mortality data; see subsection 4.3 for additional details.

To maintain confidentiality of the submitted data, the data collection and data processing phases of the project were coordinated by SOA staff, working directly with outside data compilers. MIB Solutions, Inc. (MIB) was used to perform the initial validation checks on the data. Swiss Re was subsequently selected to perform additional validation checks, initiate various statistical analyses, and, per approval by the Committee, impute missing information. In a number of cases, direct contact was made with the data contributors (coordinated through and including SOA staff) to address specific issues with their data submission.

In large part because of efforts by RPEC to increase the total amount of experience to be included in the study, the submission of raw data for the project continued through April 2011. As a consequence of this prolonged data collection process, some contributors of private plan information submitted data that included mortality experience that extended into the 2009 calendar year.[17] Ultimately, the SOA received raw data from a total of 123 private and public pension plans.

3.3 Preliminary Review for Reasonableness and Completeness

MIB performed a number of high-level tests designed to assess the overall reasonableness and completeness of the raw data collected. These tests identified a surprisingly large number of plans (primarily private plans) that had missing, incomplete, or inconsistent information.[18] In addition to those more obvious data problems, a significant number of plans that passed the initial data checks produced preliminary A/E ratios (with expected deaths based on RP-2000 rates projected to the exposure year using Scale BB) that were unusually high or low.

Swiss Re was engaged to perform a detailed reasonableness analysis on the data (plan identity was masked) and to determine a course of action to retain as much data in the study as possible. SOA staff worked with Swiss Re to contact the data contributors through December 2012 in an attempt to correct the inconsistent/incomplete data.

After removing data that fell outside of the study's observation period, RPEC immediately identified significant problems with two large submissions. One dataset did not include a consistent "Member ID" within each record that RPEC had requested as part of the original data collection process; see subsection 3.4 for more details on the use of these consistent identifiers in this study. Despite repeated efforts by SOA staff to have the dataset resubmitted with consistent IDs—and clear messages that RPEC would exclude that dataset if the consistent IDs were not provided—the contributor did not resubmit the data.

A preliminary inspection of the entire dataset submitted by one contributor indicated that there were obvious problems with the date of death field. After confirming the data problem, the contributor worked with SOA staff and Swiss Re to provide a subset of the original dataset with correct death information. That effort also proved unsuccessful, and the contributor ultimately communicated that it would not be able to provide accurate data.

[17] The basic data submitted by two of the large public plans contained mortality experience extending into calendar year 2009, as well as for calendar years prior to 2004.

[18] See RPEC's Response to Comments on RP-2014 Mortality Tables Exposure Draft for a more comprehensive reconciliation of the data with missing, incomplete or inconsistent information.

3.4 Record-Specific Data Consolidation and Validation

RPEC requested that a consistent "Member ID" be included for each record submitted as part of the original data collection process. The intent was to use this identifier to link together multiple years' worth of data for each participant (within a single plan) resulting in one "consolidated" record per person. These consolidated records could then be followed through their entire exposure window, increasing the probability that each participant was credited with his or her appropriate amount (and type) of exposure, particularly when the participant had transitions between the different retirement plan phases (e.g., active Employee to Healthy Retiree). The use of consolidated records also facilitated the checking of key data fields for internal consistency and the handling of late-reported deaths.

The Swiss Re team devoted a great deal of effort to construction of the consolidated records, and the process did, in fact, uncover a significant number of previously undetected data inconsistencies. For example, Swiss Re identified a number of records with inconsistent gender codes, which were later found to be concentrated in plans whose data was submitted by organizations that often reused the same identifier for the beneficiary of a deceased participant.

After signing confidentiality agreements that permitted access to individual de-identified plan-level data, members of the Data subteam reviewed the univariate analyses of the consolidated record dataset prepared by Swiss Re. The univariate analyses, performed separately on each of the Employee, Healthy Retiree, Beneficiary, and Disabled Retiree subpopulations, provided the subteam with summaries of the overall quality and quantity of the data, including exposures, deaths, and A/E ratios (on both headcount and amount-weighted bases) stratified by factors such as gender, age grouping, collar, amount, and calendar year. The univariate analyses also identified aspects of the intermediate dataset that required additional attention.

The remainder of this subsection highlights the reasonability analyses undertaken and the procedures implemented by Swiss Re (with oversight by RPEC) to determine a final set of data to be used as the starting point for the development of RP-2014 mortality tables.

Age Ranges

RPEC excluded individual life-years of exposure from the study that lay outside of defined age ranges. The age ranges were established according to patterns typically observed in pension plans, informed by the results of the univariate analysis as to the depth of data available. The following table presents the age ranges for the four participant categories:

Participant Category	Lowest Reasonable Age	Highest Reasonable Age
Employee	20	70
Healthy Retiree	50	100
Beneficiary	50	100
Disabled Retiree	45	100

Missing Dates of Death

Some retiree records switched to survivor status without indicating a date of death for the retiree. The following approach was adopted to address the missing data:

- If a date of death was included in the data, it was assumed to be the date of the retiree's death rather than the beneficiary's.
- If a date of benefit commencement for the beneficiary was included in the data, the retiree was assumed to have died the preceding day.
- If neither date was provided, RPEC estimated the date of death to have been on the retiree's birthday in the year of status change.

Status at Death for First Exposure Year Death Records

Most of the records for deaths in the first year of the submitted data did not include status at the beginning of that year. In such cases, Swiss Re relied upon other data included for the individual to determine status as of the beginning of the year of death. For example, if there was neither a retirement date nor a disability date on the record, the participant was assumed to be an active employee at the time of death.

Multiple Retirement Dates

Generally, multiple retirement dates were ignored with retirement assumed to have occurred on the initial retirement date. If the individual was indicated to be disabled, the first retirement date was assumed to be the date of disability and the participant was assumed to be disabled from that point. If there was more than one retirement date and the record indicated that the participant was likely a surviving beneficiary, then the second retirement date was assumed to be the date of death.

Plans with Predominantly Male or Female Participants

Plans consisting of less than 30 percent male lives or more than 80 percent male lives were flagged for verification. The SOA staff contacted submitters who then confirmed that the male/female proportions in the plan data were reasonable.

Missing Termination Dates

Some records contained neither termination date nor reason for termination. In these cases, the termination year was assumed to be the year after the last record.

Gender and Hire Age

In a few cases, gender was not consistent within a single consolidated record, in which case it was assumed the correct gender was the one that appeared most often.

If hire date was missing, hire age was assumed to be 30 or, if younger than 30 at the beginning of the record, the date of hire was assumed to be in the year preceding the earliest year in the record.

Salary and Benefit Amounts

The submitted data included a number of very low or very high retirement benefit amounts. In those cases, the Data subteam went back to the data submitters to verify the accuracy of those amounts. If submitters indicated that their data was not submitted on the expected monthly basis, the amounts were adjusted appropriately.

Salary and retirement benefit amounts for those Employees and Annuitants, respectively, were imputed if no such amount was originally submitted. The imputed amount for Employees with missing salary was $50,000 per year. The imputed annual retirement benefit for Healthy and Disabled Retirees was $21,300, and the imputed annual retirement benefit for Beneficiaries was $14,200.

3.5 In-Depth A/E Ratio Analysis

At this point the remaining dataset consisted of approximately 32.8 million life-years of exposure, split between approximately 19.9 life-years for public plan participants and approximately 12.9 life-years for private plan participants.

The expected number of deaths—the "E" in the A/E ratios—was determined on a year-by-year basis for each remaining plan based on the applicable collar-adjusted RP-2000 mortality table, projected using Scale BB to the appropriate year in the observation period. For each status/collar combination, a "normalized" A/E ratio was developed, effectively scaling all of the ratios in that subgroup so that the average A/E ratio for the entire subgroup was 100 percent. This was done to ensure an appropriate basis of comparison for determining outlier A/E ratios.

The Data subteam then developed approximate 95 percent confidence intervals for the resulting normalized A/E ratios for each plan/status combination. If the low end of the 95 percent confidence interval was greater than 110 percent or the high end less than 90 percent, the plan was flagged for additional examination. For example, assume that the Employees in Plan X produced a normalized A/E ratio of 0.63, with a corresponding 95 percent confidence interval of 0.50 to 0.76. Since 0.76 (the high end of the confidence interval) is less than 0.90, Plan X would be flagged.

Flagged plans with a small number of expected deaths[19] were dropped from the study. For the remaining flagged plans, the Data subteam asked the respective contributors about the reasonableness of the submitted data. If the contributing organization confirmed that the observed A/E ratio was reasonable, the plan remained in the study data; otherwise, the plan was dropped.

RPEC wishes to highlight the fact that with three exceptions,[20] all records removed as a result of this in-depth normalized A/E ratio analysis occurred at the full plan level; i.e., all submitted

[19] The drop thresholds were 30 for Employees and Healthy Retirees, and 20 for Beneficiaries and Disabled Retirees.
[20] Two plans each consisted of a small number of Employees (each with an outlier A/E ratio) and a much larger number of Healthy Retirees (each with a very reasonable A/E ratio). For both plans, RPEC decided to exclude the Employees and include the Healthy Retirees in the final dataset. A third plan had the reverse situation, and the small Retiree group was excluded while the larger Employee group was included.

participants in a given plan were either entirely included in the study or entirely excluded from the study.

3.6 Summary of the Final Dataset

After review of the multivariate analysis subsequently performed by Swiss Re, RPEC decided to exclude the public plan data from the study; see subsection 4.3. Table 3.1 presents a reconciliation of the various datasets, starting with the total life-years of exposure eligible for inclusion in the study prior to RPEC's in-depth A/E analysis and ending with the final life-years of exposure included in the study. Table 3.2 provides a reconciliation of the final private plan dataset based on participant status.

	Life-Years of Exposure		
	Total	**Public Plans**	**Private Plans**
Data before in-depth A/E analysis	**32,753,688**	**19,886,552**	**12,867,136**
Minus: Data for plans with outlier A/E ratios that could not be confirmed by the contributor	4,533,246	2,166,954	2,366,292
Final dataset, before public plan exclusion	**28,220,442**	**17,719,598**	**10,500,844**
Minus: Public plan exclusion	17,719,598	17,719,598	-
Final RP-2014 dataset, after public plan exclusion	**10,500,844**	-	**10,500,844**

Table 3.1

	Life-Years of Exposure				
	Employees	**Healthy Retirees**	**Surviving Beneficiaries**	**Disabled Retirees**	**Total**
Private plan exposures before in-depth A/E analysis	**5,800,000**	**5,432,289**	**1,209,162**	**425,686**	**12,867,136**
Exposures for private plans with suspicious A/E ratios that could not be confirmed by the contributor	1,343,255	796,244	169,793	57,000	2,366,292
Final dataset	**4,456,745**	**4,636,045**	**1,039,368**	**368,686**	**10,500,844**

Table 3.2

The exposures and deaths included in the final RP-2014 dataset are summarized in Table 3.3; additional breakdowns of this data by age group, collar type, and income quartile can be found in Tables C-1 through C-8 in Appendix C. The five plans with the largest quantity of amount-weighted Employee exposure represented approximately 37 percent of the total amount-weighted exposure in the Employee dataset. The five plans with the largest quantity of amount-weighted Healthy Retiree exposure represented approximately 66 percent of the total amount-weighted exposure of that dataset.

Summary of Final Dataset

	Number		Number with Amount		Annual Amount ($000s)		Percent with Amounts	
	Life-Years of Exposure	Deaths	Life-Years of Exposure	Deaths	$-Years of Exposure	$-Weighted Deaths	Exposure	Deaths
Employees								
Males	2,467,108	5,358	1,656,319	2,432	110,486,189	142,103	67.1%	45.4%
Females	1,989,637	2,277	1,763,513	1,807	89,903,158	76,639	88.6%	79.4%
Total	4,456,745	7,635	3,419,833	4,239	200,389,346	218,741	76.7%	55.5%
Healthy Retirees								
Males	3,165,190	110,647	3,073,985	109,400	50,632,202	1,317,018	97.1%	98.9%
Females	1,470,855	45,586	1,381,319	44,838	14,154,745	345,305	93.9%	98.4%
Total	4,636,045	156,233	4,455,303	154,238	64,786,947	1,662,323	96.1%	98.7%
Beneficiaries								
Males	60,549	3,245	59,653	3,174	298,633	14,875	98.5%	97.8%
Females	978,819	45,341	977,104	45,195	6,502,346	266,151	99.8%	99.7%
Total	1,039,368	48,586	1,036,758	48,369	6,800,979	281,026	99.7%	99.6%
Disabled Retirees								
Males	240,917	11,901	232,495	11,678	2,311,336	101,974	96.5%	98.1%
Females	127,769	4,062	110,378	3,725	907,787	26,033	86.4%	91.7%
Total	368,686	15,963	342,873	15,403	3,219,123	128,008	93.0%	96.5%
Total Annuitants	6,044,099	220,782	5,834,934	218,010	74,807,049	2,071,357	96.5%	98.7%
Total Dataset	**10,500,844**	**228,417**	**9,254,767**	**222,249**	**275,196,395**	**2,290,098**	**88.1%**	**97.3%**

Table 3.3

3.7 Determination of Amount-Based Quartiles

The RP-2000 Report included amount-based tables (Small, Medium, and Large amount categories based on fixed annual benefit amounts) for Healthy Annuitants only. The current study analyzed quartile-based[21] mortality trends for both Employees and Annuitants based on annual salary for the former and annual retirement benefit amount for the latter. The quartile breakpoints summarized in Table 3.4 were all developed based on gender-specific headcount exposure, that is, not based on exposure weighted by either salary or benefit amount.

	Quartile Breakpoints							
	Employees		**Healthy Retirees**		**Beneficiaries**		**Disabled Retirees**	
Percentile	Male	Female	Male	Female	Male	Female	Male	Female
25th	$ 44,916	$ 30,824	$ 8,208	$ 3,888	$ 2,304	$ 3,972	$ 5,508	$ 5,088
50th	$ 60,216	$ 46,596	$ 14,496	$ 8,784	$ 4,320	$ 6,048	$ 8,796	$ 7,584
75th	$ 77,232	$ 62,820	$ 24,756	$ 13,932	$ 6,576	$ 8,376	$ 13,068	$ 10,872

Table 3.4

So, for example, experience for a female Employee was included in Quartile 4 (also referred to as the "Top Quartile") if she was reported to have an annual salary of at least $62,820.

[21] Participants for whom no amount was submitted were excluded from the quartile-based analyses.

Section 4. Multivariate Analysis

4.1 Background on Multivariate Analysis

Although univariate analysis of mortality data is helpful in assessing the significance of individual factors one variable at a time, multivariate techniques are useful when trying to assess multiple factors for statistical significance simultaneously. Stratification of the underlying dataset can also be used to control for the interaction among various factors, but such an approach can become unstable when the number of cofactors becomes large. Even when the resulting stratified categories include enough deaths to yield credible results, it can be difficult to make sense of hundreds of cells of results, i.e., identifying patterns and determining which factors are more significant than others.

The Statistical Analysis subteam included a number of Swiss Re employees who performed all of the analyses summarized in this section. The following table summarizes the factors that the subteam analyzed for potential statistical significance with respect to differences in underlying mortality rates:

Factors	**Implications**
Private plan experience Public plan experience	If differences are not significant, public and private plan data could possibly be combined in the study.
Retired lives experience Beneficiary lives experience	If experience is significantly different, separate tables could improve measurements.
Blue collar White collar	If experience is significantly different, collar-specific tables could improve measurements.
Amount (benefit/salary levels)	A consistent pattern of mortality differences between annuitants with high versus low benefits or active employees with high versus low salaries may suggest tables that vary by amount could improve measurements.
Combination of collar and amount	If amount-specific differences within collar categories are significant, separate tables based on both collar and amount could improve measurements.
Duration	If duration effects are significant, select-and-ultimate tables could produce superior measurements.

4.2 Nature of Analyses

In reviewing the dataset that remained at this point, RPEC relied primarily on logistic regression techniques performed on a gender-/age-specific basis. Logistic regression models the natural logarithm of the odds ratio to develop a relative risk (RR) factor, with corresponding *p*-values and confidence intervals. RR values are calculated relative to a specific reference population while controlling for one or more selected cofactors. An RR value close to 1.0 indicates that the underlying mortality rates corresponding to the factor being tested are not significantly different from those of the reference population, whereas an RR value outside of a small interval around 1.0

typically indicates that the influence of the selected factor is a statistically significant predictor of a different mortality pattern from that of the reference population.

Supplementing the logistic regression analyses described above, Swiss Re modeled the number of deaths on a grouped basis using generalized linear models, alternatively assuming Poisson and negative binomial distributions.

4.3 Summary of Multivariate Analysis and Conclusions for Nondisabled Participants

Private Plan and Public Plan Experience

Because the final dataset did not include any active employees for the three public plans, RPEC performed a “public versus private” logistic regression on the Healthy Retiree dataset only. This analysis indicated statistically significant structural differences in the underlying mortality rates produced from the public and private plan datasets. These structural differences included:

- Gender-based differences: The odds ratio of age-specific male-to-female mortality was much higher for the private plan dataset than for the public plan dataset.
- Amount-based differences: The amount of variation between the bottom quartile and top quartile mortality was much greater for the private plan dataset than for the public plan dataset.
- Age-based differences: The public plan mortality for annuitants under age 65 exhibited a number of distinct features relative to the private plan mortality at those ages.
- No collar information was submitted for the public plans, precluding analysis based on collar.

RPEC’s conclusion was that the raw Healthy Retiree mortality rates generated by the three public plans were significantly different from the corresponding private plan rates, and, therefore, the public and private datasets should not be combined. RPEC further concluded that the mortality experience of the three public plans was so disparate that it would not be appropriate to develop separate “public plan retiree” mortality tables based on the aggregated public plan data. Hence, RPEC decided to exclude the nondisabled public plan data from the remainder of the study.

As stated in subsection 2.1, an important motivation for the study was the requirement in IRC Section 430(h)(3) for the Secretary of the Treasury to review at least every 10 years the “applicable mortality rates” used for minimum funding and various other regulatory requirements. The fact that the final RP-2014 tables were based exclusively on data from uninsured private plans makes those tables more appropriate as potential replacements for the applicable mortality rate structure currently in place; see section 11.3 for a discussion of possible applications of RP-2014 for public plans.

Retiree and Beneficiary Experience

A review of Tables C-5 and C-6 (in Appendix C) shows that the amount of data submitted for Male Beneficiaries was small relative to that for Female Beneficiaries. RPEC concluded that there was not enough data to perform any meaningful statistical analyses on the Male Beneficiary data.

For females in private plans, a logistic regression that controlled for all key cofactors (including gender, collar, and benefit amount) indicated that Beneficiary mortality experience differed significantly from that of Healthy Retirees.[22] There are a number of reasons for different patterns in mortality between the Healthy Retiree and Beneficiary subpopulations, most notably the well-documented temporary increase in relative mortality rates immediately following the death of a spouse [10].

Given that most pension actuaries will likely apply these postretirement mortality tables to populations of annuitants that include some combination of retirees and surviving beneficiaries, RPEC concluded that it would be appropriate to develop “Healthy Annuitant” mortality tables that reflect the experience of the combined datasets. (This is consistent with the approach taken in the RP-2000 tables.)

Consideration was given to providing separate tables for female Healthy Retiree and female Beneficiary populations, but concluded that their use would be too limited to justify inclusion in the report.

