THE RP-2000 MORTALITY TABLES

The RP-2000 Mortality Tables

Executive Summary

The Retirement Protection Act of 1994 (RPA) established mortality assumptions to be used when calculating Current Liabilities for pension plans. This was the first time that standard tables had been mandated for this purpose. The Secretary of the Treasury has the authority to promulgate a new table in the year 2000. The Society of Actuaries (SoA) conducted this study of uninsured pension plan mortality in response to RPA and to ensure that the Treasury Department would have current and thorough information available when it considers updating the mandatory mortality table. The SoA charged the Retirement Plans Experience Committee (RPEC) with the responsibility for conducting this study.

The purpose of this report is to provide actuaries with all of the significant findings of the RPEC along with full explanation of when and how these should be used in reviewing or setting mortality rates for specific plans. The report does not recommend specific tables to the Secretary of Treasury to adopt in conformance to RPA. The SoA believes it is appropriately the role of the American Academy of Actuaries to recommend tables to the Secretary based on this mortality study and other pertinent information.

This report presents the RP-2000 Tables, new graduated basic amount-adjusted mortality tables projected to the year 2000, and explains how the tables were developed. Scale AA is recommended for projecting the proposed mortality rates beyond the year 2000. The report compares experience by type of employment, amount of annuity, and industry. Actuaries should keep in mind that these tables were developed from experience on mortality for uninsured pension plans and are only recommended for use for those types of plans.

The final database used for this study reflects nearly 11 million life-years of exposure and more than 190,000 deaths, all from uninsured pension plans subject to RPA Current Liability rules. More than 100 pension plans submitted data in response to the request from the RPEC for experience from plan years 1990 through 1994. The RPEC determined that this volume of data was sufficient to produce valid mortality tables.

The contributors were asked to provide data defined by several characteristics including Standard Industrial Classification (SIC) and amount. The contributors indicated whether the plan covered hourly or salaried workers, and whether the plan was collectively bargained or not. Based on this information, plans were categorized as blue collar, white collar, or mixed collar. The data contributors summarized their mortality experience into cells by age, gender, and status (employees, retirees, disableds, and beneficiaries).

For each cell, the RPEC asked the submitter to provide the number of participants on the valuation date, the amounts of annual pay or annuities, the number of deaths during the year following the valuation date, and the amounts associated with those deaths. While all data contributors included the number of participants and the number of deaths, many did not provide information on amounts. About 60 percent of the exposed employee lives and 40 percent of the exposed annuitant lives included

information about amounts. The RPEC used data from plans providing amounts to adjust the lives-based mortality for the entire database to an amount-adjusted basis.

The RPEC generated separate tables by gender for employees, healthy annuitants, and disabled retirees. The RPEC agreed that there was sufficient data for credible tables for these groups and that the mortality among the groups differed sufficiently to justify use of separate tables. Where unisex tables are desirable, the RPEC recommends that the actuary should construct blended tables based on the proportion of each gender in the plan population.

The healthy annuitant table combines experience of healthy retirees and beneficiaries. A combined employee and healthy annuitant table was also produced as a more direct comparison to earlier tables and for actuaries to use if a combined table is needed. The RPEC encourages use of the separate employee and healthy annuitant tables.

Using the RP-2000 mortality table for healthy annuitants may overstate plan liabilities if used to value benefits for both healthy and disabled annuitants. However, the RP-2000 mortality table for disabled retirees may not be appropriate for valuing benefits of disabled annuitants in all cases. This table is based on the experience of all disabled annuitants whether or not they were eligible to receive Social Security disability benefits. Actuaries should use professional judgment when applying this table if the plan's definition of disability is particularly strict or liberal.

The central year of the data for these tables was estimated as 1992 and the tables were projected to the base year 2000. Three sources of data were reviewed to study recent trends in mortality. These were Social Security, Federal Civil Service, and the data collected for this study. The RPEC developed mortality improvement factors to project from 1992 to 2000 based on analysis of these sources. To study long-term trends in mortality the RPEC examined data from four sources: Social Security, Federal Civil Service, the Railroad Retirement Board, and the SoA group annuity mortality studies. The RPEC decided to recommend the use of Scale AA for projecting mortality rates beyond the year 2000. Scale AA was developed for use with the Group Annuity Reserving 1994 table. The RPEC recommends projection of mortality rates and encourages the use of generational mortality projection. In cases where it is not material or cost effective to incorporate generational mortality projection, the actuary should project mortality improvement on a comparable static basis.

Statistical analysis of the data showed that collar type and amount are both significant predictors of mortality for this data set. For example, for male annuitants age 65 to 69 the small amount mortality was 77 percent greater than the large amount mortality and blue collar mortality was 43 percent greater than white collar mortality. By comparison, male annuitant mortality was 31 percent greater than female mortality at age 67. Collar type is defined as blue or white depending on the characteristics of the group. Amount is defined as low, medium, or high based on the individual's annuity. SIC was not found to be a consistently significant predictor of mortality.

The RPEC found that both collar and amount can bear a relationship to the underlying mortality characteristics of a retirement plan. The RPEC recommends that the individual characteristics and experience of a retirement plan be considered in selecting the mortality table. In certain cases either collar or amount may be appropriate factors to consider, subject to the theoretical concerns outlined in Chapter 5. While either factor was found to be a statistically significant indicator of differences in mortality, the RPEC recognizes that for the majority of plans subject to RPA legislation, adjustment of the standard mortality tables in a manner consistent with the data collection method and results of this study will be considerably more practical if the collar factor is used.

An analysis of the variability of mortality experience among plans in the same industry showed that differences were statistically significant in most cases tested. Actual deaths by plan ranged from about 20 percent below industry average to 30 percent above industry average. Significant differences were found even after adjusting for collar type and annuity size group.

Annuity values based on the RP-2000 Tables were calculated and compared to annuity values based on the GAM-83 and UP-94 tables. In general, the RP-2000 values are between two and nine percent higher for males and between three and five percent lower for females than the GAM-83 values. The RP-2000 values for males under age 80 are within two percent of the values based on the UP-94 table projected to 2000. For males at ages 80 and 90 the RP-2000 values are substantially lower than the projected UP-94 values. For females the RP-2000 values are lower than the projected UP-94 values by about two to four percent.

Chapter 1 - Background and Collection of Data

Reason for New Study

The Retirement Plans Experience Committee (RPEC) initiated the study in 1995 at the request of the Committee on Retirement Systems Research of the Society of Actuaries (SoA). This study is in response to provisions of the Retirement Protection Act of 1994 (RPA) which was passed as part of the General Agreement on Tariffs and Trade (GATT). The GATT legislation [PL 103-465] was signed by President Clinton on December 8, 1994.

The RPA changed the Current Liability provisions of the minimum funding standards in several ways. The change relevant to this study concerns the mortality assumptions used to calculate a plan's Current Liability [IRC section 412(l)(7)(C)(ii)]. Through 1999, such plans must use the 1983 Group Annuity Mortality (GAM-83) tables for healthy lives as specified in Internal Revenue Service (IRS) Revenue Ruling 95-28 and disabled lives as specified in Revenue Ruling 96-7. The latter Revenue Ruling provides for separate gender-distinct mortality tables for annuitants who became disabled after 1994 and who are receiving Social Security disability benefits. The ruling also provides for separate gender-distinct mortality tables for annuitants who became disabled before 1995, regardless of their eligibility for Social Security disability benefits. The Secretary of the Treasury may, but is not required to, promulgate a new table in 2000. Thereafter, the Secretary will be able to change the mortality standard every five years. IRS Announcement 2000-7 (January 21, 2000) states that the IRS and the Treasury Department "anticipate that in no event would there be any change in the mortality tables for plan years beginning before January 1, 2001."

The Group Annuity Reserving 1994 (GAR-94) and Uninsured Pensioner 1994 (UP-94) tables had recently been published when GATT was passed. However, the SoA believed that there was sufficient interest in the RPA provisions to call for a new study of pension plan mortality. Since sufficient data were submitted to produce a set of new mortality tables, the RPEC asked the SoA for authorization to produce a set of mortality tables based on the experience submitted. The SoA approved the request.

Role of the RPEC

Initially the RPEC had two goals for its work on the new mortality data. The first was the traditional role of performing a complete mortality study for actuaries to use in determining the best mortality rates for an individual plan. The second was to recommend a table or set of tables for the Secretary of Treasury to adopt in conformance with GATT legislation.

It soon became clear that these two goals could not both be met in one study. The RPEC could not produce a single report that both (1) presents the full range of tables and modifications that should be considered by actuaries in selecting the most appropriate mortality rate for a pension plan, and (2) presents a more narrow set of tables to be recommended to the Secretary of the Treasury for adoption in conformance with RPA.

We discussed this issue with officials of the Society of Actuaries and agreed that our report should focus on the traditional role of providing full information with appropriate caveats on the source and potential use of the mortality tables. This report is not a recommendation to the Secretary of the Treasury for tables to adopt in conformance with RPA. The SoA believes it is appropriately the role of the American Academy of Actuaries to recommend tables to the Secretary based on this mortality study and other pertinent information.

RPEC Process

All of the RPEC meetings have been open. Representatives of the four government agencies with a potential interest in the work were kept informed of the meetings throughout and often attended the meetings. The four agencies are the Office of Tax Policy of the Treasury Department, the Internal Revenue Service (IRS), the Pension Benefit Guaranty Corporation (PBGC), and the Pension and Welfare Benefits Administration (PWBA) of the Department of Labor. Other interested parties, including representatives of the American Academy of Actuaries and other committees of the SoA have attended meetings. The minutes of all of the meetings have been published in the Pension Section News.

RPEC Membership

The members of the RPEC are Vincent Amoroso, Kevin Binder, John Kalnberg, Lindsay Malkiewich, Julie Pope, Barthus Prien, Gregory Schlappich, and Diane Storm. The Chair is Edwin Hustead and the Vice-Chair is Michael Virga. Four of the members had participated in the committees that had developed the UP-94 and GAR-94 mortality tables.

Call for Data

The RPEC developed a set of data submission instructions, along with an explanatory cover letter requesting the data (see Appendix A). These were sent to all members of the Pension Section of the Society of Actuaries on September 29, 1995. A letter from representatives of four large industrial companies to many of their colleagues encouraged participation in the study.

The original deadline for submissions of December 31, 1995 was extended twice to allow for the submission of major sets of data that were being prepared. Eventually data collection was closed on June 1, 1996.

Data Requested

For each plan, actuaries were asked to provide a plan number assigned by the submitter, the plan sponsor's Standard Industrial Classification (SIC) code, and the type of participants (salaried, hourly, union, non-union, or a combination). If the participants were not all of one type, the submitter was asked to estimate the percentage of each type in the plan. Submitters were also asked to provide a

brief summary of eligibility and benefit formulas, the disability provisions, and any other information that would be helpful in interpreting the data.