Variations by Collar

RPEC performed gender-specific logistic regression analyses separately for the Employee and Annuitant populations and in all cases found very clear evidence for variations in mortality rates by collar. The collar effects were found to be more pronounced in males than in females. When controlling for benefit amount, the overall RR value for Blue Collar Healthy Annuitants (relative to White Collar Healthy Annuitants) was 1.22 for males and 1.14 for females. When controlling for salary amount, the overall RR values for Blue Collar Employees (relative to White Collar Employees) were 1.42 for males and 1.20 for females. For both males and females, the differences attributable to collar tended to diminish with advancing age.

Variations by Amount

RPEC’s gender-specific logistic regression analyses identified clear evidence for variations in mortality experience based on salary amount for Employees and benefit amount for Annuitants. (See subsection 3.7 for a description of RPEC’s quartile breakpoints.) When controlling for collar, the overall RR value for Top Quartile Annuitants (relative to Bottom Quartile Annuitants) was 0.65 for males and 0.86 for females. When controlling for collar, the corresponding overall RR values for Employees were 0.53 for males and 0.43 for females. For both genders, the differences attributable to benefit amount tended to diminish with advancing age.

Variations by Collar and Amount

As indicated above, collar and amount are both independent predictors of mortality in models where both factors are included. By reviewing models in which only one of those factors is

[22] The age-specific ratios of (a) female Beneficiary mortality rates to (b) female Healthy Retiree rates decreased from approximately 2.5 at age 50 and to approximately 0.9 at age 90; the crossover point (ratio of 1.0) occurred between ages 78 and 79.

included, it is possible to determine whether one factor is a stronger predictor than the other. For Healthy Annuitants, collar was the more significant factor; amount tended to be more significant for Employees.

By considering the amount relationships within collar-stratified models, it can be determined if the effects are similar for white and blue collar participants. For Healthy Annuitants, the amount effects were similar but slightly stronger in the white collar models. For Employees, the amount effects were considerably stronger in the white collar models, particularly for the middle two quartiles (relative to the bottom quartile).

Although separate tables could have been developed for each collar and amount combination, RPEC decided that the extra complexity was not warranted given the high degree of correlation between collar and amount. Therefore, RPEC concluded that either collar or amount could be appropriate factors to consider in selecting a set of base mortality rates. See subsection 13.2 for a more in-depth discussion regarding the application of these findings to specific situations.

Variations by Duration

Analysis of mortality by duration since retirement depends on retirement age. Virtually all of the retirements in the final Healthy Retiree dataset occurred between ages 50 and 75. Records with retirement ages under 50 or over 75 were omitted from durational analyses.

Logistic regression analysis indicated that there was a slight variation in the overall pattern in mortality based on duration since retirement. For example, relative mortality rates for both genders tended to slope slightly upwards for the first four years after retirement (attaining an RR value of approximately 1.15 relative to "duration 1" rates) and then slope slightly downwards from that point forward, dropping a bit below 1.0 after duration year 7.

Given the relatively minor impact of duration on mortality patterns and the additional complexity required to accommodate select-and-ultimate assumptions, RPEC expects that few pension actuaries will feel the need to reflect durational effects in the valuation of Healthy Annuitant obligations. Therefore, no such select period tables were created as part of this study.

4.4 Statistical Analyses for Disabled Retirees

Public plan disabled life data was submitted by two very large plans and logistic regression analyses showed that there were significant differences in the mortality patterns between these two plans. Additional analyses identified inherent differences in mortality patterns for disabled participants in public plans relative to those in private plans. Therefore, RPEC decided to base the RP-2014 Disabled Retiree mortality rates exclusively on private plan disabled life experience.[23]

The final Disabled Retiree dataset was dominated by two large private plans that represented 61 percent of the amount-weighted exposure benefit amount. RPEC's analysis showed that relative to all other plans in the dataset, the largest plan had slightly better mortality experience and the

[23] Hence, all of the RP-2014 tables (healthy and disabled) are based on private plan data only.

next largest plan slightly worse mortality experience. As these differences were not extreme, RPEC decided to include the two large plans in the final dataset.

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.

As part of the initial data collection process, RPEC requested plan-specific information with respect to the eligibility criteria for disabled retirement benefits. The types of disability eligibility included Social Security award, own occupation (lifetime), own occupation (limited period), any occupation (lifetime) and any occupation (limited period). Although there was some indication that plans that require eligibility for Social Security disability benefits experience slightly higher mortality relative to those plans without such a criterion, RPEC was not able to reach any definitive conclusions based on this analysis.

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.

As a result of these analyses, RPEC decided to develop only one set of gender-specific mortality rates for Disabled Retirees.

4.5 Determination of RP-2014 Base Mortality Tables to Be Developed

Based on these statistical analyses, RPEC concluded that there was sufficient evidence of variation in mortality patterns to construct the following gender-specific base mortality tables from the private plan dataset:

- *Employee Tables*
    - Total (all nondisabled data)
    - Blue Collar
    - White Collar
    - Bottom Quartile (based on salary)
    - Top Quartile (based on salary)
- *Healthy Annuitant Tables*[24]
    - Total (all nondisabled data)
    - Blue Collar
    - White Collar
    - Bottom Quartile (based on benefit amount)
    - Top Quartile (based on benefit amount)
- *Disabled Retiree Table*

[24] The term "Healthy Annuitant Tables" refers to tables based on the combined populations of Healthy Retirees and Beneficiaries.

When used without specific collar or quartile qualifiers, the “RP-2014 Employee” and “RP-2014 Healthy Annuitant” tables refer to the respective “Total (all nondisabled data)” tables above.

RPEC also analyzed Employee and Healthy Annuitant mortality rates for the middle two amount quartiles combined. As addressed more fully in subsection 13.2, the Committee believes that quartile-based mortality tables will typically provide more value as a measure of the disparity in mortality rates between the highest and lowest amount quartiles than they do as practical alternatives for the measurement of retirement plan obligations. In addition, the middle-two-quartile rates were often close to the corresponding total (nondisabled) rates, particularly at ages greater than 70 for male Healthy Annuitants and ages greater than 60 for female Healthy Annuitants, Therefore, RPEC decided that the inclusion of an additional set of middle-two-quartile tables was not necessary.

For completeness, this report also includes a set of gender-specific mortality rates for Juveniles (for ages 0 through 17) based on the most recent Social Security Administration mortality tables projected to 2014; see Section 9 for details.

Section 5. Raw Rate Projection and Graduation

5.1 Overview

Three key steps were involved in the development of smoothed mortality tables as of 2014:

- Projection of raw rates to 2014
- Graduation of the projected raw rates (over age ranges for which sufficiently robust exposures existed) and
- Extension of the graduated rates to extreme (very old or very young) ages.

The next two subsections describe the projection and graduation methodologies used by the Graduation subteam. The extension methodologies varied by participant subgroup and are described in the following four sections.

5.2 Projection of Raw Rates to 2014

The first step in the process involved the projection of the raw mortality rates from 2006 (the central year of the dataset) to 2014. Each of the individual gender- and age-specific raw mortality rates was projected from 2006 to 2014 using the Scale MP-2014 mortality improvement rates [13]. The projection factor for an age-70 female in 2014, for example, is equal to 0.8234, which is equal to the product of the complements of the eight Scale MP-2014 mortality improvement rates for age-70 females for years 2007 through 2014.

Note that the projection of raw rates to 2014 was also applied to the Disabled Retiree population. As discussed in the Scale MP-2014 report, recent experience supports the application of mortality improvement trend to the rates for both nondisabled and disabled lives.

5.3 Basic Graduation Methodology

The selection of an appropriate graduation methodology is an important aspect of mortality table construction. As with any set of statistical data, raw mortality rates usually include some random fluctuations that can mask the underlying "true" mortality rates. As has been the case with previous SOA mortality studies, the final sets of raw rates were graduated to produce smooth tables that reflect underlying mortality patterns.

A number of different graduation methods are currently available for smoothing mortality data, each of which involves a balancing of smoothness and fit. After considering some of the more recently developed techniques, RPEC decided to use the traditional Whittaker-Henderson (Type B) method, which historically has been one of the most commonly used methods for construction of pension-related mortality tables in the United States and Canada. RPEC decided to apply the Whittaker-Henderson method with the “Lowrie variation,” a technique that improves fit when graduating mortality rates over a wide range of ages [5, 8, 9].

All of the graduated mortality tables are amount-weighted. For Employees, amount-weighting was based on annual salary; for Healthy Annuitants and Disabled Retirees amount-weighting was based on annual retirement benefit.

5.4 Selection of Whittaker-Henderson-Lowrie Graduation Parameters

The key parameters for the Whittaker-Henderson-Lowrie method are the following:

- The order of the difference equation being used to express smoothness
- The h value, which balances fit and smoothness
- The Lowrie r value, which is the assumed annual growth rate in the underlying dataset being graduated.

In addition to balancing smoothness and fit, RPEC established a number of other criteria in selecting appropriate parameters for each of the datasets being graduated:

- All graduated q_x values must be strictly greater than 0.0 and strictly less than 1.0.
- The graduated q_x values should be strictly increasing with age[25].
- The range of ages covered by each graduation should be as large as possible, subject to exposure constraints.

The Graduation subteam estimated 90 percent confidence intervals for each of the raw datasets and used these as additional benchmarks to select final Whittaker-Henderson-Lowrie parameters. The subteam concluded that third order difference equations produced graduated rates that best met the desired criteria described above. Based on the selection of this parameter, the Whittaker-Henderson-Lowrie graduation process involved minimization of the following formula[26]:

$$\sum w_x \, (u_x - v_x)^2 + \, h \sum (\Delta^3 u_x - r \Delta^2 u_x)^2,$$

where:

- w_x are the amount-based weights;
- v_x are the raw mortality rates;
- u_x are the graduated mortality rates; and
- Δ^n represents the n^{th} order finite difference operator.

A summary of the h values and Lowrie r values that were selected for each individual dataset is included in Appendix B. It should also be noted that RPEC used "normalized" weights in the Whittaker-Henderson-Lowrie graduation, so the h values are significantly smaller than those used in Whittaker-Henderson applications that did not utilize such normalization [5].

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[25] Some of the final RP-2014 rates for males in their mid-20s decrease slightly with age. This is a consequence of the process RPEC used to extend rates to the youngest Employee ages, not the graduation methodology.

[26] The most general form of the Whittaker-Henderson-Lowrie formula includes terms that make reference to a "standard table." Given that RPEC's objective was to create new pension-related mortality tables based on current data, the need for "standard table" terms in the RP-2014 graduation formula was deemed unnecessary.

5.5 Graduation Age Ranges by Participant Subgroup

For each individual subset of (projected) raw mortality rates that required smoothing, the Graduation subteam paid close attention to corresponding exposure amounts, standard deviations and associated 90 percent confidence intervals, each on an age-specific basis. This process helped the subteam determine appropriate age ranges for graduating each of the different sets of mortality rates. The lower and upper age ranges of the various graduations performed by the subteam are listed in Appendix B.

Given the relatively small amount of active Employee data included in the final dataset (including only 7,635 total deaths), the Graduation subteam concluded that it would not be appropriate to graduate anything other than the two gender-specific “Total” Employee tables, and even in those two cases, the graduation process covered only ages 35 through 65. Section 7 describes how the collar- and amount-specific Employee tables were subsequently developed from the Total Employee tables. The projected raw rates for Disabled Retirees were graduated between ages 45 and 95.

Before passing these rates on to the Table Extension subteam, the Graduation subteam carefully reviewed all of the graduated rates for both external and internal consistency. This process led to some extremely small adjustments to a few of the graduated rates.

Section 6. Construction of RP-2014 Healthy Annuitant Tables

6.1 Overview

RPEC developed Healthy Annuitant mortality rates starting at age 50 and extending through age 120. As displayed in Table 3.3, the percentage of Annuitants who did not have any benefit amount submitted was relatively small. For purposes of developing amount-weighted mortality rates, RPEC imputed the average retirement benefit for those with benefit amounts submitted for each Annuitant record with missing amount.

Subsection 6.2 starts with an overview of the Table Extension subteam's deliberations in connection with the shape and ultimate level of mortality at the highest ages and concludes with a description of the methodology ultimately selected to extend the graduated rates to age 120, the end of the mortality table. Subsection 6.3 describes the process used to extend the Healthy Annuitant tables down to age 50 (for the subpopulations for which graduated rates were developed starting at some age greater than 50).

6.2 Extension of Graduated Annuitant Rates to Age 120

The first step for the Table Extension subteam was to extend the graduated Healthy Annuitant rates to the oldest ages. The process required decisions regarding the highest mortality rates and highest ages to be reflected in the tables. The RP-2000 study used 0.4 as the highest mortality rate in the tables. Since publication of the RP-2000 report, there have been extensive studies of centenarians in the 21st century as many more people are now living to age 100. Although some researchers believe that mortality rates will continue to rise with advancing age until they reach 1.0, most of the recent studies suggest that there is a highest annual mortality rate and that rate is less than 1.0 [2, 3, 7].

The subteam was persuaded by the predominance of research that indicates a highest annual rate that is less than 1.0. Recent studies suggest that the maximum annual rate is closer to 0.5 than to the 0.4 used in the RP-2000 tables. For example, both Gampe's analysis of 637 thoroughly validated supercentenarians (people aged 110 and older) in the International Database on Longevity [2] and Kestenbaum and Ferguson's study of 325 U.S. supercentenarians [7] suggest that annual mortality rates tend to level off at approximately 0.5.

The subteam considered three different methods for extension of death rates beyond the last graduated rate. Two of these were the Gompertz [4] and Kannisto [6] mortality laws. The third was to fit a cubic polynomial to the data. The Gompertz method was eliminated once the subteam decided on a maximum annual rate of 0.5, because the Gompertz force of mortality increases exponentially with age.[27] Both the cubic polynomial and Kannisto methods can accommodate a maximum less than 1.0.

The subteam fit Kannisto's logistic model to the RPEC data using raw exposures and death rates

[27] The Gompertz method produced annual mortality rates greater than 0.5 at ages below 110.

starting at ages 75 through the last age at which there were at least 10 deaths.[28] The model's two parameters were estimated using the weighted nonlinear least squares procedure (Gauss-Newton algorithm) in SAS, and the force of mortality was converted to death rates in Excel [1]. Lagrange interpolation was used to transition smoothly from the graduated rates to the extended (Kannisto) rates. The resulting annual mortality rates were capped at 0.5.

The subteam also developed extended rates based on the cubic polynomial method. Although the extended rates produced using the cubic polynomial and Kannisto methods were very similar, the subteam concluded that the Kannisto approach produced an overall more appealing fit to the raw rates. Therefore, the subteam decided to proceed with the Kannisto extension methodology (with a maximum annual rate of 0.5) through age 119.

RPEC discussed whether the Annuitant tables should continue the 0.5 maximum rate through age 120 or whether the age 120 rate should be set equal to 1.0. Fully aware of the miniscule financial impact of this decision, the Committee concluded that reflecting the certainty of death at some very advanced age would likely be preferred by users; hence the rate at age 120 was set equal to 1.0.

6.3 Extension of Graduated Annuitant Rates Down to Age 50

The underlying exposures were large enough for the Graduation subteam to graduate almost all of the Healthy Annuitant tables down through age 50. For those subgroups for which the youngest graduated age was greater than 50, the rates down to age 50 were extended by reference to the total plan rates for that category. For example, the female Healthy Annuitant White Collar rates were extended between ages 50 through 59 by reference to the female Total Healthy Annuitant rates at those ages.

[28] Through age 104 for males and age 106 for females.

Section 7. Construction of RP-2014 Employee Tables

7.1 Overview

The RP-2014 Employee mortality tables start at age 18 and extend through age 80.[29]

The sparseness of Employee data at ages less than 35 and ages greater than 65 in the final dataset, in conjunction with data that were submitted without salary information, created a number of challenges for the Graduation and Table Extension subteams. As a result, the graduation/extension techniques described in this section are considerably more complex than for any of the other participant subgroups.

Subsection 7.2 describes how the Graduation subteam first used the subpopulation of Employees for whom salary information was submitted to extrapolate amount-weighted mortality rates for the entire Employee dataset. Subsection 7.3 first describes the techniques used to extend the graduated Total Employee rates from age 35 down to age 18, and then how those rates were used to develop rates between ages 18 and 35 for the other (collar- and quartile-based) Employee tables. The last part of subsection 7.3 describes the methodology used to extend each of the five sets of gender-specific Employee tables from age 65 to age 80.

7.2 Treatment of Employee Data Submitted Without Salary Information

As can be seen from Table 3.3, the percentage of Employee records submitted without any salary information was not insignificant. Rather than simply using the imputed salaries to develop amount-weighted mortality rates or excluding large segments of data from the study, the Graduation subteam used the following five-step process (separately for males and females) for the Total Employee, Blue Collar Employee, and White Collar Employee datasets:

1. Raw *amount-weighted* mortality rates were developed for those Employees who had salary information submitted within the dataset to be graduated.
2. Raw *headcount-weighted* mortality rates were developed for those Employees who had salary information submitted within the dataset to be graduated.
3. Raw *headcount-weighted* mortality rates were developed for *all* Employees within the dataset to be graduated.
4. The raw rate from Step 1 was divided by the raw rate from Step 2 on an age-by-age basis.
5. The ratios from Step 4 were applied to the raw *headcount-weighted* mortality rates developed in Step 3.

This process was not required for the amount-weighted Employee mortality rates for either the Bottom Quartile or Top Quartile datasets since those raw rates reflected deaths and exposures for only those records for which salaries were submitted.

[29] Given the increasing levels of active employment at older ages, RPEC thought that it would be helpful to extend the Employee mortality tables through age 80, rather than stopping at age 70 as was the case with the RP-2000 tables.

7.3 Construction and Extension of Graduated Employee Rates

As noted in subsection 5.5, the Graduation subteam concluded that only the two gender-specific Total Employee datasets were suitable for graduation, and those two sets of rates were graduated between ages 35 and 65. All of the other (collar and quartile) Employee tables were developed from the gender-specific Total Employee tables, as described below.

Extension of Total Employee Rates Between Ages 18 and 35

Given the downward trend in active participation in private defined-benefit plans in the United States over the past 15 years, it was not surprising that the total life-years of Employee exposure included in the final RP-2014 dataset were smaller than those included in the RP-2000 tables. The sparseness of active Employee data under age 35 was of particular concern to the Graduation subteam. Graduating the collar and quartile Employee subpopulations created an additional challenge since the exposures and deaths within each of those subpopulations were obviously smaller—sometimes much smaller—than those for the Total Employee group.

Rather than developing graduated Employee rates at ages below 35 based on sparse data, RPEC decided it would be preferable to make use of an existing SOA table, namely the gender-specific 2008 Valuation Basic Tables[30] (2008 VBT; nonsmoker, age nearest birthday), as reference tables upon which the youngest RP-2014 Employee rates could be based [15]. The underlying data used in developing the 2008 VBT was the SOA's Individual Life Experience Committee's 2002-2004 Intercompany Study, which contained considerably more exposures and deaths between ages 18 and 35 than did the final RP-2014 Employee dataset.

The Graduation subteam first projected the 2008 VBT rates to 2014 using the Scale MP-2014 mortality improvement rates. The subteam then determined two gender-specific "scaling factors" (based on a ratio of actual deaths to expected deaths calculated using the projected 2008 VBT rates) that were then applied to the respective projected 2008 VBT rates for ages 18 through 25. The subteam then filled in the gap between ages 25 and 35 using cubic polynomials that matched the gender-specific rates at ages 24, 25, 35, and 36.

In summary, the Total Employee rates for ages 18 through 65 were developed in three steps:

1. Ages 35 through 65: Standard Whittaker-Henderson-Lowrie graduation
2. Ages 18 through 25: Scaled version of the 2008 VBT rates projected to 2014 and
3. Ages 26 through 34: Cubic polynomial interpolation.