Actuaries were asked to submit data celled according to the following characteristics:

- Valuation date
- Age nearest valuation date
- Gender
- Participant status - employee, non-disabled retiree, disabled retiree, or beneficiary
- Annuity size for retirees and beneficiaries - small (annuity of less than $6,000 a year), medium ($6,000 to $14,400 a year) or large (more than $14,400 a year)

For each cell, the submitter was asked to provide the following information:

- The number of participants on the valuation date
- Total annual pay for employees
- Total annual benefit for retirees and beneficiaries
- Number and annual pay for deaths among employees during the year following the valuation date
- Number and annual benefit for deaths among retirees and beneficiaries during the year following the valuation date

The preferred period of measurement was plan years ending in 1990 through 1994.

Data Collection Process

To ensure confidentiality, submissions were first received by Tom Edwalds, FSA, of the Society of Actuaries. The SoA staff checked that each submission contained both a computer diskette and hard copy of the data, along with a description of pertinent plan benefits. The three automobile industry submitters were concerned about confidentiality and asked for special processing of their data. The automobile industry submitted data split up into many small files in order to mask the identity of the contributor. The SoA staff verified that all of the small files used identical formats, that the hard copies all had the same appearance, and that the sum of the exposures and deaths by gender, collar, and status for the files submitted by each company matched the control totals provided. The small files were then copied onto four diskettes in such a way that each diskette contained some of the files submitted by each manufacturer. The hard copies of the data were placed into binders in the same order as the small files were organized on the diskettes. The list of plan numbers used by each manufacturer has been kept strictly confidential by SoA staff.

The data were then forwarded to the research team contracted to code, review, and summarize the data. The research team consisted of Kathleen S. Elder, FSA, and Laxman Hegde, Ph.D., at Frostburg State University. Ms. Elder is an Associate Professor of Actuarial Science with over 14 years experience in the pension field. Dr. Hegde is a statistician with extensive consulting experience in statistical analysis and expertise in major statistical software.

Development of Data Base

Elder consolidated the type categories into blue or white collar. The type was set as blue collar if more than 70 percent of the participants were hourly or union. The type was set as white collar if more than 70 percent of the participants were salaried and non-union. If the type could not be determined from the available information, Elder called the submitting actuary to determine if one of the two types could be assigned. If the type still could not be determined, it was set as mixed collar.

Annuity size was coded as small, medium, or large based on the designation by the submitter using the definition provided by the RPEC. Other data were coded as unknown amount. Submitters were asked to use the straight-life equivalents of annuities, if possible. Only one plan submitted data that were specifically converted to the straight-life equivalent and most of the other submitters stated that the conversion was not made. The RPEC decided that combining all amounts as reported would not significantly distort the analysis.

In order to maintain the confidentiality of the data, Elder then stripped the plan identifiers from the database prepared for the RPEC. Every cell accessible to the RPEC contained data from at least two plans, so the RPEC had no way of analyzing data by plan or of identifying or reconstructing the experience of any plan.

Industry code was the initial two digits of the SIC code. Since there was only one plan in SIC 35xx (machinery except electrical) it was merged with the plans in industry code 36 (electrical and electronic machinery) to preserve confidentiality. After this combination and the exclusion of plans in two other codes for the reasons discussed in Chapter 2, there remained 35 industry codes in the data set.

Thirty-eight percent of the submissions, including 58 percent of the exposure years, were for all plan years from 1990 through 1994. The rest covered a mix of years with some plans providing fewer than five years and others using a period that extended up to a year before or after the 1990 through 1994 plan years. The RPEC deemed a midpoint of 1992 to be appropriate for the combined data.

A summary of plan provisions, including eligibility for early retirement and disability benefits, was submitted for almost all of the plans. This information was used to check for data inconsistencies such as retirees who were too young to retire under the plan provisions.

Chapter 2 - Validation of Data and Final Data Set

The members of the RPEC and the research team reviewed all data for reasonableness. Elder discussed questions concerning potential errors with the submitters. Questions about the automobile industry data were relayed through Edwalds.

Reasonableness checks were applied to the data received for each pension plan, including:

- aging of participant population by category from year to year
- significant increase/decrease in participant count by category from year to year
- unusual ages (e.g. "old" employees or "young" retirees)
- proportions of population in various groups (e.g. male/female, active/retiree)
- increases in salary from year to year

After the initial review, the number of deaths in each of the individual pension plans was compared to the expected number of deaths based on the total experience of the entire group by category as defined by participant gender, collar, and status. Submitters of pension plans with data outside a 95 percent confidence interval were contacted to determine if a correction should be made. Some of the data sets were accepted as valid based on explanations by the submitters. Other data sets were corrected by the submitters. This procedure was used for all data contributions, including the auto manufacturers data. The reasonableness checks on the automobile data were performed by Edwalds because of the confidentiality agreement. All questioned data were corrected to the satisfaction of the RPEC.

One of the auto manufacturers was among those who decided to resubmit corrected data. In order to maintain the confidentiality of all of the automobile contributors, Edwalds stripped the valuation date from the corrected submission and the submissions of the other firms from the automobile industry and combined them before forwarding the corrected data to the researchers. The RPEC voted to accept the auto manufacturers' data, as corrected, into the final data set. Results were later compared with and without the auto manufacturers' data. The RPEC found that the raw quinquennial death rates were quite similar both ways. Appendix B shows the effect of the auto manufacturers data.