Construction of the Collar- and Quartile-Based Rates Between Ages 18 and 65

Given RPEC's concerns with the relatively small size of the Employee subpopulations, the Committee decided to develop each of these four sets of collar- and quartile-based rates (between ages 18 and 65) as appropriately scaled versions of the Total Employee rates. Each of these scaling factors was calculated so that the expected number of amount-weighted deaths using the "scaled"

[30] The 2008 VBT was developed (without margins) for the valuation of individual life insurance products that reflect standard and preferred underwriting criteria.

Total Employee rates for ages 18 through 65 was equal to the sum of actual amount-weighted deaths between those ages included in the final dataset for that subpopulation.

For example, the sum of actual amount-weighted deaths between ages 18 and 65 for White Collar males between the ages of 18 and 65 was approximately $77.7 million, but approximately $69.8 million when adjusted for improvement to 2014 with Scale MP-2014. The expected number of amount-weighted deaths based on the unadjusted male Total Employee table between ages 18 and 65 was approximately $99.5 million. Therefore, the constant scaling factor used to construct the White Collar male rates between ages 18 and 65 was approximately 0.70.

Extension Between Ages 65 and 80

The extension methodology selected by the subteam was based on analysis of the ratios of Employee rates to the corresponding Healthy Annuitant rates. Studies performed by the Office of Personnel Management indicated that these "Employee/Healthy Annuitant" (Ee/HA) mortality rate ratios for participants in the U.S. Civil Service Retirement System remained fairly consistent—at levels approximately equal to 40 percent for both genders—through age 75.

The subteam developed corresponding Ee/HA ratios for ages 50 through 65 based on the RP-2014 data. Although the ratios for the female tables hovered fairly consistently around the 40 to 50 percent level throughout the 50 to 65 age range, the ratios based on the male rates all exhibited upward trends. For example, the Ee/HA ratios based on the Total (nondisabled) male tables increased from approximately 40 percent at age 50 to approximately 75 percent at age 65.

Based on these results, the Graduation and Table Extension subteams thought it reasonable to extend the Employee rates beyond age 65 by assuming that the mortality rates between ages 65 and 80 increase at a constant exponential rate that would—if extended all the way to age 90—equal a certain percentage of the corresponding age 90 Healthy Annuitant rate. Based on the Ee/HA ratio analysis described in the previous paragraphs, the subteams selected age-90 Ee/HA target ratios of 50 percent for females and 80 percent for males.

For example, the age-65 mortality rate for a female White Collar Employee is 0.003119, and the age-90 mortality rate for a female White Collar Healthy Annuitant is 0.100207. The constant factor that when applied to 0.003119 for 25 years produces a value of 0.0501035 (i.e., 50 percent of 0.100207) is 1.117465. Hence, the female White Collar Employee mortality rate for each of the ages 66 through 80 was calculated as 1.117465 times the rate at the preceding age.

Section 8. Construction of RP-2014 Disabled Retiree Tables

RPEC developed Disabled Retiree rates starting at age 18 and extending through age 120.

The Graduation subteam first produced smoothed Disabled Retiree rates between the ages of 45 and 90. The Disabled Retiree rates between ages 18 and 44 were set equal to a gender-specific constant factor times the Total Employee rates. These factors (approximately 17.5 for males and 13.8 for females) were determined by taking the ratios of the graduated age-45 Disabled Retiree rate to the Total Employee age-45 rate. Cubic polynomial interpolation was used to develop smoothed rates between age 90 and age 105, the age at which the Disabled Retiree rates were assumed to converge to the Healthy Annuitant rates.

Section 9. Construction of RP-2014 Juvenile Rates

For completeness, RPEC has also included a set of gender-specific Juvenile mortality rates for ages 0 through 17.[31] The rates of ages 0 through 12 were set equal to the projected 2014 rates developed by the Social Security Administration. The gender-specific Juvenile rates for ages 13 through 17 were calculated using two cubic polynomials (one for each gender) that reproduced the SSA rates at ages 11 and 12 and reproduced the Total Employee rates at ages 18 and 19.

[31] RPEC recommends the use of the RP-2014 Employee tables for Beneficiaries between the ages of 18 and 50.

Section 10. Comparison of Projected RP-2000 Rates to RP-2014 Rates

10.1 Overview

It is helpful to compare annualized rates of mortality *improvement* for Scale AA and Scale MP-2014 over the period 2000 through 2014 prior to comparing projected RP-2000 and RP-2014 mortality rates. Figures 10.1(M) and 10.1(F) compare Scale AA rates (which do not vary by calendar year) to the annualized mortality improvement over the 14-year period produced using Scale MP-2014 rates.[32]

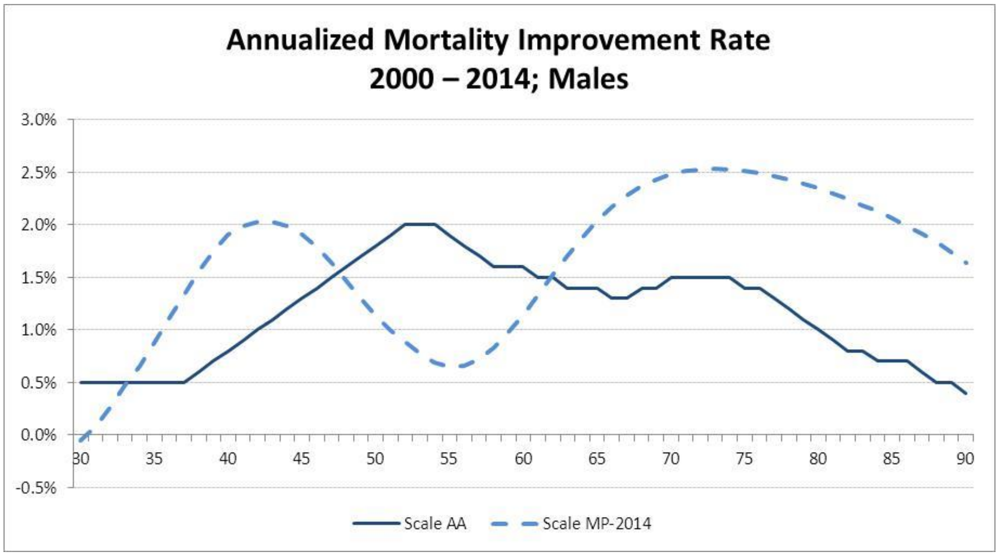

Figure 10.1(M)

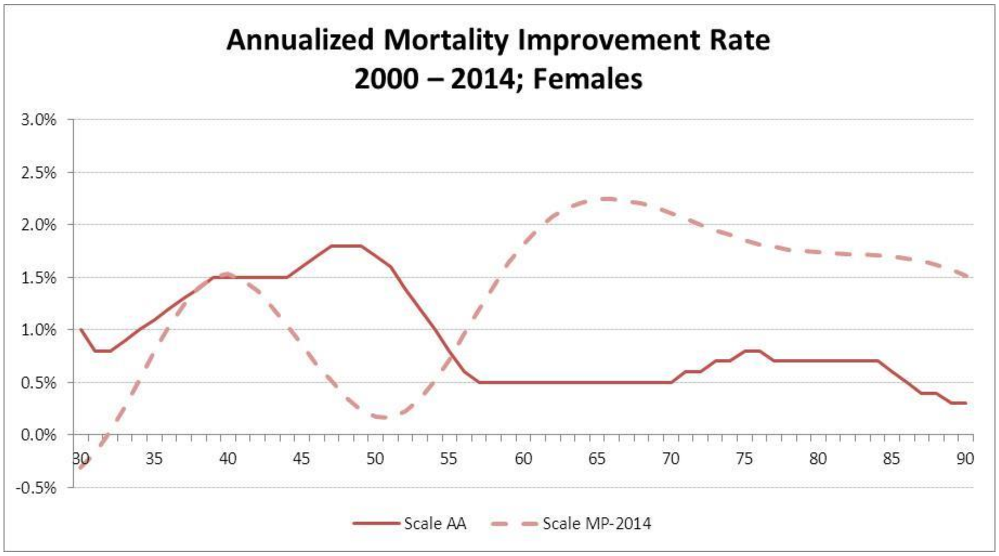

Figure 10.1(F)

[32] The annualized Scale MP-2014 rate of mortality improvement at age *x* is calculated as 1.0 minus P^(1/14), where P is the product of 14 terms (one for each calendar year 2001 through 2014) of the form {1.0 minus Scale MP-2014 rate at age *x* in calendar year *y*}.

Figures 10.1(M) and 10.1(F) highlight one of the key advantages of the two-dimensional Scale MP-2014 over the "age-only" Scale AA; specifically, the ability to capture and project year-of-birth cohort effects. The valleys (around age 50 for females and around age 55 for males) represent the relatively low levels of mortality improvement experienced by the "baby boom" generation between 2000 and 2014, while the surrounding hills represent the relatively higher levels of mortality improvement experienced by the "Silent" and "Gen X" generations over that period.

The remainder of this section contains a number of graphs that display the ratios of projected RP-2000 rates to RP-2014 rates. With the exception of the Disabled Retiree rates discussed in subsection 10.4, all of the RP-2000 rates are projected from 2000 to 2014 in two different ways; once using Scale AA and a second time using the two-dimensional Scale MP-2014. Note that a ratio *greater* than 1.0 means that the projected RP-2014 mortality rate is *smaller* than the corresponding projected RP-2000 rate.

10.2 Comparison of Employee Rates

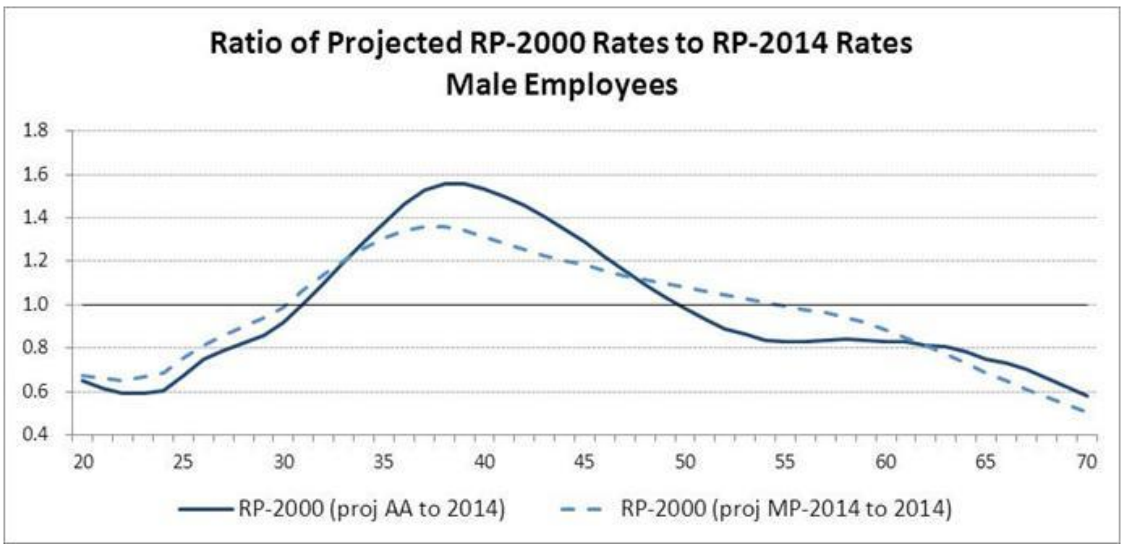

Figure 10.2(M)

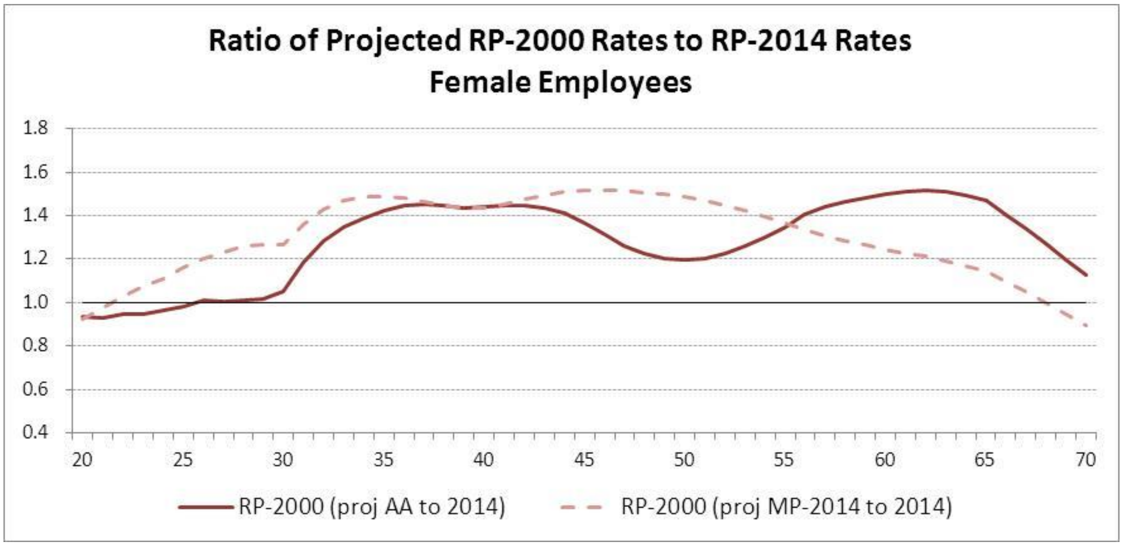

Figure 10.2(F)

Figure 10.2 (M) shows that the male RP-2014 rates are higher than the projected RP-2000 rates at the younger and older Employee ages, but lower than the projected RP-2000 rates between ages 35 and (approximately) 50. Projecting the RP-2000 rates using Scale MP-2014 generally produces ratios closer to 1.0 than projecting using Scale AA. Figure 10.2(F) shows that the female RP-2014 rates are significantly smaller than the projected RP-2000 rates at almost all Employee ages. RPEC had speculated that a possible explanation for this phenomenon was that the female RP-2000 rates did not reflect any projection for mortality improvement between 1992 (the central year of the RP-2000 dataset) and 2000, but further analysis indicated that the absence of any mortality projection for females during that time period had very little impact on the ratios displayed in Figure 10.2(F).[33]

[33] Data available at the time of the RP-2000 study suggested that there was little or no improvement in female mortality rates during the period between 1992 and 2000. This was confirmed in the Scale MP-2014 rates; see, for example, Figure 3(F) in subsection 4.5 of that report [14].

10.3 Comparison of Healthy Annuitant Rates

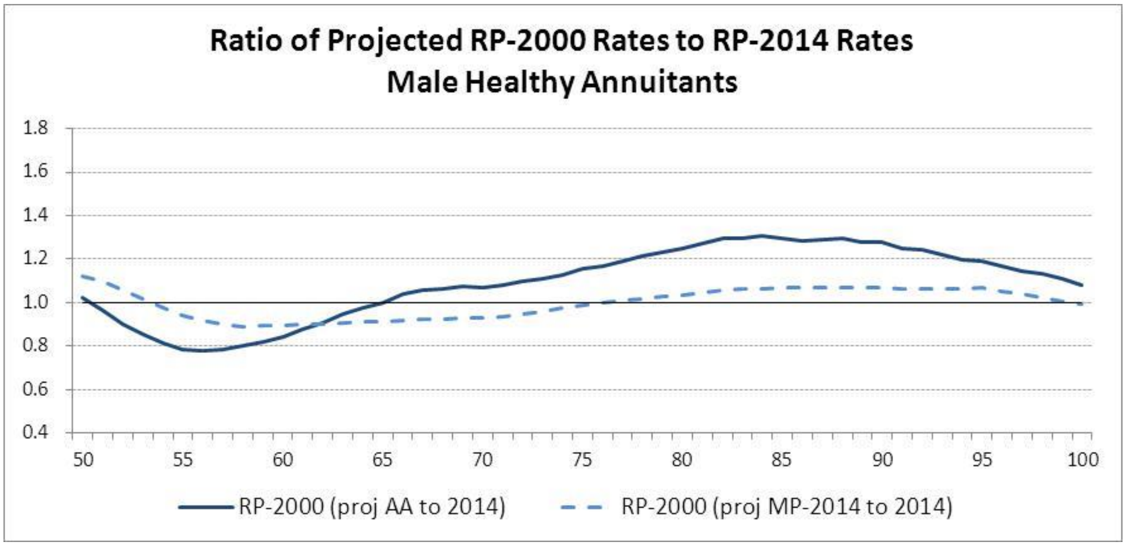

Figure 10.3(M)

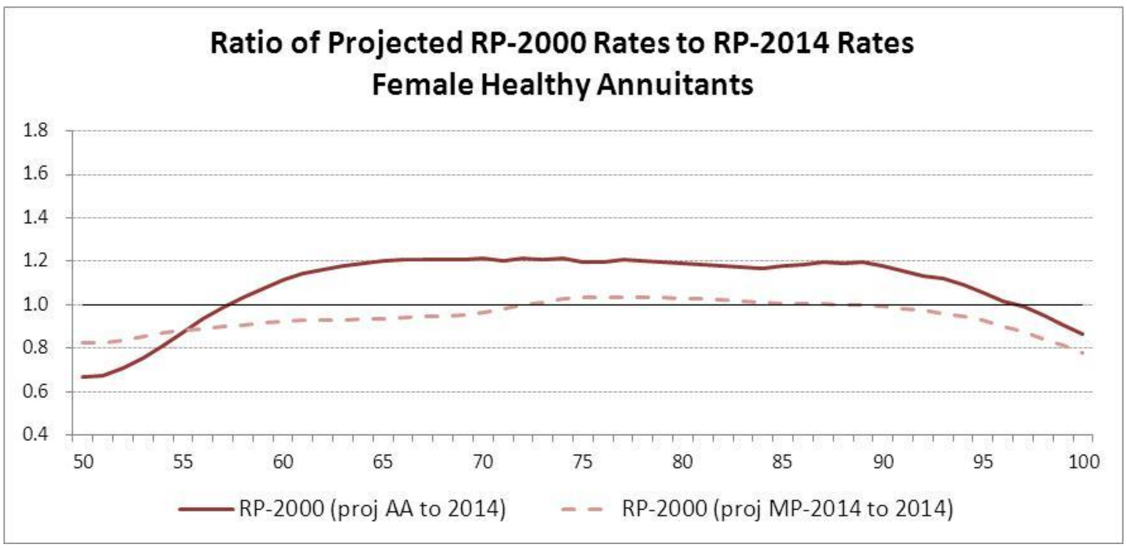

Figure 10.3(F)

Figure 10.3 (M) shows that the male RP-2000 Healthy Annuitant rates projected with Scale MP-2014 are much closer to the male RP-2014 rates than are the RP-2000 rates projected using Scale AA. Figure 10.3(F) shows that starting around age 60, the female RP-2014 Healthy Annuitant rates are relatively close to the RP-2000 rates projected using Scale MP-2014, but quite a bit lower than the RP-2000 rates projected using Scale AA.

10.4 Comparison of Disabled Retiree Rates

Figures 10.4(M) and 10.4(F) differ from the prior four displays in that the solid lines show the ratios of RP-2000 Disabled Retiree rates *without any projection* to RP-2014 Disabled Retiree rates. The dashed line represents the ratio of RP-2000 Disabled Retiree rates projected with Scale MP-

2014 to the corresponding RP-2014 rates. The fact that both of the dashed lines are much closer to 1.0 than their solid line companions supports the claim in subsection 6.2 of the Scale MP-2014 Report that recent mortality improvement patterns for disabled lives in the United States have generally mirrored those for nondisabled lives.