Some data were submitted with ages based on attained age rather than nearest age on respective valuation dates. These data were adjusted to an age nearest birthday basis by assigning one-half of the exposures and deaths to the age shown and one-half of exposures and deaths to the next age.

Exclusions

The primary reason for excluding data was incomplete information. Data submissions that combined all inactive statuses (healthy retirees, beneficiaries, and/or disability retirees) or combined active employees

with one or more inactive statuses were excluded. Data submitted in 5-year groups rather than single ages were also excluded. Data with unknown participant status were excluded.

One plan was excluded because the measurement period for the deaths did not match the measurement period for the corresponding valuation cells of exposure. In other words, deaths reported by that plan included persons who were not in the exposure at the beginning of the year or who were included in the exposure at the end of the year of death.

Records of retirees under age 28 and active employees under age 16 were excluded from the database.

In addition, the RPEC excluded data of pension plans that are not directly affected by the RPA Current Liability rules so that the resulting mortality experience would be more appropriate for purposes of the Act. This resulted in the exclusion of data submitted for two large multiemployer pension plans in the transportation industry (industry code 42) and a large government pension plan (industry code 99). Table 2-1 summarizes the exposures excluded from the study by reason for exclusion.

Table 2-1
Exposures Excluded from RP-2000 Base Tables

	Exposures (000s)	Percent
Multi-employer	1,381	9.5%
Government	866	5.9%
Statuses not differentiated	1,213	8.3%
Exposure mismatch	184	1.3%
Quinquennial ages	9	0.1%
Ages out of range	1	0.0%
Total excluded	3,655	25.0%
Total included	10,957	75.0%
Total submitted	14,612	100.0%

Appendix C compares the mortality of the multi-employer data that was excluded from the final data base. Since the total multi-employer data were only from two plans, the comparison is presented as information only and should not be used to establish multi-employer mortality tables.

Resulting Data Set

The data set accepted by the RPEC as the basis for the mortality tables in this report included 10,957,103 exposed life-years and 190,928 deaths. Table 2-2 shows the distribution of these exposures by industry and gender.

Table 2-2
Distribution of Exposures by Industry

SIC	Industry Name	Males Exposures (000s)	Males Percent	Females Exposures (000s)	Females Percent	Total Exposures (000s)	Total Percent
37	Transportation	3,119	42%	1,142	33%	4,261	39%
36	Electronic Equipment	1,310	18%	516	15%	1,825	17%
48	Communications	552	7%	528	15%	1,080	10%
29	Petroleum	377	5%	101	3%	477	4%
33	Primary Metal Industries	373	5%	92	3%	465	4%
28	Chemicals	266	4%	148	4%	414	4%
26	Paper	120	2%	71	2%	192	2%
13	Oil and Gas Extraction	110	1%	43	1%	153	1%
	All Other	1,216	16%	873	25%	2,089	19%
	Total	7,443	100%	3,514	100%	10,957	100%

Table 2-2 shows that the Transportation industry data were 39 percent of the total and a substantial portion of the data in Transportation came from the auto industry. None of the auto industry data included the amount of salary or annuity. The RPEC reviewed the results with and without the auto industry to determine if the experience would have been substantially different without the auto industry. Results of that review are shown in Appendix B.

Tables 2-3 through 2-10 summarize the data for male and female exposures for employees, healthy retirees, beneficiaries, and disabled lives. Table 2-11 aggregates all data. Amounts were reported for 50 percent of the exposures. About 60 percent of the exposed employee life-years and 38 percent of the exposed annuitant life-years included information about amounts.

Tables 2-3 through 2-10 compare raw death rates computed by dividing deaths by exposures within age groups for three categories. The first is the death rates based on number from the entire data base. The second is the death rates based on number only for data for which amount was reported. The third is the death rates based on amount.

The comparison of the two death rates determined by number shows that, in general, there was not a substantial difference between the death rates for the entire data base and the data base limited to those with amount reported.

Table 2-3

Male Employee Basic Data									
	Number		Number with Amount		Annual Pay Amount		Death Rates Based on		
	Exposed	Deaths	Exposed	Deaths	Exposed	Deaths	Number	Number with Amount	Amount
Under 20	4,277	1	1,818	-	14,944,430	-	0.0002	0.0000	0.0000
20 – 24	88,048	47	43,736	19	993,849,115	387,384	0.0005	0.0004	0.0004
25 –29	289,561	120	163,605	77	5,432,400,241	2,322,299	0.0004	0.0005	0.0004
30 – 34	470,759	305	293,815	192	12,381,451,767	6,957,045	0.0006	0.0007	0.0006
35 – 39	618,165	656	369,827	407	17,380,265,328	15,810,951	0.0011	0.0011	0.0009
40 – 44	683,785	951	386,614	529	19,015,234,526	23,428,812	0.0014	0.0014	0.0012
45 – 49	685,397	1,396	382,283	756	20,965,721,062	36,256,149	0.0020	0.0020	0.0017
50 – 54	542,545	1,675	292,405	816	17,290,300,385	41,822,975	0.0031	0.0028	0.0024
55 – 59	317,072	1,402	155,446	667	8,952,868,958	32,159,560	0.0044	0.0043	0.0036
60 – 64	142,549	1,027	59,438	445	3,255,013,808	19,797,094	0.0072	0.0075	0.0061
65 – 69	24,788	266	8,563	85	473,454,515	4,409,926	0.0107	0.0099	0.0093
70 – 74	4,225	49	1,607	19	79,851,106	1,031,978	0.0116	0.0118	0.0129
75 – 79	694	9	352	5	19,849,571	330,069	0.0130	0.0142	0.0166
80 – 84	206	5	114	5	5,838,553	145,134	0.0243	0.0439	0.0249
85 – 89	79	2	49	2	2,019,298	70,545	0.0253	0.0408	0.0349
90 – 94	95	-	9	-	225,378	-	0.0000	0.0000	0.0000
95 & Over	-	-	-	-	-	-	0.0000	0.0000	0.0000
Total	3,872,245	7,911	2,159,681	4,024	106,263,288,041	184,929,921			
Blue Collar	1,587,710	4,178	613,458	1,482	23,759,818,389	50,406,611			
White Collar	1,853,701	3,063	1,469,965	2,407	79,398,379,015	129,855,193			
Mixed Collar	430,834	670	76,258	135	3,105,090,637	4,668,117			