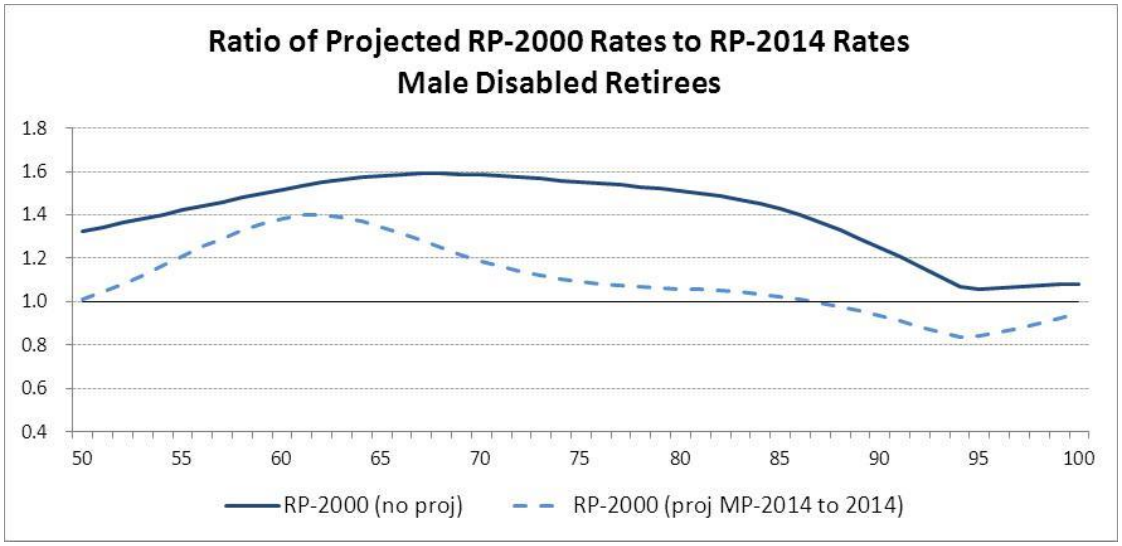

Figure 10.4(M)

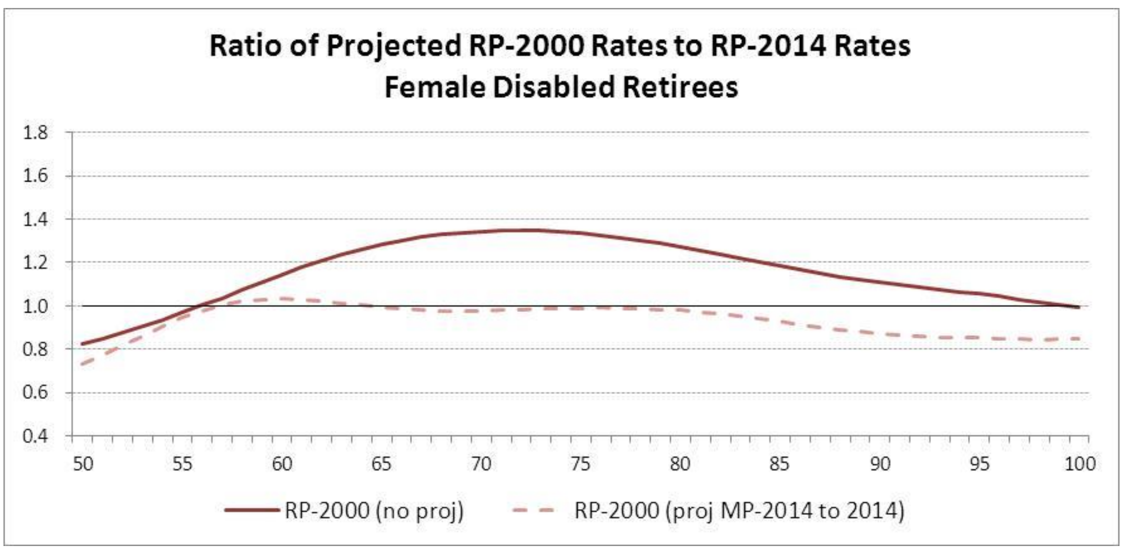

Figure 10.4(F)

10.5 Comparison of Collar-Specific Mortality Rates

The Supplement to the RP-2000 Report contained Blue Collar (BC) and White Collar (WC) versions of the RP-2000 Combine Healthy mortality tables [13]. Exclusively for the purposes of comparing collar-based mortality rates, RPEC constructed "hypothetical combined healthy" collar-specific RP-2014 tables based on (1) collar-specific Employee rates for ages under 50, (2) collar-specific Healthy Annuitant rates for ages over 70, and (3) a 20-year linear blend[34] of the collar-specific Employee and Healthy Annuitant rates between ages 50 and 70. The following graphs display the ratios of the projected collar-specific RP-2000 rates to the collar-specific RP-2014 rates.

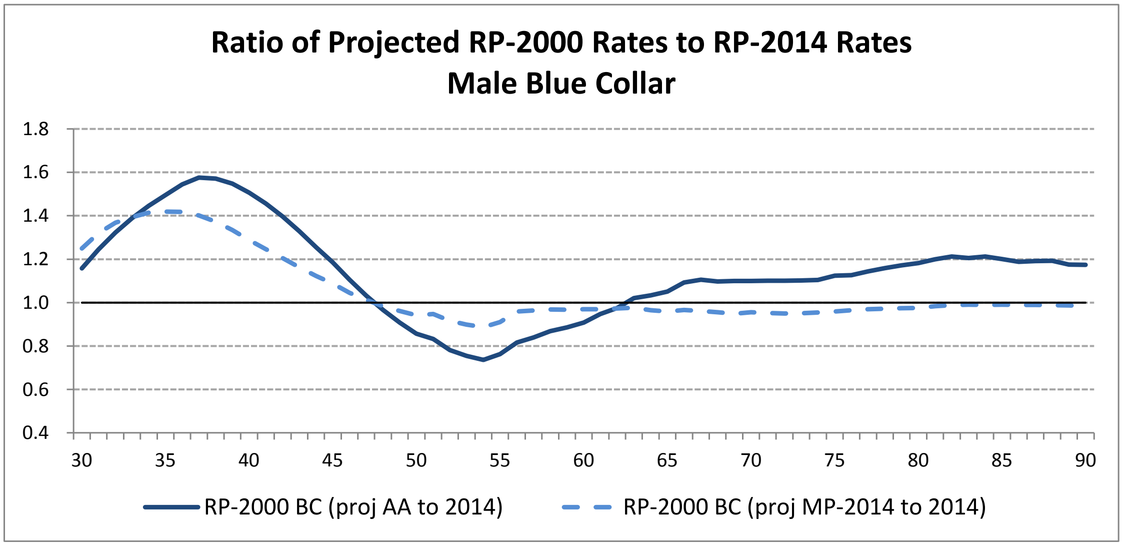

Figure 10.5(M)

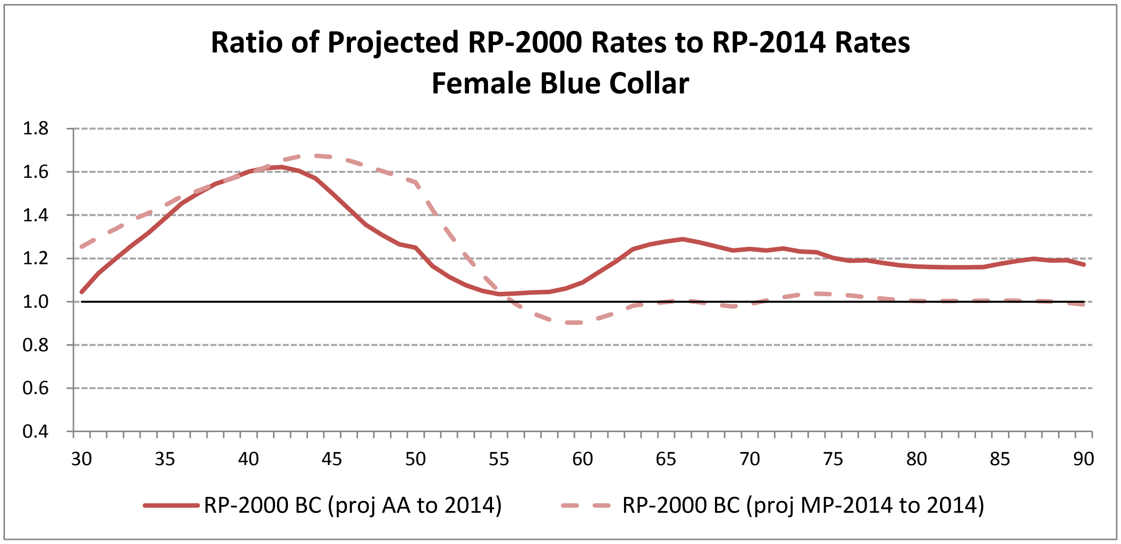

Figure 10.5(F)

[34] For example, the blended rate at age 51 was 95 percent of the Employee rate plus 5 percent of the Healthy Annuitant rate.

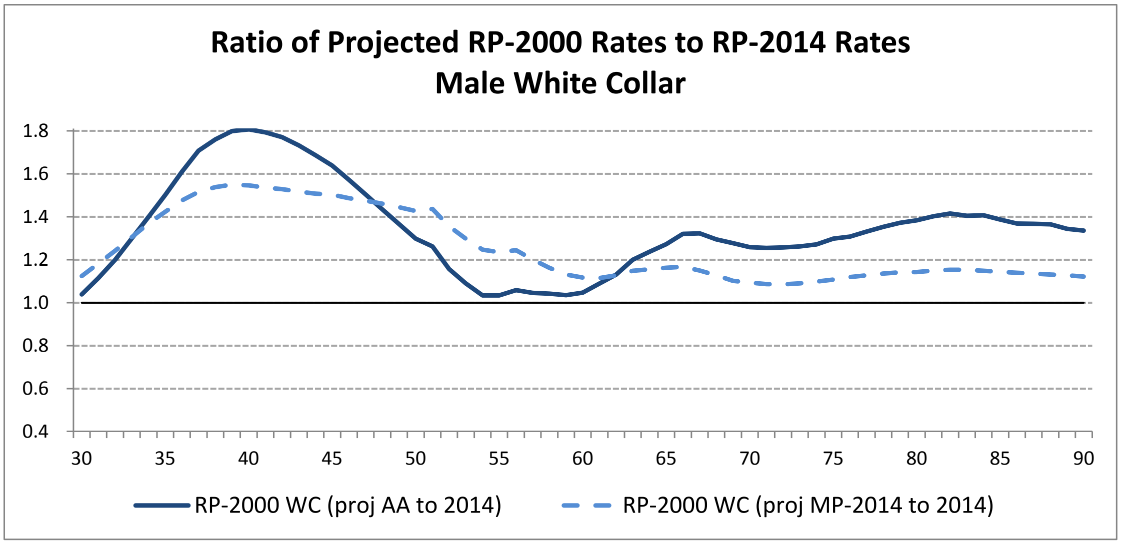

Figure 10.6(M)

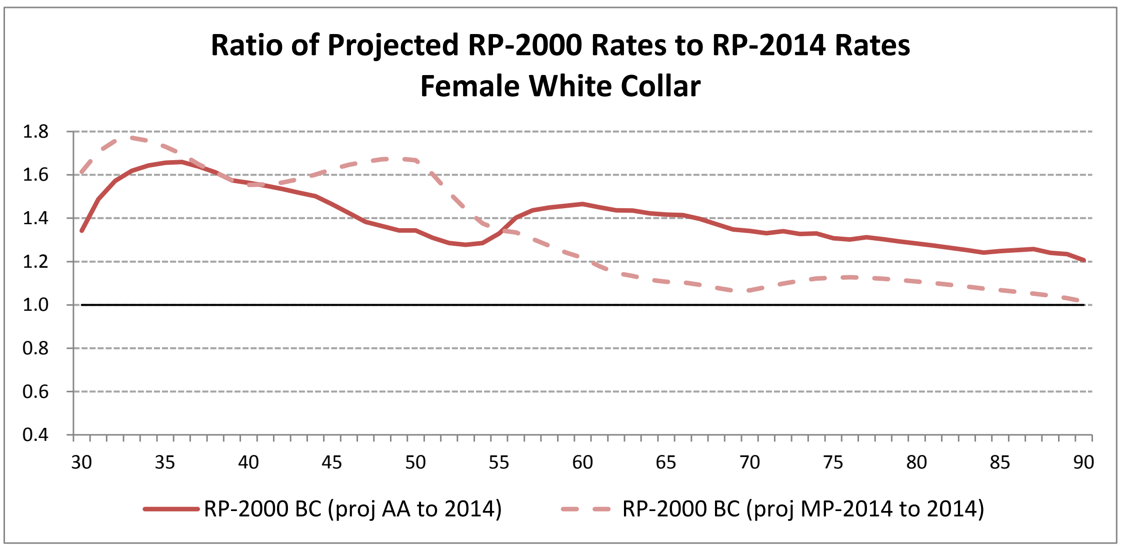

Figure 10.6(F)

Many of the patterns discussed in subsections 10.2 and 10.3 (for Total Employees and Total Healthy Annuitants, respectively) can be seen in the four collar-related graphs above. For example, the ratios for ages over 60 are considerably more stable—and are generally much closer to 1.0—than those at the younger ages.

Section 11. Application of RP-2014 Mortality Tables

11.1 Background

Relatively few U.S. retirement programs are large enough to support the development of fully credible mortality tables based exclusively on the plan's own experience. The selection of appropriate forward-looking mortality assumptions for all other U.S. retirement plans relies on "benchmark" tables, typically developed by the SOA. Depending on the size and demographic characteristics[35] of the covered population, one or more of these benchmark tables could be used without adjustment, with appropriate loads, or as the reference table for credibility-weighted blended mortality rates.

11.2 Application of RP-2014 Tables for Private Plans

RPEC maintains that, as of their release date, the RP-2014 tables presented in this report represent the most current and complete benchmarks of U.S. private pension plan mortality experience, and the Committee recommends consideration of their use for the measurement of private pension plan obligations, effective immediately. The Committee also recommends generational projection of mortality rates using Scale MP-2014, or a suitably parameterized version of the RPEC_2014 model.

11.3 Possible Application of RP-2014 Tables for Public Plans

Despite the fact that RPEC's analysis of three extremely large public plans indicated that there were statistically significant structural differences in underlying mortality rates between the public and private plan datasets, the Committee believes that it would not necessarily be inappropriate—or inconsistent[36]—for actuaries to consider one or more of the RP-2014 tables as suitable mortality benchmarks for a specific public plan. In those instances where collar-specific versions of the RP-2014 tables are being considered, RPEC cautions actuaries not to rely solely on the bargaining status of the covered group in the ultimate selection of an appropriate set of base mortality rates. The Committee also recommends generational projection of mortality rates using Scale MP-2014, or an appropriately parameterized version of the RPEC_2014 model.

[35] RPEC recommends that the individual characteristics and experience of the covered group be considered whenever base mortality rates are selected.
[36] A significant number of public plans currently use RP-2000, which was developed exclusively from private plan mortality experience.

Section 12. Financial Implications

12.1 Preliminary Comparison of 2014 Annuity Values

Figures 12.1(M) and 12.1(F) display the percentage increase in 2014 monthly annuity values (all calculated at an annual interest rate of 6.0 percent) of moving to RP-2014 Healthy Annuitant rates projected generationally with Scale MP-2014 from RP-2000 Healthy Annuitant rates projected generationally with (a) Scale AA and (b) Scale MP-2014.

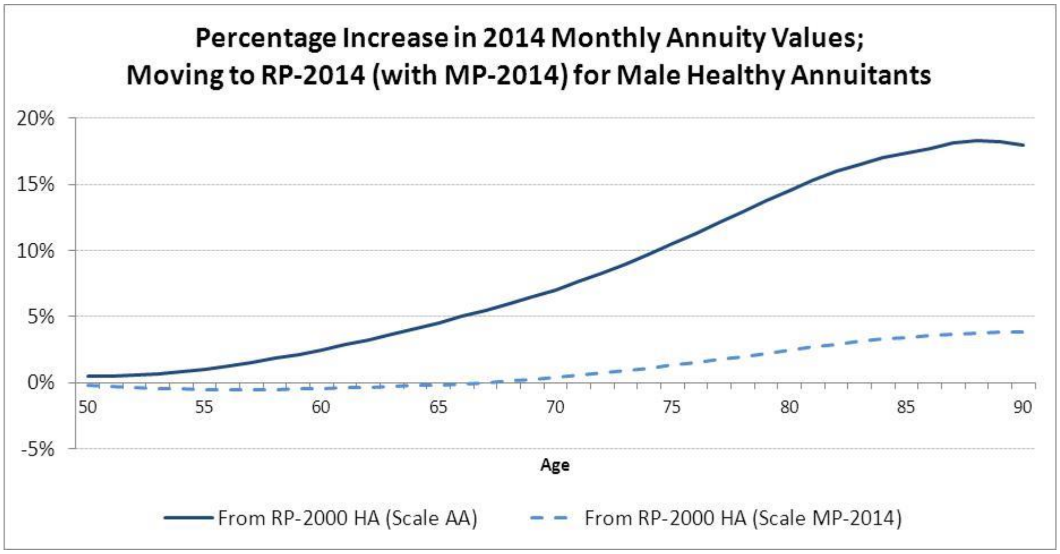

Figure 12.1(M)

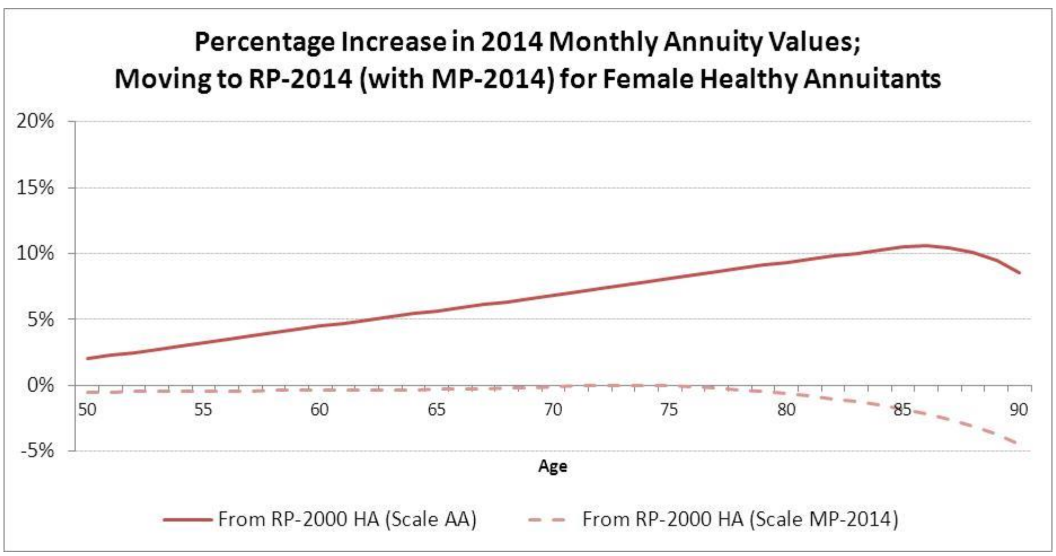

Figure 12.1(F)

For a male age 75, for example, the 2014 monthly annuity value based on RP-2014 Healthy Annuitant rates projected generationally with Scale MP-2014 is 10.5 percent higher than the 2014 monthly annuity value calculated using RP-2000 Healthy Annuitant rates projected generationally with Scale AA. The corresponding increase in the monthly annuity value based on RP-2000 rates projected generationally with Scale MP-2014 is only 1.3 percent.