Table 2-4

Female Employee Basic Data									
	Number		Number with Amount		Annual Pay Amount		Death Rates Based on		
	Exposed	Deaths	Exposed	Deaths	Exposed	Deaths	Number	Number with Amount	Amount
Under 20	5,538	-	2,776	-	21,462,175	-	0.0000	0.0000	0.0000
20 – 24	90,411	9	57,403	7	1,146,112,727	111,447	0.0001	0.0001	0.0001
25 –29	230,182	45	155,858	33	4,352,463,785	766,918	0.0002	0.0002	0.0002
30 – 34	310,377	126	220,944	95	7,409,980,625	2,716,448	0.0004	0.0004	0.0004
35 – 39	329,607	198	236,324	149	8,465,073,137	5,190,039	0.0006	0.0006	0.0006
40 – 44	330,240	289	241,862	219	8,885,989,499	7,472,737	0.0009	0.0009	0.0008
45 – 49	251,168	355	178,383	263	6,673,208,286	9,271,146	0.0014	0.0015	0.0014
50 – 54	165,253	338	111,499	227	3,932,203,561	7,814,004	0.0020	0.0020	0.0020
55 – 59	94,103	270	59,157	173	1,853,462,893	5,130,346	0.0029	0.0029	0.0028
60 – 64	44,312	199	24,757	103	710,337,381	2,879,525	0.0045	0.0042	0.0041
65 – 69	9,236	67	4,629	31	124,074,071	885,120	0.0072	0.0067	0.0071
70 – 74	1,659	13	808	10	17,371,121	269,434	0.0078	0.0124	0.0155
75 – 79	202	2	103	-	2,163,687	-	0.0099	0.0000	0.0000
80 – 84	31	-	8	-	176,301	-	0.0000	0.0000	0.0000
85 – 89	6	-	1	-	4,435	-	0.0000	0.0000	0.0000
90 – 94	32	-	1	-	49,500	-	0.0000	0.0000	0.0000
95 & Over	1	-	-	-	-	-	0.0000	0.0000	0.0000
Total	1,862,358	1,911	1,294,513	1,310	43,594,133,184	42,507,164			
Blue Collar	628,438	833	388,681	519	10,775,671,329	13,922,012			
White Collar	926,708	807	790,419	705	29,608,349,947	26,500,749			
Mixed Collar	307,212	271	115,413	86	3,210,111,908	2,084,403			

Table 2-5

Male Retiree Basic Data									
	Number		Number with Amount		Annual Benefit Amount		Death Rates Based on		
	Exposed	Deaths	Exposed	Deaths	Exposed	Deaths	Number	Number with Amount	Amount
Under 30	5	-	1	-	41,214	-	0.0000	0.0000	0.0000
30 – 34	20	-	9	-	47,267	-	0.0000	0.0000	0.0000
35 – 39	167	2	130	1	609,115	6,552	0.0120	0.0077	0.0108
40 – 44	943	1	820	1	5,895,868	4,335	0.0011	0.0012	0.0007
45 - 49	9,653	50	5,985	29	67,364,496	282,338	0.0052	0.0048	0.0042
50 – 54	101,653	733	49,615	256	729,561,227	3,240,821	0.0072	0.0052	0.0044
55 – 59	338,490	2,907	170,479	1,338	2,578,197,404	16,841,831	0.0086	0.0078	0.0065
60 – 64	664,145	8,851	301,914	3,846	4,423,948,064	46,604,539	0.0133	0.0127	0.0105
65 – 69	748,065	15,848	275,003	5,901	3,061,302,858	55,096,691	0.0212	0.0215	0.0180
70 – 74	622,721	21,081	227,937	7,679	2,102,244,099	60,072,120	0.0339	0.0337	0.0286
75 – 79	417,054	23,482	154,544	8,580	1,157,464,896	57,410,697	0.0563	0.0555	0.0496
80 – 84	223,977	20,357	83,475	7,410	524,030,844	43,701,271	0.0909	0.0888	0.0834
85 – 89	94,523	13,264	34,425	4,581	196,434,686	25,499,914	0.1403	0.1331	0.1298
90 – 94	28,170	5,927	9,663	1,898	50,114,753	9,875,600	0.2104	0.1964	0.1971
95 – 99	5,347	1,520	1,859	475	9,227,046	2,320,837	0.2843	0.2555	0.2515
100 – 104	556	190	194	58	946,358	265,080	0.3417	0.2990	0.2801
105 – 109	50	7	21	1	53,688	565	0.1400	0.0476	0.0105
110 & Over	4	-	-	-	-	-	0.0000	0.0000	0.0000
Total	3,255,543	114,220	1,316,074	42,054	14,907,483,883	321,223,191			
Blue Collar	1,410,896	58,806	523,282	22,967	3,814,613,520	133,297,044			
White Collar	1,065,205	28,589	593,811	13,934	8,215,734,823	129,783,604			
Mixed Collar	779,442	26,825	198,981	5,153	2,877,135,540	58,142,543			

Table 2-6

Female Retiree Basic Data									
	Number		Number with Amount		Annual Benefit Amount		Death Rates Based on		
	Exposed	Deaths	Exposed	Deaths	Exposed	Deaths	Number	Number with Amount	Amount
Under 30	10	-	1	-	1,390	-	0.0000	0.0000	0.0000
30 – 34	35	-	9	-	37,428	-	0.0000	0.0000	0.0000
35 – 39	77	1	37	1	127,550	1,050	0.0130	0.0270	0.0082
40 – 44	263	2	173	1	1,056,493	2,398	0.0076	0.0058	0.0023
45 - 49	2,985	7	2,460	7	30,822,081	106,110	0.0023	0.0028	0.0034
50 – 54	23,816	70	16,619	54	207,335,096	614,218	0.0029	0.0032	0.0030
55 – 59	80,434	357	50,308	236	511,810,725	2,198,610	0.0044	0.0047	0.0043
60 – 64	165,898	1,312	81,799	651	739,923,617	5,716,503	0.0079	0.0080	0.0077
65 – 69	189,458	2,386	68,201	819	469,788,435	5,207,778	0.0126	0.0120	0.0111
70 – 74	167,995	3,447	52,357	1,107	298,630,042	5,685,301	0.0205	0.0211	0.0190
75 – 79	116,048	3,932	32,526	1,135	143,371,546	4,767,086	0.0339	0.0349	0.0332
80 – 84	70,361	3,959	20,779	1,190	81,625,350	4,572,232	0.0563	0.0573	0.0560
85 – 89	34,215	3,217	10,283	944	38,612,321	3,506,795	0.0940	0.0918	0.0908
90 – 94	11,078	1,745	3,101	479	11,885,158	1,735,395	0.1575	0.1545	0.1460
95 – 99	2,269	444	448	85	1,680,208	310,536	0.1957	0.1897	0.1848
100 – 104	159	39	31	4	132,494	18,923	0.2453	0.1290	0.1428
105 – 109	9	3	3	1	5,232	2,289	0.3333	0.3333	0.4375
110 & Over	7	-	1	-	1,796	-	0.0000	0.0000	0.0000
Total	865,117	20,921	339,136	6,714	2,536,846,962	34,445,224			
Blue Collar	266,590	7,205	113,929	2,738	711,319,008	12,737,913			
White Collar	324,791	7,975	72,071	1,260	546,338,533	7,098,717			
Mixed Collar	273,736	5,741	153,136	2,716	1,279,189,421	14,608,594			

Table 2-7

Male Beneficiary Basic Data									
	Number		Number with Amount		Annual Benefit Amount		Death Rates Based on		
	Exposed	Deaths	Exposed	Deaths	Exposed	Deaths	Number	Number with Amount	Amount
Under 20	13	-	4	-	17,588	-	0.0000	0.0000	0.0000
20 – 24	29	1	7	-	23,294	-	0.0345	0.0000	0.0000
25 – 29	38	1	23	-	51,754	-	0.0263	0.0000	0.0000
30 – 34	84	4	25	-	64,159	-	0.0476	0.0000	0.0000
35 – 39	156	6	73	2	206,446	4,124	0.0385	0.0274	0.0200
40 – 44	306	3	167	1	500,048	3,459	0.0098	0.0060	0.0069
45 – 49	517	11	305	7	891,343	27,065	0.0213	0.0230	0.0304
50 – 54	850	15	485	7	1,884,893	13,548	0.0176	0.0144	0.0072
55 – 59	1,465	31	772	18	2,478,958	37,456	0.0212	0.0233	0.0151
60 – 64	2,623	53	1,332	33	4,617,797	91,719	0.0202	0.0248	0.0199
65 – 69	4,508	144	2,157	68	7,214,567	217,818	0.0319	0.0315	0.0302
70 – 74	4,835	231	2,371	90	7,150,610	247,767	0.0478	0.0380	0.0346
75 – 79	3,893	270	1,861	97	5,501,201	322,994	0.0694	0.0521	0.0587
80 – 84	2,392	205	1,203	88	3,354,323	205,359	0.0857	0.0732	0.0612
85 – 89	942	108	570	51	1,818,461	176,601	0.1146	0.0895	0.0971
90 – 94	347	48	252	30	724,997	75,884	0.1383	0.1190	0.1047
95 – 99	28	7	17	5	40,190	10,284	0.2500	0.2941	0.2559
100 – 104	1	-	-	-	-	-	0.0000	0.0000	0.0000
105 – 109	5	-	4	-	10,608	-	0.0000	0.0000	0.0000
110 & Over	2	-	-	-	-	-	0.0000	0.0000	0.0000
Total	23,034	1,138	11,628	497	36,551,237	1,434,078			
Blue Collar	11,924	539	4,949	154	11,954,402	367,096			
White Collar	8,386	395	4,929	217	21,019,200	833,814			
Mixed Collar	2,724	204	1,750	126	3,577,635	233,168			