It is instructive to compare the graphs in Figures 12.1(M) and 12.1(F) to the corresponding graphs of ratios of Healthy Annuitant mortality rates shown in Figures 10.3(M) and 10.3(F).

- *For Male Healthy Annuitants:*
    - Comparing RP-2014 (Scale MP-2014) to RP-2000 projected with *Scale AA*: The RP-2014 rates are significantly lower than the projected RP-2000 rates for all ages over 65, and the monthly annuity values based on RP-2014 are considerably higher than those based on the projected RP-2000 rates.
    - Comparing RP-2014 (Scale MP-2014) to RP-2000 projected with *Scale MP-2014*: The RP-2014 rates are generally slightly greater than the projected RP-2000 rates prior to age 76 and very slightly lower after age 76. The pattern of increases in monthly annuity values shown in Figure 11.1(M) is consistent with that pattern.

- *For Female Healthy Annuitants:*
    - Comparing RP-2014 (Scale MP-2014) to RP-2000 projected with *Scale AA*: The RP-2014 rates are significantly lower than the projected RP-2000 rates for all ages between 57 and 95, and the monthly annuity values based on RP-2014 are considerably higher than those based on the projected RP-2000 rates.
    - Comparing RP-2014 (Scale MP-2014) to RP-2000 projected with *Scale MP-2014*: The RP-2014 rates are very slightly lower than the projected RP-2000 rates between ages 72 and 89, and are otherwise slightly greater than the projected RP-2000 rates. The resulting pattern of increases in monthly annuity values shown in Figure 11.1(F) is remarkably close to zero, except at the oldest ages, where the slightly greater mortality rates at those ages produce slightly lower annuity values.

12.2 Annuity Impact of Adopting New Mortality Assumptions

Table 12.2[37] displays a comparison of 2014 deferred-to-age-62 monthly annuity due values[38] (all calculated at an annual interest rate of 6.0 percent) based on various combinations of base mortality rates[39] and projection scales[40] most commonly used by pension actuaries. The right-hand side of the table shows the percentage increase in value that would result from a move away from each of

[37] Table 12.2 is a repeated version of Table 1.1 in the Executive Summary.
[38] All annuity values presented in Table 12.2 (and other tables in this report) have been determined using generational projection of future mortality improvements and the standard approximation to Woolhouse's formula:

$$_{n|}\ddot{a}_x^{(12)} \approx {}_{n|}\ddot{a}_x - \left({}^{11}\!/_{24}\right) \times {}_nE_x$$

[39] The UP-94 table and the RP-2000 Combined Healthy table.
[40] Scale AA, Scale BB, and Scale MP-2014; see Section 2 of [14] for additional background on the first two of these mortality projection scales.

these mortality assumption sets to RP-2014 base rates (Total Employee rates through age 61 and Total Healthy Annuitant rate at ages 62 and above) projected with Scale MP-2014.

		Monthly Deferred-to-62 Annuity Due Values Generational @ 2014					*Percentage Change of Moving to RP-2014 (with MP-2014) from:*			
	Base Rates	UP-94	RP-2000	RP-2000	RP-2000	RP-2014	UP-94	RP-2000	RP-2000	RP-2000
	Proj. Scale	AA	AA	BB	MP-2014	MP-2014	AA	AA	BB	MP-2014
	Age									
Males	25	1.3944	1.4029	1.4135	1.4324	**1.4379**	*3.1%*	*2.5%*	*1.7%*	*0.4%*
	35	2.4577	2.4688	2.4881	2.5259	**2.5363**	*3.2%*	*2.7%*	*1.9%*	*0.4%*
	45	4.3316	4.3569	4.3963	4.4662	**4.4770**	*3.4%*	*2.8%*	*1.8%*	*0.2%*
	55	7.6981	7.7400	7.8408	7.9735	**7.9755**	*3.6%*	*3.0%*	*1.7%*	*0.0%*
	65	11.0033	10.9891	11.2209	11.5053	**11.4735**	*4.3%*	*4.4%*	*2.3%*	*-0.3%*
	75	8.0551	7.8708	8.2088	8.5842	**8.6994**	*8.0%*	*10.5%*	*6.0%*	*1.3%*
	85	4.9888	4.6687	5.0048	5.2978	**5.4797**	*9.8%*	*17.4%*	*9.5%*	*3.4%*
Females	25	1.4336	1.4060	1.4816	1.5097	**1.5195**	*6.0%*	*8.1%*	*2.6%*	*0.6%*
	35	2.5465	2.4931	2.6145	2.6666	**2.6853**	*5.5%*	*7.7%*	*2.7%*	*0.7%*
	45	4.5337	4.4340	4.6264	4.7198	**4.7497**	*4.8%*	*7.1%*	*2.7%*	*0.6%*
	55	8.1245	7.9541	8.2532	8.4373	**8.4544**	*4.1%*	*6.3%*	*2.4%*	*0.2%*
	65	11.7294	11.4644	11.8344	12.1437	**12.0932**	*3.1%*	*5.5%*	*2.2%*	*-0.4%*
	75	8.9849	8.6971	9.0649	9.4045	**9.3996**	*4.6%*	*8.1%*	*3.7%*	*-0.1%*
	85	5.7375	5.5923	5.9525	6.2910	**6.1785**	*7.7%*	*10.5%*	*3.8%*	*-1.8%*

Table 12.2

Corresponding annuity comparisons at interest rates of 0 percent, 4 percent, and 8 percent are included in Appendix D.

Table 12.3 presents a comparison of 2014 deferred-to-age-62 monthly annuity due values calculated using the collar- and quartile-based RP-2014 base rates to those developed using the "Total RP-2014" basis described above (all calculated at an annual interest rate of 6.0 percent).

		Monthly Deferred-to-62 Annuity Due Values; Generational @ 2014 with MP-2014 Projection Scale					**Percentage Change** of Moving from Total Base Rates to Collar or Amount Adjusted Base Rates			
	Base Rates	Total	Blue Collar	White Collar	Bottom Quartile	Top Quartile	Blue Collar	White Collar	Bottom Quartile	Top Quartile
	Age									
Males	25	**1.4379**	1.3920	1.4999	1.3781	1.5179	*-3.2%*	*4.3%*	*-4.2%*	*5.6%*
	35	**2.5363**	2.4521	2.6521	2.4258	2.6841	*-3.3%*	*4.6%*	*-4.4%*	*5.8%*
	45	**4.4770**	4.3241	4.6908	4.2745	4.7465	*-3.4%*	*4.8%*	*-4.5%*	*6.0%*
	55	**7.9755**	7.7184	8.3497	7.6275	8.4307	*-3.2%*	*4.7%*	*-4.4%*	*5.7%*
	65	**11.4735**	11.1272	11.9685	11.0495	12.0948	*-3.0%*	*4.3%*	*-3.7%*	*5.4%*
	75	**8.6994**	8.3301	9.1162	8.3030	9.3704	*-4.2%*	*4.8%*	*-4.6%*	*7.7%*
	85	**5.4797**	5.2448	5.7148	5.2445	5.8493	*-4.3%*	*4.3%*	*-4.3%*	*6.7%*
Females	25	**1.5195**	1.5008	1.5511	1.4918	1.5548	*-1.2%*	*2.1%*	*-1.8%*	*2.3%*
	35	**2.6853**	2.6501	2.7450	2.6342	2.7501	*-1.3%*	*2.2%*	*-1.9%*	*2.4%*
	45	**4.7497**	4.6848	4.8613	4.6592	4.8659	*-1.4%*	*2.3%*	*-1.9%*	*2.4%*
	55	**8.4544**	8.3409	8.6549	8.3179	8.6411	*-1.3%*	*2.4%*	*-1.6%*	*2.2%*
	65	**12.0932**	11.9234	12.3959	11.9490	12.3490	*-1.4%*	*2.5%*	*-1.2%*	*2.1%*
	75	**9.3996**	9.1986	9.6987	9.2072	9.7841	*-2.1%*	*3.2%*	*-2.0%*	*4.1%*
	85	**6.1785**	6.0473	6.3727	6.1073	6.5775	*-2.1%*	*3.1%*	*-1.2%*	*6.5%*

Table 12.3

Table 12.4 compares 2014 monthly annuity due values (no deferral period) for *Disabled Retirees* (DR) under a number of different mortality bases: RP-2000 DR with no projection, RP-2014 DR with no projection, and RP-2014 DR projected generationally with Scale MP-2014. All annuity values are calculated using an annual interest rate of 6.0 percent and Disabled Retiree mortality rates.

		Monthly Annuity Due Values; Disabled Retiree Mortality			**Percentage Change** of Moving to RP-2014 (with MP-2014) from:	
	Base Rates	RP-2000 DR	RP-2014 DR	**RP-2014 DR**	RP-2000 DR	RP-2014 DR
	Proj. Scale	None	None	**MP-2014**	None	None
	Age					
Males	35	11.6038	13.1716	**13.6328**	*17.5%*	*3.5%*
	45	10.6345	11.8554	**12.3085**	*15.7%*	*3.8%*
	55	9.2062	10.6603	**11.0478**	*20.0%*	*3.6%*
	65	7.6580	9.0350	**9.4201**	*23.0%*	*4.3%*
	75	5.8156	6.8730	**7.1876**	*23.6%*	*4.6%*
	85	4.1341	4.5085	**4.6812**	*13.2%*	*3.8%*
Females	35	14.0090	14.3692	**14.7388**	*5.2%*	*2.6%*
	45	12.8485	13.1184	**13.5162**	*5.2%*	*3.0%*
	55	11.1620	11.8067	**12.2252**	*9.5%*	*3.5%*
	65	9.3069	10.0283	**10.4623**	*12.4%*	*4.3%*
	75	7.1520	7.6504	**7.9959**	*11.8%*	*4.5%*
	85	5.0481	5.2126	**5.4279**	*7.5%*	*4.1%*

Table 12.4

Section 13. Observations and Other Considerations

13.1 Comparing RP-2000 and RP-2014

The RP-2014 mortality tables represent a significant modernization of the corresponding RP-2000 tables. Although both the RP-2000 and RP-2014 studies developed sets of pension-related mortality tables based on the experience of uninsured retirement programs in the United States, a number of important differences are present in the respective datasets and final results. This subsection summarizes the main differences between the two studies.

Relative Percentages of Exposure by Collar

Table 13.1 presents a summary of the percentages of life-years of exposure in the final RP-2000 and RP-2014 datasets split by participant subgroup and collar. The blue collar concentrations for the Employee and Healthy Retiree subgroups are considerably higher in the RP-2014 datasets, particularly for females. In light of this higher concentration of blue collar data in the RP-2014 dataset, one would expect the total (all nondisabled) RP-2014 rates to be somewhat higher than those based on a dataset with blue collar concentrations more similar to those in the RP-2000 study.

		Collar Concentration (Life-Years of Exposure)					
		Males			Females		
		Blue	White	Mixed	Blue	White	Mixed
Employee	RP-2000	41.0%	47.9%	11.1%	33.7%	49.8%	16.5%
	RP-2014	61.3%	33.6%	5.1%	68.1%	27.8%	4.1%
Retiree	RP-2000	43.3%	32.7%	23.9%	30.8%	37.5%	31.6%
	RP-2014	52.2%	27.6%	20.1%	56.1%	31.4%	12.5%
Beneficiary	RP-2000	51.8%	36.4%	11.8%	61.5%	28.1%	10.5%
	RP-2014	56.3%	31.9%	11.9%	59.1%	28.5%	12.4%
Disabled Retiree	RP-2000	73.1%	16.0%	11.0%	69.3%	15.3%	15.4%
	RP-2014	60.1%	11.9%	28.0%	73.3%	13.8%	12.9%
Total	RP-2000	43.3%	40.0%	16.7%	39.4%	41.6%	19.0%
	RP-2014	56.4%	29.5%	14.1%	62.5%	28.7%	8.8%

Table 13.1

The different blue collar concentrations make direct comparisons between the Total nondisabled tables in the RP-2000 and RP-2014 studies less clear. RPEC attempted to quantify the impact of the different collar concentrations by developing approximate "re-balanced" versions of the Healthy Annuitant tables. The Committee ultimately concluded that these hypothetical re-balanced tables were not particularly helpful in providing additional insight into explaining differences between the Total nondisabled tables in the RP-2000 and RP-2014 reports.

Given the higher mortality rates typically experienced by blue collar participants, users should carefully consider the underlying characteristics of the covered group before automatically selecting the (Total) Employee and (Total) Healthy Annuitant tables, especially for covered groups that contain a large percentage of white collar (or highly paid) participants.

Projection from Central Year of Raw Data to Base Year of Table

The central year of data in the RP-2000 Report was 1992. As described in Chapter 4 of that report, raw mortality rates for male Employees and male Healthy Retirees were projected from 1992 to 2000 using improvement factors that reflected recent short-term experience at that time. Based on that trend experience, the RP-2000 authors decided not to reflect any mortality improvement for females between 1992 and 2000.

The central year of the raw RP-2014 mortality was 2006. All raw rates in the RP-2014 report—including those for Disabled Retirees—were projected to 2014 prior to graduation using Scale MP-2014 mortality improvement rates.

Amount-Based Tables

The amount-based categories (Small, Medium, and Large) in the RP-2000 report were applied to Healthy Annuitants only and were based on annual retirement benefit amount breakpoints of $6,000 and $14,400. The amount-based categories in the RP-2014 study were applied to both the Employee and Annuitant populations based on gender- and subgroup-specific quartiles of annual salary and annual retirement benefit amount, respectively.

Absence of "Combined Healthy" Tables

The RP-2000 Report included gender-specific "Combined Healthy" tables, i.e., single tables constructed from Employee rates through age 50, Healthy Annuitant rates at ages 70 and above, and a blend of the two sets of rates for ages 51 through 69. The blending of rates was based on the cumulative retirement rates derived from the underlying RP-2000 Healthy Annuitant dataset. Using this approach, the average retirement age reflected in the RP-2000 Combined Healthy tables was approximately 59 for males and 60 for females.

RPEC believes that actuarial practice in the United States has developed to the point that combined tables—especially ones based on retirement patterns that might not be appropriate for many covered groups—are no longer necessary. Hence, this RP-2014 report does not include any such Combined Healthy tables. Given a mature plan, if an actuary wishes to construct a combined mortality table, RPEC suggests taking into account the current composition, on a benefits-weighted basis, of the participant group at the ages where there is significant overlap between employees and annuitants, and blending the appropriate RP-2014 Employee and Healthy Annuitant tables accordingly. The actuary may wish to smooth away irregularities in the observed age-by-age composition of employees and annuitants.

Disabled Retiree Mortality

In the RP-2000 Report, the Disabled Retiree mortality rates below age 45 for males and females were all set equal to the corresponding Disabled Retiree rate at age 45. In addition, mortality improvement rates for years after 2000 were generally not applied to the RP-2000 Disabled Retiree rates.

Similar to the RP-2000 study, RPEC developed graduated Disabled Retiree rates starting at age 45. For ages below 45, however, RPEC decided to develop RP-2014 Disabled Retiree rates based on a constant gender-specific multiple[41] of the corresponding Total Employee rates. In the Scale MP-2014 report, RPEC also recommends that Disabled Retiree rates for years after 2014 be projected for future mortality improvements.

13.2 Relative Mortality: Collar- and Quartile-Based Tables

The RP-2000 Report and the subsequent Supplement Report included analyses of "relative mortality" based on collar type (for Employees and Healthy Annuitants) and benefit amount (for Healthy Annuitants). The RP-2014 study continued the analysis of collar-based relative mortality and expanded the analysis of amount-based relative mortality to salary quartiles for active Employee and retirement benefit quartiles for Annuitants.

As discussed in subsection 4.3, both collar and amount quartile were determined to be statistically significant indicators of differences in base mortality rates for nondisabled lives. The statistical analysis also indicated that collar color and amount quartiles were correlated. For example, white collar participants tended to end up in higher amount quartiles, producing relatively low mortality rates in both subcategories. Therefore, it would generally be inappropriate to apply both collar and amount adjustments simultaneously.

RPEC has concerns about the use of amount quartile as a basis for pension-related mortality differences, especially for Healthy Annuitants. These concerns are based primarily on the fact that the absolute dollar values of the retirement benefits upon which the Healthy Annuitant quartiles were based were not adjusted to reflect any differences based on plan design, the calendar year of benefit commencement, the retiree's age at commencement, the form of benefit payment, or whether the benefit was subject to periodic cost-of-living adjustments. At a very basic level, it was usually impossible to tell whether "Bottom Quartile" benefit amounts were attributable to low salaries, short service, or both.

In addition to these concerns about retirement benefit amount, the quartile breakpoints were based on salary and retirement amounts paid during the 2004 through 2008 study observation period. This fact makes direct translation of those quartile breakpoints to corresponding amounts in calendar years 2014 and beyond difficult to apply in practice.

Therefore, RPEC suggests that it will generally be more practical for users to apply collar-based relative mortality tables than quartile-based relative mortality tables.[42] That said, the variety of populations that satisfy the criteria for blue (or white) collar classification is quite broad, and users

[41] The multiples are based on the ratio of the age-45 Disabled Retiree rate to the age-45 Total Employee rate; approximately 17.5 for males and 13.8 for females.

[42] An example where the application of Top Quartile tables might be appropriate is the measurement of obligations for covered groups with very high compensation levels.

should always take into consideration the individual characteristics and experience of the covered group in the selection of an appropriate set of base mortality rates.

13.3 Application of Disabled Retiree Mortality Rates

The RP-2000 Disabled Retiree mortality tables were based on the experience of all disabled lives without regard to the definition of disability of the underlying plan. For the current study, RPEC requested information that it hoped would permit analysis of pension-related disabled life mortality rates on a more refined basis; that is, plan-specific eligibility criteria for disability retirement benefits and date of retirement. Of the 368,686 life-years of exposure in the current study, 25 percent was for plans with a "Social Security" definition, 55 percent was for plans with an "own occupation" definition, 7 percent was for plans with an "any occupation" definition, and 12 percent was distributed among a number of other disability criteria. The Committee also studied variations in disabled life mortality by duration since disablement.

Due to the relatively small volume of private plan disability data collected, RPEC was not able to reach any definitive conclusions on differences in mortality by either the definition of disability or duration; see subsection 5.4 for a discussion of the statistical analysis for Disabled Retirees. Consequently the gender-specific RP-2014 Disabled Retiree mortality tables reflect the aggregated experience of the entire disabled life subgroup dataset.

Actuaries should use professional judgment when applying the RP-2014 Disabled Retiree mortality tables if the particular plan's definition of disability is particularly strict or liberal. In addition, the Committee recommends that disabled life mortality rates be projected using Scale MP-2014 mortality improvement rates (or an appropriately parameterized RPEC_2014 model) on a generational basis.[43]

13.4 Impact on Age-65 Life Expectancy Values

Table D-1 (in Appendix D) displays monthly annuity values calculated using a zero percent interest rate. Comparing the 2014 age-65 monthly annuity values based on (1) RP-2000 Healthy Annuitant base rates projected with Scale AA and (2) RP-2014 Healthy Annuitant base rates projected using Scale MP-2014, the 2014 age-65 cohort life expectancy[44] increased approximately 10.4 percent for males (from 19.6 years to 21.6 years) and approximately 11.3 percent for females (from 21.4 years to 23.8 years).

13.5 Headcount-Weighted and Amount-Weighted Mortality Rates

All of the RP-2014 mortality rates are based on amount-weighted exposures and deaths. While RPEC believes the use of amount-weighted mortality rates for the measurement of pension plan obligations continues to be appropriate, there are other applications for which the use of headcount-weighted mortality rates might be more suitable and possibly produce more accurate results. These

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[43] See subsection 6.2 of the Scale MP-2014 report for the rationale behind this recommendation [14].