Table 2-8

Female Beneficiary Basic Data									
	Number		Number with Amount		Annual Benefit Amount		Death Rates Based on		
	Exposed	Deaths	Exposed	Deaths	Exposed	Deaths	Number	Number with Amount	Amount
Under 20	17	-	2	-	2,996	-	0.0000	0.0000	0.0000
20 – 24	52	1	29	1	59,900	2,427	0.0192	0.0345	0.0405
25 – 29	121	2	65	-	190,119	-	0.0165	0.0000	0.0000
30 – 34	515	9	188	3	494,807	4,000	0.0175	0.0160	0.0081
35 – 39	1,677	5	615	1	1,834,354	710	0.0030	0.0016	0.0004
40 – 44	3,923	19	1,483	8	4,350,227	22,489	0.0048	0.0054	0.0052
45 – 49	8,566	30	2,856	11	9,072,133	20,353	0.0035	0.0039	0.0022
50 – 54	19,218	87	7,199	42	25,105,440	116,199	0.0045	0.0058	0.0046
55 – 59	37,947	285	14,246	138	53,115,671	461,591	0.0075	0.0097	0.0087
60 – 64	72,629	880	27,410	329	94,017,128	957,367	0.0121	0.0120	0.0102
65 – 69	118,110	2,138	43,206	760	131,641,568	2,044,862	0.0181	0.0176	0.0155
70 – 74	149,516	3,918	53,526	1,391	140,397,319	3,444,932	0.0262	0.0260	0.0245
75 – 79	141,176	5,398	46,355	1,628	103,269,138	3,490,732	0.0382	0.0351	0.0338
80 – 84	93,254	5,597	28,425	1,579	58,171,801	3,019,378	0.0600	0.0555	0.0519
85 – 89	44,665	4,316	12,568	1,084	24,356,125	2,055,072	0.0966	0.0863	0.0844
90 – 94	14,800	2,243	3,929	509	7,359,854	996,421	0.1516	0.1295	0.1354
95 – 99	2,685	593	782	137	1,518,716	242,734	0.2209	0.1752	0.1598
100 – 104	260	72	87	24	168,091	30,104	0.2769	0.2759	0.1791
105 – 109	34	6	11	1	11,695	36	0.1765	0.0909	0.0031
110 & Over	10	1	1	-	274	-	0.1000	0.0000	0.0000
Total	709,175	25,600	242,983	7,646	655,137,356	16,909,407			
Blue Collar	435,866	16,245	108,870	3,241	199,855,451	5,437,415			
White Collar	199,065	6,382	78,256	2,072	287,509,858	6,094,324			
Mixed Collar	74,244	2,973	55,857	2,333	167,772,047	5,377,668			

Table 2-9

Male Disabled Annuitant Basic Data									
	Number		Number with Amount		Annual Benefit Amount		Death Rates Based on		
	Exposed	Deaths	Exposed	Deaths	Exposed	Deaths	Number	Number with Amount	Amount
Under 30	5	-	5	-	55,193	-	0.0000	0.0000	0.0000
30 – 35	130	4	15	-	22,583	-	0.0308	0.0000	0.0000
35 – 39	2,331	29	158	3	772,908	22,635	0.0124	0.0190	0.0293
40 – 44	8,323	139	937	25	5,854,688	151,671	0.0167	0.0267	0.0259
45 – 49	17,411	410	2,515	86	18,464,071	637,947	0.0235	0.0342	0.0346
50 – 54	26,683	783	4,569	136	34,936,344	1,235,866	0.0293	0.0298	0.0354
55 – 59	36,001	1,325	7,782	283	61,729,312	2,326,766	0.0368	0.0364	0.0377
60 – 64	51,231	2,280	12,064	509	89,975,061	3,919,260	0.0445	0.0422	0.0436
65 – 69	57,983	3,191	14,429	782	97,038,223	5,041,302	0.0550	0.0542	0.0520
70 – 74	48,139	3,439	12,872	911	79,031,912	5,403,689	0.0714	0.0708	0.0684
75 – 79	28,661	2,742	7,952	759	45,206,389	3,957,455	0.0957	0.0954	0.0875
80 – 84	11,371	1,521	3,300	445	17,280,919	2,212,304	0.1338	0.1348	0.1280
85 – 89	3,016	523	955	173	4,856,706	743,491	0.1734	0.1812	0.1531
90 - 94	754	154	206	57	1,031,359	272,007	0.2042	0.2767	0.2637
95 – 99	133	42	50	19	211,615	85,546	0.3158	0.3800	0.4043
100 & Over	10	2	1	-	6,382	-	0.2000	0.0000	0.0000
Total	292,182	16,584	67,810	4,188	456,473,665	26,009,939			
Blue Collar	213,502	12,006	40,967	2,527	228,086,285	12,721,277			
White Collar	46,605	2,517	11,441	687	97,952,954	5,402,883			
Mixed Collar	32,075	2,061	15,402	974	130,434,426	7,885,779			