[44] Because both RP-2000 and RP-2014 mortality rates are amount-weighted, the resulting life expectancies are also amount-weighted.

other applications might include estimates of average age at death, projections of retirement plan populations, and the measurement of obligations for retirement programs with relatively flat benefit structures.[45]

The reason for using a weighted version of a mortality table (either pension-amount-weighted, headcount-weighted, or otherwise) is to obtain the most appropriate result for the particular application at hand. For the measurement of most pension obligations, tables weighted by benefit amount generally produce the most appropriate results, while headcount-weighted tables might be more appropriate for the measurement of many OPEB plan obligations. As a consequence, the Committee believes that it would not necessarily be inappropriate–or inconsistent–to use (amount-weighted) RP-2014 tables to measure pension plan obligations and the corresponding headcount-weighted versions of those RP-2014 tables to measure OPEB plan obligations, even when the two covered populations are identical.

Sets of headcount-weighted mortality tables, denoted RPH-2014 (for Retirement Plans Headcount-weighted), are presented in the Supplement to the RP-2014 Mortality Tables Report [16], which is available here.

[45] An example of such a program might be a post-employment medical plan that provides a flat-dollar subsidy for pre-Medicare participants and a different (typically smaller) flat-dollar subsidy for Medicare-eligible participants.

Appendix A. RP-2014 Rates

	Total Dataset; Males			Total Dataset; Females			
Age	Employee	Healthy Annuitant	Disabled Retiree	Employee	Healthy Annuitant	Disabled Retiree	Age
18	0.000328		0.005744	0.000157		0.002162	18
19	0.000369		0.006462	0.000162		0.002231	19
20	0.000406		0.007110	0.000162		0.002231	20
21	0.000449		0.007863	0.000162		0.002231	21
22	0.000488		0.008546	0.000162		0.002231	22
23	0.000509		0.008914	0.000166		0.002286	23
24	0.000516		0.009036	0.000169		0.002328	24
25	0.000484		0.008476	0.000173		0.002383	25
26	0.000462		0.008090	0.000179		0.002465	26
27	0.000449		0.007863	0.000187		0.002576	27
28	0.000444		0.007775	0.000196		0.002700	28
29	0.000446		0.007810	0.000206		0.002837	29
30	0.000452		0.007915	0.000218		0.003003	30
31	0.000463		0.008108	0.000231		0.003182	31
32	0.000477		0.008353	0.000244		0.003361	32
33	0.000492		0.008616	0.000258		0.003553	33
34	0.000508		0.008896	0.000272		0.003746	34
35	0.000523		0.009159	0.000286		0.003939	35
36	0.000536		0.009386	0.000300		0.004132	36
37	0.000551		0.009649	0.000318		0.004380	37
38	0.000570		0.009982	0.000339		0.004669	38
39	0.000595		0.010420	0.000365		0.005027	39
40	0.000628		0.010997	0.000396		0.005454	40
41	0.000671		0.011750	0.000433		0.005964	41
42	0.000725		0.012696	0.000477		0.006570	42
43	0.000793		0.013887	0.000529		0.007286	43
44	0.000876		0.015340	0.000589		0.008112	44
45	0.000973		0.017039	0.000657		0.009049	45
46	0.001087		0.017741	0.000733		0.009635	46
47	0.001215		0.018428	0.000816		0.010215	47
48	0.001358		0.019101	0.000906		0.010787	48
49	0.001515		0.019757	0.001001		0.011352	49

Age	Total Dataset; Males Employee	Total Dataset; Males Healthy Annuitant	Total Dataset; Males Disabled Retiree	Total Dataset; Females Employee	Total Dataset; Females Healthy Annuitant	Total Dataset; Females Disabled Retiree	Age
50	0.001686	0.004064	0.020395	0.001102	0.002768	0.011907	50
51	0.001871	0.004384	0.021016	0.001206	0.002905	0.012450	51
52	0.002072	0.004709	0.021621	0.001315	0.003057	0.012979	52
53	0.002289	0.005042	0.022210	0.001429	0.003225	0.013494	53
54	0.002527	0.005384	0.022791	0.001548	0.003412	0.013992	54
55	0.002788	0.005735	0.023369	0.001673	0.003622	0.014479	55
56	0.003079	0.006099	0.023953	0.001805	0.003858	0.014958	56
57	0.003407	0.006478	0.024557	0.001946	0.004128	0.015439	57
58	0.003779	0.006877	0.025190	0.002097	0.004436	0.015931	58
59	0.004204	0.007305	0.025868	0.002261	0.004789	0.016447	59
60	0.004688	0.007771	0.026604	0.002442	0.005191	0.016999	60
61	0.005240	0.008284	0.027414	0.002642	0.005646	0.017603	61
62	0.005867	0.008854	0.028312	0.002864	0.006156	0.018273	62
63	0.006577	0.009492	0.029314	0.003113	0.006723	0.019028	63
64	0.007377	0.010209	0.030433	0.003389	0.007352	0.019884	64
65	0.008277	0.011013	0.031685	0.003696	0.008048	0.020860	65
66	0.009175	0.011916	0.033081	0.004113	0.008821	0.021976	66
67	0.010171	0.012930	0.034633	0.004577	0.009679	0.023250	67
68	0.011275	0.014067	0.036353	0.005094	0.010633	0.024702	68
69	0.012498	0.015342	0.038253	0.005669	0.011692	0.026348	69
70	0.013854	0.016769	0.040346	0.006309	0.012868	0.028203	70
71	0.015357	0.018363	0.042647	0.007021	0.014171	0.030280	71
72	0.017023	0.020141	0.045170	0.007813	0.015614	0.032591	72
73	0.018870	0.022127	0.047935	0.008695	0.017210	0.035148	73
74	0.020918	0.024345	0.050965	0.009676	0.018977	0.037962	74
75	0.023188	0.026826	0.054287	0.010768	0.020938	0.041045	75
76	0.025704	0.029608	0.057934	0.011983	0.023118	0.044413	76
77	0.028493	0.032735	0.061945	0.013336	0.025554	0.048078	77
78	0.031585	0.036258	0.066363	0.014841	0.028288	0.052059	78
79	0.035012	0.040232	0.071235	0.016516	0.031366	0.056372	79
80	0.038811	0.044722	0.076616	0.018380	0.034844	0.061036	80
81		0.049795	0.082562		0.038783	0.066074	81
82		0.055526	0.089136		0.043246	0.071506	82
83		0.061996	0.096405		0.048305	0.077357	83
84		0.069290	0.104436		0.054032	0.083652	84

Age	Total Dataset; Males			Total Dataset; Females			Age
	Employee	Healthy Annuitant	Disabled Retiree	Employee	Healthy Annuitant	Disabled Retiree	
85		0.077497	0.113303		0.060504	0.090420	85
86		0.086712	0.123081		0.067801	0.097694	86
87		0.097038	0.133850		0.076012	0.105510	87
88		0.108591	0.145697		0.085230	0.113909	88
89		0.121499	0.158714		0.095563	0.122939	89
90		0.135908	0.173005		0.107126	0.132652	90
91		0.151322	0.187464		0.119744	0.143420	91
92		0.167422	0.202100		0.133299	0.155186	92
93		0.184030	0.216924		0.147720	0.167890	93
94		0.201074	0.231944		0.162971	0.181474	94
95		0.218559	0.247169		0.179034	0.195880	95
96		0.236535	0.262610		0.195903	0.211049	96
97		0.255059	0.278276		0.213565	0.226923	97
98		0.274170	0.294176		0.231991	0.243443	98
99		0.293848	0.310320		0.251123	0.260551	99
100		0.313988	0.326717		0.270858	0.278189	100
101		0.334365	0.343376		0.291040	0.296297	101
102		0.354599	0.360308		0.311444	0.314819	102
103		0.374524	0.377522		0.331900	0.333694	103
104		0.393982	0.395026		0.352232	0.352865	104
105		0.412831	0.412831		0.372273	0.372273	105
106		0.430946	0.430946		0.391860	0.391860	106
107		0.448227	0.448227		0.410849	0.410849	107
108		0.464592	0.464592		0.429112	0.429112	108
109		0.479987	0.479987		0.446544	0.446544	109
110		0.494376	0.494376		0.463061	0.463061	110
111		0.500000	0.500000		0.478604	0.478604	111
112		0.500000	0.500000		0.493137	0.493137	112
113		0.500000	0.500000		0.500000	0.500000	113
114		0.500000	0.500000		0.500000	0.500000	114
115		0.500000	0.500000		0.500000	0.500000	115
116		0.500000	0.500000		0.500000	0.500000	116
117		0.500000	0.500000		0.500000	0.500000	117
118		0.500000	0.500000		0.500000	0.500000	118
119		0.500000	0.500000		0.500000	0.500000	119
120		1.000000	1.000000		1.000000	1.000000	120

	Blue Collar; Males		Blue Collar; Females		
Age	Employee	Healthy Annuitant	Employee	Healthy Annuitant	Age
18	0.000424		0.000176		18
19	0.000478		0.000182		19
20	0.000525		0.000182		20
21	0.000581		0.000182		21
22	0.000632		0.000182		22
23	0.000659		0.000186		23
24	0.000668		0.000190		24
25	0.000626		0.000194		25
26	0.000598		0.000201		26
27	0.000581		0.000210		27
28	0.000575		0.000220		28
29	0.000577		0.000231		29
30	0.000585		0.000244		30
31	0.000599		0.000259		31
32	0.000617		0.000274		32
33	0.000637		0.000289		33
34	0.000657		0.000305		34
35	0.000677		0.000321		35
36	0.000694		0.000336		36
37	0.000713		0.000357		37
38	0.000738		0.000380		38
39	0.000770		0.000409		39
40	0.000813		0.000444		40
41	0.000868		0.000486		41
42	0.000938		0.000535		42
43	0.001026		0.000593		43
44	0.001134		0.000661		44
45	0.001259		0.000737		45
46	0.001407		0.000822		46
47	0.001572		0.000915		47
48	0.001757		0.001016		48
49	0.001961		0.001123		49

Age	Blue Collar; Males		Blue Collar; Females		Age
	Employee	Healthy Annuitant	Employee	Healthy Annuitant	
50	0.002182	0.004064	0.001236	0.002822	50
51	0.002421	0.004384	0.001353	0.003045	51
52	0.002681	0.004733	0.001475	0.003275	52
53	0.002962	0.005151	0.001603	0.003514	53
54	0.003270	0.005573	0.001736	0.003763	54
55	0.003608	0.005999	0.001876	0.004025	55
56	0.003984	0.006435	0.002024	0.004304	56
57	0.004409	0.006887	0.002182	0.004607	57
58	0.004890	0.007364	0.002352	0.004941	58
59	0.005440	0.007882	0.002536	0.005315	59
60	0.006067	0.008456	0.002739	0.005735	60
61	0.006781	0.009101	0.002963	0.006208	61
62	0.007592	0.009829	0.003212	0.006737	62
63	0.008511	0.010653	0.003491	0.007328	63
64	0.009546	0.011580	0.003801	0.007987	64
65	0.010711	0.012615	0.004145	0.008725	65
66	0.011786	0.013765	0.004600	0.009550	66
67	0.012969	0.015035	0.005105	0.010476	67
68	0.014271	0.016435	0.005665	0.011512	68
69	0.015704	0.017980	0.006286	0.012671	69
70	0.017281	0.019687	0.006976	0.013966	70
71	0.019016	0.021577	0.007741	0.015411	71
72	0.020925	0.023674	0.008590	0.017020	72
73	0.023026	0.026008	0.009532	0.018806	73
74	0.025338	0.028608	0.010578	0.020783	74
75	0.027882	0.031507	0.011738	0.022971	75
76	0.030682	0.034740	0.013026	0.025393	76
77	0.033763	0.038346	0.014455	0.028081	77
78	0.037153	0.042369	0.016041	0.031074	78
79	0.040883	0.046856	0.017801	0.034418	79
80	0.044988	0.051859	0.019754	0.038164	80
81		0.057434		0.042368	81
82		0.063644		0.047092	82
83		0.070561		0.052397	83
84		0.078261		0.058348	84

	Blue Collar; Males		Blue Collar; Females		
Age	Employee	Healthy Annuitant	Employee	Healthy Annuitant	Age
85		0.086831		0.065011	85
86		0.096365		0.072457	86
87		0.106965		0.080765	87
88		0.118750		0.090030	88
89		0.131850		0.100356	89
90		0.146410		0.111865	90
91		0.161805		0.124323	91
92		0.177682		0.137597	92
93		0.193835		0.151596	93
94		0.210178		0.166269	94
95		0.226707		0.181584	95
96		0.243460		0.197517	96
97		0.260487		0.214044	97
98		0.277810		0.231991	98
99		0.295399		0.251123	99
100		0.313988		0.270858	100
101		0.334365		0.291040	101
102		0.354599		0.311444	102
103		0.374524		0.331900	103
104		0.393982		0.352232	104
105		0.412831		0.372273	105
106		0.430946		0.391860	106
107		0.448227		0.410849	107
108		0.464592		0.429112	108
109		0.479987		0.446544	109
110		0.494376		0.463061	110
111		0.500000		0.478604	111
112		0.500000		0.493137	112
113		0.500000		0.500000	113
114		0.500000		0.500000	114
115		0.500000		0.500000	115
116		0.500000		0.500000	116
117		0.500000		0.500000	117
118		0.500000		0.500000	118
119		0.500000		0.500000	119
120		1.000000		1.000000	120

Age	White Collar; Males Employee	White Collar; Males Healthy Annuitant	White Collar; Females Employee	White Collar; Females Healthy Annuitant	Age
18	0.000230		0.000132		18
19	0.000259		0.000137		19
20	0.000285		0.000137		20
21	0.000315		0.000137		21
22	0.000342		0.000137		22
23	0.000357		0.000140		23
24	0.000362		0.000143		24
25	0.000339		0.000146		25
26	0.000324		0.000151		26
27	0.000315		0.000158		27
28	0.000311		0.000165		28
29	0.000313		0.000174		29
30	0.000317		0.000184		30
31	0.000325		0.000195		31
32	0.000335		0.000206		32
33	0.000345		0.000218		33
34	0.000356		0.000230		34
35	0.000367		0.000241		35
36	0.000376		0.000253		36
37	0.000386		0.000268		37
38	0.000400		0.000286		38
39	0.000417		0.000308		39
40	0.000440		0.000334		40
41	0.000471		0.000365		41
42	0.000508		0.000402		42
43	0.000556		0.000446		43
44	0.000614		0.000497		44
45	0.000682		0.000554		45
46	0.000762		0.000618		46
47	0.000852		0.000689		47
48	0.000952		0.000764		48
49	0.001062		0.000845		49

Age	White Collar; Males Employee	White Collar; Males Healthy Annuitant	White Collar; Females Employee	White Collar; Females Healthy Annuitant	Age
50	0.001182	0.002764	0.000930	0.002076	50
51	0.001312	0.002981	0.001018	0.002179	51
52	0.001453	0.003202	0.001110	0.002292	52
53	0.001605	0.003429	0.001206	0.002419	53
54	0.001772	0.003661	0.001306	0.002559	54
55	0.001955	0.003908	0.001412	0.002716	55
56	0.002159	0.004121	0.001523	0.002894	56
57	0.002389	0.004356	0.001642	0.003096	57
58	0.002650	0.004616	0.001769	0.003327	58
59	0.002948	0.004905	0.001908	0.003591	59
60	0.003288	0.005225	0.002060	0.003891	60
61	0.003675	0.005582	0.002229	0.004367	61
62	0.004114	0.005984	0.002417	0.004867	62
63	0.004612	0.006442	0.002627	0.005394	63
64	0.005173	0.006969	0.002859	0.005952	64
65	0.005805	0.007580	0.003119	0.006549	65
66	0.006508	0.008290	0.003485	0.007197	66
67	0.007296	0.009114	0.003894	0.007907	67
68	0.008179	0.010066	0.004351	0.008694	68
69	0.009169	0.011159	0.004862	0.009572	69
70	0.010279	0.012402	0.005433	0.010554	70
71	0.011523	0.013803	0.006071	0.011653	71
72	0.012917	0.015375	0.006784	0.012886	72
73	0.014480	0.017130	0.007581	0.014270	73
74	0.016232	0.019088	0.008472	0.015825	74
75	0.018196	0.021279	0.009467	0.017577	75
76	0.020398	0.023738	0.010579	0.019555	76
77	0.022867	0.026510	0.011822	0.021789	77
78	0.025634	0.029651	0.013211	0.024315	78
79	0.028736	0.033225	0.014763	0.027176	79
80	0.032214	0.037307	0.016497	0.030419	80
81		0.041980		0.034101	81
82		0.047333		0.038286	82
83		0.053459		0.043044	83
84		0.060449		0.048457	84

Age	White Collar; Males: Employee	White Collar; Males: Healthy Annuitant	White Collar; Females: Employee	White Collar; Females: Healthy Annuitant	Age
85		0.068396		0.054613	85
86		0.077396		0.061611	86
87		0.087552		0.069553	87
88		0.098978		0.078550	88
89		0.111806		0.088723	89
90		0.126190		0.100207	90
91		0.141713		0.112848	91
92		0.158130		0.126555	92
93		0.175288		0.141281	93
94		0.193131		0.157007	94
95		0.211674		0.173736	95
96		0.230976		0.191477	96
97		0.251106		0.210235	97
98		0.272113		0.229998	98
99		0.293848		0.250723	99
100		0.313988		0.270858	100
101		0.334365		0.291040	101
102		0.354599		0.311444	102
103		0.374524		0.331900	103
104		0.393982		0.352232	104
105		0.412831		0.372273	105
106		0.430946		0.391860	106
107		0.448227		0.410849	107
108		0.464592		0.429112	108
109		0.479987		0.446544	109
110		0.494376		0.463061	110
111		0.500000		0.478604	111
112		0.500000		0.493137	112
113		0.500000		0.500000	113
114		0.500000		0.500000	114
115		0.500000		0.500000	115
116		0.500000		0.500000	116
117		0.500000		0.500000	117
118		0.500000		0.500000	118
119		0.500000		0.500000	119
120		1.000000		1.000000	120

Age	Bottom Quartile; Males		Bottom Quartile; Females		Age
	Employee	Healthy Annuitant	Employee	Healthy Annuitant	
18	0.000441		0.000224		18
19	0.000497		0.000231		19
20	0.000546		0.000231		20
21	0.000604		0.000231		21
22	0.000657		0.000231		22
23	0.000685		0.000237		23
24	0.000694		0.000241		24
25	0.000651		0.000247		25
26	0.000622		0.000255		26
27	0.000604		0.000267		27
28	0.000598		0.000280		28
29	0.000600		0.000294		29
30	0.000608		0.000311		30
31	0.000623		0.000329		31
32	0.000642		0.000348		32
33	0.000662		0.000368		33
34	0.000684		0.000388		34
35	0.000704		0.000408		35
36	0.000721		0.000428		36
37	0.000742		0.000454		37
38	0.000767		0.000483		38
39	0.000801		0.000521		39
40	0.000845		0.000565		40
41	0.000903		0.000618		41
42	0.000976		0.000680		42
43	0.001067		0.000754		43
44	0.001179		0.000840		44
45	0.001310		0.000937		45
46	0.001463		0.001045		46
47	0.001635		0.001164		47
48	0.001828		0.001292		48
49	0.002039		0.001428		49

	Bottom Quartile; Males		Bottom Quartile; Females		
Age	Employee	Healthy Annuitant	Employee	Healthy Annuitant	Age
50	0.002269	0.010021	0.001572	0.004429	50
51	0.002518	0.010370	0.001720	0.004648	51
52	0.002789	0.010670	0.001875	0.004891	52
53	0.003081	0.010920	0.002038	0.005160	53
54	0.003401	0.011121	0.002208	0.005459	54
55	0.003752	0.011273	0.002386	0.005795	55
56	0.004144	0.011327	0.002574	0.005941	56
57	0.004586	0.011409	0.002775	0.005962	57
58	0.005086	0.011522	0.002991	0.006029	58
59	0.005658	0.011674	0.003224	0.006147	59
60	0.006310	0.011873	0.003483	0.006322	60
61	0.007053	0.012133	0.003768	0.006562	61
62	0.007897	0.012468	0.004084	0.006877	62
63	0.008852	0.012901	0.004440	0.007278	63
64	0.009929	0.013453	0.004833	0.007779	64
65	0.011140	0.014148	0.005271	0.008394	65
66	0.012239	0.015009	0.005787	0.009140	66
67	0.013446	0.016054	0.006354	0.010032	67
68	0.014772	0.017295	0.006976	0.011080	68
69	0.016229	0.018740	0.007659	0.012294	69
70	0.017830	0.020396	0.008409	0.013679	70
71	0.019589	0.022269	0.009233	0.015240	71
72	0.021521	0.024370	0.010137	0.016979	72
73	0.023644	0.026713	0.011130	0.018900	73
74	0.025976	0.029316	0.012220	0.021009	74
75	0.028538	0.032206	0.013417	0.023315	75
76	0.031353	0.035415	0.014731	0.025831	76
77	0.034446	0.038987	0.016174	0.028576	77
78	0.037844	0.042970	0.017758	0.031576	78
79	0.041577	0.047420	0.019497	0.034868	79
80	0.045678	0.052398	0.021406	0.038501	80
81		0.057968		0.042530	81
82		0.064194		0.047019	82
83		0.071143		0.052039	83
84		0.078879		0.057667	84

Age	Bottom Quartile; Males		Bottom Quartile; Females		Age
	Employee	Healthy Annuitant	Employee	Healthy Annuitant	
85		0.087472		0.063982	85
86		0.096994		0.071068	86
87		0.107531		0.079012	87
88		0.119182		0.087909	88
89		0.132057		0.097861	89
90		0.146282		0.108983	90
91		0.161209		0.120982	91
92		0.176519		0.133744	92
93		0.192005		0.147720	93
94		0.207575		0.162971	94
95		0.223222		0.179034	95
96		0.238979		0.195903	96
97		0.255059		0.213565	97
98		0.274170		0.231991	98
99		0.293848		0.251123	99
100		0.313988		0.270858	100
101		0.334365		0.291040	101
102		0.354599		0.311444	102
103		0.374524		0.331900	103
104		0.393982		0.352232	104
105		0.412831		0.372273	105
106		0.430946		0.391860	106
107		0.448227		0.410849	107
108		0.464592		0.429112	108
109		0.479987		0.446544	109
110		0.494376		0.463061	110
111		0.500000		0.478604	111
112		0.500000		0.493137	112
113		0.500000		0.500000	113
114		0.500000		0.500000	114
115		0.500000		0.500000	115
116		0.500000		0.500000	116
117		0.500000		0.500000	117
118		0.500000		0.500000	118
119		0.500000		0.500000	119
120		1.000000		1.000000	120

Age	Top Quartile; Males		Top Quartile; Females		Age
	Employee	Healthy Annuitant	Employee	Healthy Annuitant	
18	0.000169		0.000100		18
19	0.000190		0.000103		19
20	0.000209		0.000103		20
21	0.000231		0.000103		21
22	0.000252		0.000103		22
23	0.000262		0.000105		23
24	0.000266		0.000107		24
25	0.000249		0.000110		25
26	0.000238		0.000114		26
27	0.000231		0.000119		27
28	0.000229		0.000124		28
29	0.000230		0.000131		29
30	0.000233		0.000138		30
31	0.000239		0.000147		31
32	0.000246		0.000155		32
33	0.000254		0.000164		33
34	0.000262		0.000173		34
35	0.000270		0.000181		35
36	0.000276		0.000190		36
37	0.000284		0.000202		37
38	0.000294		0.000215		38
39	0.000307		0.000232		39
40	0.000324		0.000251		40
41	0.000346		0.000275		41
42	0.000374		0.000303		42
43	0.000409		0.000336		43
44	0.000451		0.000374		44
45	0.000501		0.000417		45
46	0.000560		0.000465		46
47	0.000626		0.000518		47
48	0.000700		0.000575		48
49	0.000781		0.000635		49

Age	Top Quartile; Males		Top Quartile; Females		Age
	Employee	Healthy Annuitant	Employee	Healthy Annuitant	
50	0.000869	0.003071	0.000699	0.001463	50
51	0.000964	0.003465	0.000765	0.001699	51
52	0.001068	0.003852	0.000834	0.001947	52
53	0.001180	0.004231	0.000907	0.002210	53
54	0.001302	0.004601	0.000982	0.002490	54
55	0.001437	0.004961	0.001061	0.002789	55
56	0.001587	0.005310	0.001145	0.003111	56
57	0.001756	0.005649	0.001235	0.003462	57
58	0.001948	0.005979	0.001330	0.003846	58
59	0.002167	0.006304	0.001434	0.004265	59
60	0.002416	0.006631	0.001549	0.004724	60
61	0.002701	0.006964	0.001676	0.005223	61
62	0.003024	0.007312	0.001817	0.005764	62
63	0.003390	0.007685	0.001975	0.006345	63
64	0.003802	0.008093	0.002150	0.006967	64
65	0.004266	0.008550	0.002345	0.007634	65
66	0.004834	0.009065	0.002643	0.008350	66
67	0.005477	0.009652	0.002979	0.009119	67
68	0.006206	0.010322	0.003357	0.009950	68
69	0.007032	0.011086	0.003783	0.010851	69
70	0.007967	0.011958	0.004263	0.011829	70
71	0.009027	0.012955	0.004804	0.012896	71
72	0.010228	0.014096	0.005414	0.014068	72
73	0.011589	0.015406	0.006101	0.015359	73
74	0.013131	0.016915	0.006876	0.016794	74
75	0.014878	0.018659	0.007749	0.018397	75
76	0.016857	0.020684	0.008733	0.020201	76
77	0.019100	0.023037	0.009842	0.022239	77
78	0.021641	0.025777	0.011092	0.024548	78
79	0.024520	0.028966	0.012500	0.027168	79
80	0.027782	0.032675	0.014087	0.030142	80
81		0.036983		0.033516	81
82		0.041977		0.037345	82
83		0.047754		0.041685	83
84		0.054421		0.046604	84

	Top Quartile; Males		Top Quartile; Females		
Age	**Employee**	**Healthy Annuitant**	**Employee**	**Healthy Annuitant**	Age
85		0.062096		0.052177	85
86		0.070916		0.058485	86
87		0.081032		0.065622	87
88		0.092622		0.073689	88
89		0.105887		0.082799	89
90		0.121060		0.093082	90
91		0.137817		0.104404	91
92		0.155829		0.116696	92
93		0.174967		0.129928	93
94		0.195193		0.144103	94
95		0.216538		0.159244	95
96		0.236535		0.175384	96
97		0.255059		0.192553	97
98		0.274170		0.210771	98
99		0.293848		0.230031	99
100		0.313988		0.250285	100
101		0.334365		0.271437	101
102		0.354599		0.293320	102
103		0.374524		0.315812	103
104		0.393982		0.338781	104
105		0.412831		0.362092	105
106		0.430946		0.385613	106
107		0.448227		0.409215	107
108		0.464592		0.429112	108
109		0.479987		0.446544	109
110		0.494376		0.463061	110
111		0.500000		0.478604	111
112		0.500000		0.493137	112
113		0.500000		0.500000	113
114		0.500000		0.500000	114
115		0.500000		0.500000	115
116		0.500000		0.500000	116
117		0.500000		0.500000	117
118		0.500000		0.500000	118
119		0.500000		0.500000	119
120		1.000000		1.000000	120

Age	Juvenile Rates	
	Males	Females
0	0.007071	0.005830
1	0.000410	0.000361
2	0.000277	0.000236
3	0.000230	0.000176
4	0.000179	0.000132
5	0.000157	0.000119
6	0.000141	0.000110
7	0.000124	0.000102
8	0.000105	0.000094
9	0.000085	0.000087
10	0.000072	0.000082
11	0.000076	0.000084
12	0.000113	0.000097
13	0.000149	0.000110
14	0.000183	0.000121
15	0.000218	0.000132
16	0.000253	0.000142
17	0.000290	0.000150

Appendix B. Summary of Graduation Parameters

The following table summarizes the parameters and age ranges used in the Whittaker-Henderson-Lowrie graduation described in Section 5.

		Males				Females			
Category	**Subpopulation**	**h**	**r**	Low Age	High Age	**h**	**r**	Low Age	High Age
Employee	Total	500	9%	25	65	500	9%	30	65
Healthy Annuitant	Total	500	11%	50	95	500	11%	50	95
	Blue Collar	500	11%	50	95	500	11%	50	95
	White Collar	500	12%	55	95	500	13%	60	95
	Bottom Quartile	1,000	10%	55	95	1,000	11%	55	95
	Top Quartile	1,000	14%	50	95	1,000	13%	55	95
Disabled Retiree	Total	5,000	9%	45	95	10,000	7%	45	95

Appendix C. Summaries of the Final Dataset

Tables C-1 through C-8 summarize the exposures, deaths, and resulting raw death rates upon which the RP-2014 tables were constructed. Gender-specific tables are shown separately for each participant subgroup: Employee, Healthy Retiree, Beneficiary, and Disabled Retiree. The exposure sums (by age band, collar, or quartile) might not match the total because of rounding.

Summary of Final Male Employee Dataset

	Number		Number with Amount		Annual Salary Amount ($thousands)		Death Rates Based on		
Age Band	Exposed Life-Years	Deaths	Exposed Life-Years	Deaths	Exposed $-Years	$-Weighted Deaths	Number	Number with Amount	Amount
20 - 24	89,715	46	82,652	34	2,091,934	852	0.000513	0.000411	0.000407
25 - 29	184,125	98	160,783	79	7,385,893	2,945	0.000532	0.000491	0.000399
30 - 34	283,615	179	228,332	118	13,601,063	5,717	0.000631	0.000517	0.000420
35 - 39	326,653	264	245,802	160	16,744,955	8,595	0.000808	0.000651	0.000513
40 - 44	327,466	370	231,595	237	17,165,159	13,794	0.001130	0.001023	0.000804
45 - 49	401,995	744	237,462	363	18,198,704	22,766	0.001851	0.001529	0.001251
50 - 54	412,889	1,229	231,007	530	17,616,537	32,375	0.002977	0.002294	0.001838
55 - 59	297,605	1,244	167,561	537	12,684,833	33,956	0.004180	0.003205	0.002677
60 - 64	118,208	870	59,241	289	4,329,164	17,110	0.007360	0.004878	0.003952
65 - 69	23,235	291	11,048	80	634,172	3,766	0.012524	0.007241	0.005939
70 - 74	1,602	23	838	5	33,774	227	0.014356	0.005968	0.006720
TOTAL	2,467,108	5,358	1,656,319	2,432	110,486,189	142,103			
Blue Collar	1,511,926	4,033	931,215	1,538	48,787,046	74,351			
White Collar	829,268	1,202	623,938	816	53,119,639	62,555			
Mixed Collar	125,914	123	101,166	78	8,579,504	5,197			
Quartile 1			400,875	704	11,048,545	18,209			
Quartile 2			413,471	703	22,366,625	38,106			
Quartile 3			421,530	581	28,175,811	38,606			
Quartile 4			420,443	444	48,895,207	47,181			

Table C-1

Summary of Final Female Employee Dataset

	Number		Number with Amount		Annual Salary Amount ($thousands)		Death Rates Based on		
Age Band	Exposed Life-Years	Deaths	Exposed Life-Years	Deaths	Exposed $-Years	$-Weighted Deaths	Number	Number with Amount	Amount
20 - 24	93,827	23	91,570	22	2,184,533	345	0.000245	0.000240	0.000158
25 - 29	184,325	45	174,915	42	7,055,290	1,276	0.000244	0.000240	0.000181
30 - 34	242,234	75	220,227	69	10,834,527	2,789	0.000310	0.000313	0.000257
35 - 39	259,542	119	230,575	108	12,237,077	4,648	0.000458	0.000468	0.000380
40 - 44	271,736	188	238,599	162	13,107,651	7,271	0.000692	0.000679	0.000555
45 - 49	332,249	374	285,514	296	16,159,787	13,505	0.001126	0.001037	0.000836
50 - 54	310,934	528	265,737	407	15,131,570	18,274	0.001698	0.001532	0.001208
55 - 59	197,502	512	170,973	387	9,267,734	16,910	0.002592	0.002264	0.001825
60 - 64	77,766	307	67,829	234	3,275,552	9,233	0.003948	0.003450	0.002819
65 - 69	17,957	98	16,143	73	608,739	2,223	0.005457	0.004522	0.003652
70 - 74	1,563	8	1,431	7	40,697	165	0.005119	0.004892	0.004047
TOTAL	1,989,637	2,277	1,763,513	1,807	89,903,158	76,639			
Blue Collar	1,355,418	1,740	1,209,264	1,378	52,971,324	51,291			
White Collar	552,129	481	478,068	377	31,185,764	22,292			
Mixed Collar	82,090	56	76,181	52	5,746,070	3,055			
Quartile 1			444,823	602	8,144,748	9,372			
Quartile 2			429,979	501	17,013,695	20,132			
Quartile 3			441,834	398	23,750,433	21,186			
Quartile 4			446,878	306	40,994,282	25,948			

Table C-2

Summary of Final Male Healthy Retiree Dataset

	Number		Number with Amount		Annual Benefit Amount ($thousands)		Death Rates Based on		
Age Band	Exposed Life-Years	Deaths	Exposed Life-Years	Deaths	Exposed $-Years	$-Weighted Deaths	Number	Number with Amount	Amount
50 - 54	90,379	581	83,180	528	2,378,485	12,222	0.006428	0.006348	0.005139
55 - 59	321,789	2,647	297,712	2,479	7,521,018	51,976	0.008226	0.008327	0.006911
60 - 64	554,044	6,314	529,862	6,096	11,398,465	110,089	0.011396	0.011505	0.009658
65 - 69	631,918	10,878	613,575	10,589	9,345,608	140,895	0.017214	0.017258	0.015076
70 - 74	551,144	15,245	538,373	14,962	7,470,497	185,482	0.027661	0.027791	0.024829
75 - 79	475,418	21,163	471,264	20,996	6,234,152	252,241	0.044514	0.044553	0.040461
80 - 84	331,808	24,037	331,418	23,995	4,076,468	271,443	0.072442	0.072401	0.066588
85 - 89	155,200	18,624	155,147	18,613	1,706,185	192,182	0.120000	0.119970	0.112639
90 - 94	45,216	8,778	45,184	8,764	426,270	79,894	0.194134	0.193964	0.187425
95 - 99	7,931	2,240	7,928	2,238	71,883	19,222	0.282452	0.282301	0.267407
100 - 104	342	140	342	140	3,170	1,372	0.409463	0.409463	0.432729
TOTAL	3,165,190	110,647	3,073,985	109,400	50,632,202	1,317,018			
Blue Collar	1,653,807	56,687	1,567,972	55,578	26,854,872	666,846			
White Collar	873,812	29,080	868,575	28,955	16,433,844	464,533			
Mixed Collar	61,395	1,646	61,377	1,636	794,103	12,933			
Unknown	576,175	23,234	576,061	23,231	6,549,383	172,706			
Quartile 1			795,615	37,294	2,785,029	139,370			
Quartile 2			781,402	39,357	8,931,061	439,667			
Quartile 3			762,881	23,590	14,453,515	435,062			
Quartile 4			734,086	9,159	24,462,597	302,918			

Table C-3

Summary of Final Female Healthy Retiree Dataset

	Number		Number with Amount		Annual Benefit Amount ($thousands)		Death Rates Based on		
Age Band	Exposed Life-Years	Deaths	Exposed Life-Years	Deaths	Exposed $-Years	$-Weighted Deaths	Number	Number with Amount	Amount
50 - 54	56,200	197	40,313	151	722,653	2,128	0.003505	0.003746	0.002945
55 - 59	162,680	729	131,499	592	2,068,825	8,121	0.004481	0.004502	0.003925
60 - 64	205,228	1,512	185,868	1,363	2,562,225	17,642	0.007367	0.007333	0.006885
65 - 69	246,600	2,689	233,812	2,532	2,286,255	24,297	0.010904	0.010829	0.010628
70 - 74	238,278	4,412	231,284	4,276	2,136,333	38,892	0.018516	0.018488	0.018205
75 - 79	231,104	7,203	228,346	7,126	1,993,604	60,799	0.031168	0.031207	0.030497
80 - 84	175,842	9,386	175,353	9,360	1,384,492	71,811	0.053377	0.053378	0.051868
85 - 89	99,549	9,411	99,495	9,404	675,572	62,741	0.094536	0.094517	0.092870
90 - 94	41,933	6,743	41,914	6,733	243,919	39,070	0.160806	0.160637	0.160177
95 - 99	12,732	3,110	12,727	3,108	76,647	18,645	0.244265	0.244202	0.243264
100 - 104	709	194	707	193	4,220	1,159	0.273452	0.272835	0.274513
TOTAL	1,470,855	45,586	1,381,319	44,838	14,154,745	345,305			
Blue Collar	825,312	26,038	738,081	25,348	7,727,530	202,255			
White Collar	462,133	13,080	459,862	13,022	5,431,046	122,723			
Mixed Collar	37,160	840	37,140	840	303,571	4,102			
Unknown	146,250	5,628	146,236	5,628	692,598	16,225			
Quartile 1			350,277	12,675	591,530	19,482			
Quartile 2			346,921	15,807	2,247,510	102,463			
Quartile 3			350,860	11,104	3,879,342	120,210			
Quartile 4			333,260	5,252	7,436,364	103,150			

Table C-4

Summary of Final Male Beneficiary Dataset

	Number		Number with Amount		Annual Benefit Amount ($thousands)		Death Rates Based on		
Age Band	Exposed Life-Years	Deaths	Exposed Life-Years	Deaths	Exposed $-Years	$-Weighted Deaths	Number	Number with Amount	Amount
50 - 54	2,610	52	2,390	31	12,945	223	0.019922	0.012973	0.017222
55 - 59	4,801	91	4,535	69	24,360	301	0.018953	0.015216	0.012372
60 - 64	6,676	186	6,487	178	36,603	956	0.027861	0.027438	0.026111
65 - 69	8,199	246	8,144	244	41,262	1,325	0.030004	0.029961	0.032121
70 - 74	9,165	323	9,129	323	44,868	1,537	0.035242	0.035380	0.034266
75 - 79	10,740	574	10,684	567	52,665	2,597	0.053445	0.053071	0.049320
80 - 84	9,694	740	9,649	733	46,509	3,555	0.076334	0.075967	0.076433
85 - 89	5,893	634	5,877	632	27,475	2,731	0.107577	0.107538	0.099385
90 - 94	2,214	318	2,207	317	9,730	1,346	0.143609	0.143660	0.138365
95 - 99	525	76	522	75	2,112	293	0.144857	0.143783	0.138893
100 - 104	31	5	31	5	104	10	0.160821	0.163252	0.095241
TOTAL	60,549	3,245	59,653	3,174	298,633	14,875			
Blue Collar	34,059	1,940	33,445	1,887	169,755	9,115			
White Collar	19,300	1,071	19,049	1,053	102,701	5,120			
Mixed Collar	2,253	42	2,231	42	10,532	79			
Unknown	4,937	192	4,928	192	15,644	561			
Quartile 1			15,593	744	18,414	851			
Quartile 2			15,170	820	49,557	2,716			
Quartile 3			14,897	1,035	81,184	5,724			
Quartile 4			13,993	575	149,478	5,583			

Table C-5

Summary of Final Female Beneficiary Dataset

	Number		Number with Amount		Annual Benefit Amount ($thousands)		Death Rates Based on		
Age Band	Exposed Life-Years	Deaths	Exposed Life-Years	Deaths	Exposed $-Years	$-Weighted Deaths	Number	Number with Amount	Amount
50 - 54	24,648	174	24,401	168	160,623	867	0.007059	0.006885	0.005397
55 - 59	51,500	410	51,109	376	368,031	2,281	0.007961	0.007357	0.006197
60 - 64	81,765	896	81,382	868	592,992	5,533	0.010958	0.010666	0.009330
65 - 69	110,696	1,732	110,571	1,727	787,570	11,621	0.015646	0.015619	0.014755
70 - 74	143,577	3,199	143,453	3,195	1,000,910	20,663	0.022281	0.022272	0.020645
75 - 79	183,072	6,320	182,901	6,303	1,242,746	39,142	0.034522	0.034461	0.031497
80 - 84	189,089	10,100	188,961	10,085	1,216,879	61,451	0.053414	0.053371	0.050499
85 - 89	129,148	11,575	129,076	11,559	772,982	66,215	0.089626	0.089552	0.085661
90 - 94	52,856	7,971	52,803	7,957	295,219	43,358	0.150805	0.150693	0.146868
95 - 99	11,862	2,776	11,843	2,770	61,602	14,154	0.234024	0.233884	0.229772
100 - 104	606	188	605	187	2,792	866	0.310376	0.309234	0.310155
TOTAL	978,819	45,341	977,104	45,195	6,502,346	266,151			
Blue Collar	578,570	28,338	577,639	28,274	3,616,476	158,152			
White Collar	279,082	12,430	278,504	12,350	2,340,203	91,411			
Mixed Collar	10,023	395	9,954	394	51,408	1,526			
Unknown	111,145	4,178	111,007	4,177	494,258	15,061			
Quartile 1			254,770	12,465	567,319	30,192			
Quartile 2			240,725	14,105	1,239,367	72,571			
Quartile 3			245,133	11,747	1,720,744	81,676			
Quartile 4			236,477	6,878	2,974,916	81,712			

Table C-6

Summary of Final Male Disabled Retiree Dataset

	Number		Number with Amount		Annual Benefit Amount ($thousands)		Death Rates Based on		
Age Band	Exposed Life-Years	Deaths	Exposed Life-Years	Deaths	Exposed $-Years	$-Weighted Deaths	Number	Number with Amount	Amount
45 - 49	11,270	226	9,803	194	91,368	1,968	0.020053	0.019790	0.021543
50 - 54	26,753	664	24,311	596	254,706	6,413	0.024820	0.024516	0.025177
55 - 59	42,228	1,138	39,389	1,068	453,218	11,635	0.026949	0.027114	0.025673
60 - 64	47,754	1,530	46,236	1,486	528,718	16,190	0.032039	0.032139	0.030622
65 - 69	39,137	1,685	39,000	1,676	388,063	15,509	0.043054	0.042975	0.039965
70 - 74	28,713	1,692	28,701	1,692	243,745	13,795	0.058928	0.058953	0.056597
75 - 79	21,907	1,797	21,903	1,797	174,365	13,531	0.082028	0.082044	0.077601
80 - 84	14,659	1,639	14,659	1,639	113,915	11,894	0.111811	0.111811	0.104411
85 - 89	6,647	1,057	6,647	1,057	49,384	7,675	0.159016	0.159016	0.155414
90 - 94	1,637	412	1,637	412	12,237	2,916	0.251606	0.251606	0.238305
95 - 99	205	58	205	58	1,576	425	0.283230	0.283230	0.269767
100 - 104	6	3	6	3	41	22	0.478766	0.478766	0.533255
TOTAL	240,917	11,901	232,495	11,678	2,311,336	101,974			
Blue Collar	144,816	7,040	141,422	6,919	1,396,626	62,045			
White Collar	28,564	1,547	24,596	1,464	362,122	19,608			
Mixed Collar	3,088	92	2,035	73	16,046	387			
Unknown	64,448	3,222	64,443	3,222	536,541	19,935			
Quartile 1			60,603	3,670	207,398	12,357			
Quartile 2			57,628	3,215	411,743	22,988			
Quartile 3			57,211	2,731	614,302	28,987			
Quartile 4			57,054	2,062	1,077,893	37,643			

Table C-7

Summary of Final Female Disabled Retiree Dataset

	Number		Number with Amount		Annual Benefit Amount ($thousands)		Death Rates Based on		
Age Band	Exposed Life-Years	Deaths	Exposed Life-Years	Deaths	Exposed $-Years	$-Weighted Deaths	Number	Number with Amount	Amount
45 - 49	9,454	110	6,157	72	57,533	598	0.011636	0.011694	0.010399
50 - 54	20,449	276	14,849	178	149,859	1,649	0.013497	0.011987	0.011003
55 - 59	25,779	431	20,206	325	195,840	3,056	0.016719	0.016084	0.015605
60 - 64	23,128	480	20,478	407	182,729	3,583	0.020754	0.019875	0.019610
65 - 69	16,809	442	16,572	425	126,796	3,173	0.026296	0.025646	0.025027
70 - 74	11,791	460	11,773	458	75,832	2,888	0.039011	0.038901	0.038090
75 - 79	8,348	485	8,337	485	48,487	2,830	0.058097	0.058174	0.058365
80 - 84	6,229	499	6,225	499	35,292	2,913	0.080105	0.080158	0.082535
85 - 89	3,946	522	3,943	519	23,469	3,048	0.132289	0.131629	0.129876
90 - 94	1,473	252	1,473	252	9,528	1,576	0.171042	0.171042	0.165408
95 - 99	350	100	350	100	2,337	681	0.285324	0.285324	0.291291
100 - 104	13	5	13	5	84	37	0.381262	0.381262	0.444416
TOTAL	127,769	4,062	110,378	3,725	907,787	26,033			
Blue Collar	93,633	2,999	84,033	2,811	738,944	20,808			
White Collar	17,619	545	10,653	414	100,435	3,431			
Mixed Collar	2,139	69	1,323	51	8,124	241			
Unknown	14,378	449	14,368	449	60,284	1,554			
Quartile 1			28,727	1,245	90,545	4,126			
Quartile 2			27,369	1,093	173,235	6,885			
Quartile 3			27,226	888	247,524	7,934			
Quartile 4			27,056	499	396,483	7,088			

Table C-8

Appendix D. Additional Annuity Comparisons

The following tables are in the same format as Table 12.2, but based on 2014 annuity values developed at interest rates of 0 percent, 4 percent, and 8 percent.

Interest rate = 0.0 percent:

		Monthly Deferred-to-62 Annuity Due Values; Generational @ 2014					**Percentage Change** of Moving to RP-2014 (with MP-2014) from:			
	Base Rates	UP-94	RP-2000	RP-2000	RP-2000	RP-2014	UP-94	RP-2000	RP-2000	RP-2000
	Proj. Scale	AA	AA	BB	MP-2014	MP-2014	AA	AA	BB	MP-2014
	Age									
Males	25	24.1101	24.0151	25.6070	26.1403	**26.3616**	*9.3%*	*9.8%*	*2.9%*	*0.8%*
	35	23.4524	23.3271	24.7181	25.3203	**25.5453**	*8.9%*	*9.5%*	*3.3%*	*0.9%*
	45	22.7925	22.7045	23.9194	24.5843	**24.7624**	*8.6%*	*9.1%*	*3.5%*	*0.7%*
	55	22.3153	22.2262	23.3319	24.0953	**24.2169**	*8.5%*	*9.0%*	*3.8%*	*0.5%*
	65	19.8369	19.6025	20.6171	21.5665	**21.6354**	*9.1%*	*10.4%*	*4.9%*	*0.3%*
	75	12.0767	11.6333	12.4554	13.3079	**13.6055**	*12.7%*	*17.0%*	*9.2%*	*2.2%*
	85	6.3948	5.8958	6.4251	6.9321	**7.2250**	*13.0%*	*22.5%*	*12.4%*	*4.2%*
Females	25	25.4466	24.6984	27.8604	29.1471	**28.9955**	*13.9%*	*17.4%*	*4.1%*	*-0.5%*
	35	25.0597	24.2615	27.0324	28.2846	**28.1799**	*12.5%*	*16.2%*	*4.2%*	*-0.4%*
	45	24.7292	23.8978	26.2755	27.4918	**27.4011**	*10.8%*	*14.7%*	*4.3%*	*-0.3%*
	55	24.5560	23.7370	25.7238	26.9773	**26.8015**	*9.1%*	*12.9%*	*4.2%*	*-0.7%*
	65	22.1717	21.3985	22.8712	24.0931	**23.8069**	*7.4%*	*11.3%*	*4.1%*	*-1.2%*
	75	14.1053	13.5570	14.5275	15.4743	**15.3061**	*8.5%*	*12.9%*	*5.4%*	*-1.1%*
	85	7.6059	7.4367	8.0639	8.7413	**8.4324**	*10.9%*	*13.4%*	*4.6%*	*-3.5%*

Table D-1

Interest rate = 4.0 percent:

		Monthly Deferred-to-62 Annuity Due Values; Generational @ 2014					**Percentage Change** of Moving to RP-2014 (with MP-2014) from:			
	Base Rates	UP-94	RP-2000	RP-2000	RP-2000	RP-2014	UP-94	RP-2000	RP-2000	RP-2000
	Proj. Scale	AA	AA	BB	MP-2014	MP-2014	AA	AA	BB	MP-2014
	Age									
Males	25	3.4455	3.4586	3.5323	3.5823	**3.5997**	*4.5%*	*4.1%*	*1.9%*	*0.5%*
	35	5.0036	5.0151	5.1150	5.2004	**5.2271**	*4.5%*	*4.2%*	*2.2%*	*0.5%*
	45	7.2642	7.2908	7.4326	7.5687	**7.5946**	*4.5%*	*4.2%*	*2.2%*	*0.3%*
	55	10.6314	10.6670	10.8975	11.1216	**11.1352**	*4.7%*	*4.4%*	*2.2%*	*0.1%*
	65	13.0681	13.0186	13.3903	13.7992	**13.7797**	*5.4%*	*5.8%*	*2.9%*	*-0.1%*
	75	9.0982	8.8553	9.3028	9.7851	**9.9409**	*9.3%*	*12.3%*	*6.9%*	*1.6%*
	85	5.3857	5.0175	5.4051	5.7527	**5.9641**	*10.7%*	*18.9%*	*10.3%*	*3.7%*
Females	25	3.5645	3.4850	3.7340	3.8251	**3.8419**	*7.8%*	*10.2%*	*2.9%*	*0.4%*
	35	5.2236	5.0970	5.4250	5.5627	**5.5909**	*7.0%*	*9.7%*	*3.1%*	*0.5%*
	45	7.6719	7.4766	7.9013	8.1052	**8.1425**	*6.1%*	*8.9%*	*3.1%*	*0.5%*
	55	11.3406	11.0614	11.5990	11.9265	**11.9323**	*5.2%*	*7.9%*	*2.9%*	*0.0%*
	65	14.1065	13.7355	14.3017	14.7677	**14.6860**	*4.1%*	*6.9%*	*2.7%*	*-0.6%*
	75	10.2822	9.9286	10.4265	10.8908	**10.8611**	*5.6%*	*9.4%*	*4.2%*	*-0.3%*
	85	6.2560	6.1003	6.5286	6.9484	**6.7929**	*8.6%*	*11.4%*	*4.0%*	*-2.2%*

Table D-2

Interest rate = 8.0 percent:

		Monthly Deferred-to-62 Annuity Due Values; Generational @ 2014					**Percentage Change** of Moving to RP-2014 (with MP-2014) from:			
	Base Rates	UP-94	RP-2000	RP-2000	RP-2000	RP-2014	UP-94	RP-2000	RP-2000	RP-2000
	Proj. Scale	AA	AA	BB	MP-2014	MP-2014	AA	AA	BB	MP-2014
	Age									
Males	25	0.5865	0.5910	0.5898	0.5976	**0.5995**	*2.2%*	*1.4%*	*1.6%*	*0.3%*
	35	1.2495	1.2571	1.2561	1.2742	**1.2787**	*2.3%*	*1.7%*	*1.8%*	*0.4%*
	45	2.6624	2.6817	2.6862	2.7246	**2.7297**	*2.5%*	*1.8%*	*1.6%*	*0.2%*
	55	5.7213	5.7603	5.8002	5.8829	**5.8813**	*2.8%*	*2.1%*	*1.4%*	*0.0%*
	65	9.4508	9.4554	9.6028	9.8074	**9.7714**	*3.4%*	*3.3%*	*1.8%*	*-0.4%*
	75	7.2112	7.0691	7.3281	7.6262	**7.7127**	*7.0%*	*9.1%*	*5.2%*	*1.1%*
	85	4.6461	4.3658	4.6596	4.9090	**5.0667**	*9.1%*	*16.1%*	*8.7%*	*3.2%*
Females	25	0.6004	0.5904	0.6145	0.6240	**0.6289**	*4.8%*	*6.5%*	*2.3%*	*0.8%*
	35	1.2875	1.2641	1.3112	1.3326	**1.3434**	*4.3%*	*6.3%*	*2.5%*	*0.8%*
	45	2.7677	2.7148	2.8061	2.8519	**2.8729**	*3.8%*	*5.8%*	*2.4%*	*0.7%*
	55	5.9888	5.8815	6.0553	6.1651	**6.1832**	*3.2%*	*5.1%*	*2.1%*	*0.3%*
	65	9.9738	9.7805	10.0306	10.2451	**10.2104**	*2.4%*	*4.4%*	*1.8%*	*-0.3%*
	75	7.9534	7.7168	7.9938	8.2487	**8.2562**	*3.8%*	*7.0%*	*3.3%*	*0.1%*
	85	5.2959	5.1617	5.4676	5.7444	**5.6622**	*6.9%*	*9.7%*	*3.6%*	*-1.4%*

Table D-3

Appendix E. Study Data Request Material

E.1 Cover Letter

New Pension Plan Mortality Study—Requirements Document

Under the Pension Protection Act of 2006, the Secretary of Treasury is required to consider revisions to prescribed mortality tables at least every 10 years. Currently, the prescribed table is based on the RP-2000 table, which was constructed using data from 1990-94. While the current IRS-prescribed table includes projections on the RP-2000 table, leadership within the pension actuarial community believes that it is prudent to start work now on a new mortality table so that it will be available at the point that the next Treasury review is required and is available as soon as possible for general practice use regardless of U.S. Treasury mandates. In addition, a key portion of this project is to evaluate and likely develop new projection scales for mortality improvement projections.

The Retirement Plans Experience Committee (RPEC) of the Society of Actuaries is undertaking a new mortality study of pension plan experience that will form the basis for a new table and projection scale. This request and study have the support of the SOA's Pension Section Council, Pension Research Committee and the American Academy of Actuaries' Pension Practice Council.

Our hope is to conduct this study in a more expedited timeframe. Some of the key milestone dates are as follows:

- Data submission due: 12/21/09
- Data validation completed: 4/30/10
- Initial report drafted: 9/15/10
- Final report released: 11/15/10

Your firm is being asked to submit data for this study. We hope that you will be able to do so. Our goal is to collect data that allows us to develop a table (or tables) that covers not just the private employer-based pension system, but has application for public sector and other systems as well.

Ideally, the data will be provided in one file. However, if you will be providing a file for each year, please include member I.D.s so that we can track individual members from file to file.

For those contributors who have access to more than one plan, please provide data for as many plans as possible. If a firm is not able to supply data on all their business, we ask that they submit a representative sample, taking into account large plans vs. small plans, hourly vs. salaried, plan design characteristics such as final average vs. flat benefits and other characteristics.

We are requesting data on the five calendar years 2004-08. If your firm is not able to provide data for this full period, please let us know what period is feasible. We are also hoping that some firms can provide data at a higher level for a more extended period, such as 20 years, that can be used to examine mortality improvement trends. Please let us know if you are able to provide data of this type.

The data will be kept confidential at the plan and the contributor level. Only the data compiler and SOA staff will have access to this information. There will be a confidentiality agreement with the data compiler in this regard.

Korrel Rosenberg at the Society office will be following up to this request regarding your firm's participation and is the best person to serve as the ongoing contact. If you wish, you may contact Korrel at krosenberg@soa.org or 847-706-3567. Questions regarding this effort and this material can be directed to Korrel. As necessary, they will be addressed by me and the rest of RPEC.

E.2. Participant Information Summary

Data Elements for 2009 Mortality Study
Participant Information

Item	Required (R) or Optional (O)	Comments
Plan ID	R	
Member ID	R	
Sex	R	
Date of Birth	R	
Date of Hire	R*	Required for active employees and optional for other statuses.
Date of Retirement	R*	
Date of Exit (other than death, i.e. non-vested termination, cash out)	R*	
Date of Death	R*	
Status (active employee, terminated employee, disability in pay, disability not in pay, retiree, beneficiary, deceased)	R	
Salary (for active employees)	O	Optional, but highly desirable
Total Monthly Pension in Pay (for individuals in pay status)	R	
Beneficiary Birth Date	R**	Required if beneficiary is receiving pension
Beneficiary Benefit Start Date	R**	Required if beneficiary is receiving pension
Form of Benefit (e.g., life only, life with a guarantee period, joint and survivor)	O	
Workforce Characteristics (salaried, hourly, union)	O	Optional, but highly desirable; Can indicate workforce characteristics for a group in cover submission
Eligible for Retiree Health Benefits?	O	

* Leave blank if not applicable.
** If the beneficiary information is kept in a separate record, the beneficiary birth date and benefit start date would appear in the date of birth and date of retirement fields.

E.3. Plan Information Summary

Data Elements for 2009 Mortality Study	
Plan Information	
Item	**Comments**
Plan ID:	
Industry Type	
- SIC Code:	
Country	
- U.S. ☐	
- Canada ☐	
Definition of Disability	
- Social Security / CPP / QPP ☐	
- Own Occupation - lifetime ☐	
- Own Occupation - limited period ☐	
- Any Occupation - lifetime ☐	
- Any Occupation - limited period ☐	
- No Disability Provision in Plan ☐	
- Other (please explain): ☐	
Disability Classification	
- Are disabled retirees reclassified as retirees at age 65?	
Plan Type	
- Single Employer ☐	
- Multi-Employer ☐	
- Multiple-Employer ☐	
- Public Sector ☐	
- Other (please explain): ☐	
Plan Size	
- Number of Actives:	
- Number of Retirees:	
- Number of Other Inactives (e.g., deferred vested members):	
Plan Design	
- Final Average Pay ☐	
- Career Average Pay ☐	
- Percent of Contributions ☐	
- Flat Benefit ☐	
- Cash Balance ☐	
- Other (please explain): ☐	
Participation in Social Security	
- Yes, whole group ☐	
- No, whole group ☐	
- Some ☐	
- Which subgroups? (please list):	
Normal Retirement Eligibility Definition	
(e.g., full payment starting at age 65):	
Early Retirement Eligibility Definition	
(e.g., earliest date eligible to retire & earliest date eligible for unreduced pension):	
Phased Retirement	
- Yes ☐	
- No ☐	

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