Table 2-10

Female Disabled Annuitant Basic Data									
	Number		Number with Amount		Annual Benefit Amount		Death Rates Based on		
	Exposed	Deaths	Exposed	Deaths	Exposed	Deaths	Number	Number with Amount	Amount
Under 30	2	-	1	-	1,963	-	0.0000	0.0000	0.0000
30 – 35	50	-	7	-	26,738	-	0.0000	0.0000	0.0000
35 – 39	984	3	125	3	663,811	12,178	0.0030	0.0240	0.0183
40 – 44	3,015	17	749	8	5,176,023	69,737	0.0056	0.0107	0.0135
45 – 49	5,358	49	1,494	24	10,660,044	172,103	0.0091	0.0161	0.0161
50 – 54	7,202	72	1,687	29	11,876,837	203,351	0.0100	0.0172	0.0171
55 – 59	8,723	173	2,414	62	15,335,219	469,523	0.0198	0.0257	0.0306
60 – 64	11,347	268	3,592	92	19,931,258	526,673	0.0236	0.0256	0.0264
65 – 69	12,842	362	4,507	133	20,861,206	668,552	0.0282	0.0295	0.0320
70 – 74	12,192	510	3,499	150	14,247,788	649,833	0.0418	0.0429	0.0456
75 – 79	8,206	501	1,918	129	6,768,822	416,487	0.0611	0.0673	0.0615
80 – 84	4,728	368	1,737	128	6,271,731	473,722	0.0778	0.0737	0.0755
85 – 89	2,235	219	1,110	108	4,075,631	394,454	0.0980	0.0973	0.0968
90 - 94	525	96	289	57	1,081,881	211,705	0.1829	0.1972	0.1957
95 – 99	49	13	22	6	82,362	21,837	0.2653	0.2727	0.2651
100 & Over	5	1	3	-	12,552	-	0.2000	0.0000	0.0000
Total	77,463	2,652	23,154	929	117,073,866	4,290,155			
Blue Collar	53,656	1,792	8,120	369	34,410,784	1,482,027			
White Collar	11,866	470	4,790	215	28,229,344	1,067,199			
Mixed Collar	11,941	390	10,244	345	54,433,738	1,740,929			

Table 2-11

Summary of Basic Data								
	Number		Number with Amount		Annual Benefit Amount		Percent with Amounts	
	Exposed	Deaths	Exposed	Deaths	Exposed	Deaths	Exposed	Deaths
Employees								
Male	3,872,245	7,911	2,159,681	4,024	106,263,288,041	184,929,921	55.77%	50.87%
Female	1,862,358	1,911	1,294,513	1,310	43,594,133,184	42,507,164	69.51%	68.55%
Total	5,734,603	9,822	3,454,194	5,334	149,857,421,225	227,437,085	60.23%	54.31%
Healthy Retirees								
Male	3,255,543	114,220	1,316,074	42,054	14,907,483,883	321,223,191	40.43%	36.82%
Female	865,117	20,921	339,136	6,714	2,536,846,962	34,445,224	39.20%	32.09%
Total	4,120,660	135,141	1,655,210	48,768	17,444,330,845	355,668,415	40.17%	36.09%
Beneficiaries								
Male	23,034	1,138	11,628	497	36,551,237	1,434,078	50.48%	43.67%
Female	709,175	25,600	242,983	7,646	655,137,356	16,909,407	34.26%	29.87%
Total	732,209	26,738	254,611	8,143	691,688,593	18,343,485	34.77%	30.45%
Disabled Retirees								
Male	292,182	16,584	67,810	4,188	456,473,665	26,009,939	23.21%	25.25%
Female	77,463	2,652	23,154	929	117,073,866	4,290,155	29.89%	35.03%
Total	369,645	19,236	90,964	5,117	573,547,531	30,300,094	24.61%	26.60%
Total Annuitants	5,222,514	181,115	2,000,785	62,028	18,709,566,969	404,311,994	38.31%	34.25%

Chapter 3 - Construction of Basic Table

Selection and Production of Basic Tables

The primary tables produced by the RPEC are the following gender distinct tables:

Employees
Healthy Annuitants (healthy retirees and beneficiaries combined)
Disabled Retirees

The RPEC elected to publish separate tables for healthy annuitants and employees because the data for ages with substantial experience from both data sets indicated that mortality is significantly lower for employees than for healthy annuitants. The RPEC found that there was a significant difference between the mortality for female beneficiaries and healthy female retirees. However, the RPEC decided that there was not enough data on male beneficiaries to determine male beneficiary mortality rates. While separate tables could have been produced for female retirees and beneficiaries, the RPEC believes that the practicing actuary need not use distinct tables for these groups.

For the purpose of calculating Current Liabilities, RR 96-7 mandates the use of the same mortality table for healthy annuitants and disabled annuitants when Social Security disability status is unknown and the disabilities occurred after 1994. This precludes the use of separate mortality tables for disabled annuitants in that case. The data contributors for this study did not provide information on the subgroup of disabled retirees who were also receiving Social Security benefits. Therefore, the RP-2000 mortality table for disabled annuitants presented in this report is not appropriate to predict the mortality of either of the post-1994 disabled subgroups specified in RR 96-7 but it may be appropriate for mortality of those disabled before 1995. However, using the RP-2000 mortality table for healthy annuitants may overstate plan liabilities if used to value benefits for both healthy and disabled annuitants.

The tables were produced through the following steps, described in this chapter:

- The raw q_xs were determined based on lives
- Amount-adjusted q_xs were determined by applying amount adjustment factors
- Healthy retiree and beneficiary rates were blended to produce healthy annuitant rates
- The amount-adjusted q_xs were graduated

- Tables were extended to extreme ages

Selection of Graduation Methods

Selection of an appropriate graduation method is critical to the production of an actuarial mortality table. In this case, as for previous published tables, the final rates were graduated to produce a set of rates that change continuously to reflect underlying mortality patterns. Graduation was also used to determine the amount-adjusted q_xs.

The selection of a graduation method involves a compromise between smoothness and fit. The task of the RPEC was to use methods that produced reasonably smooth tables but did not mask major underlying characteristics of mortality. For instance, the use of a Gompertz or Makeham formula creates very smooth rates but masks the deceleration of mortality increases at the very old ages.

The two methods used by the actuarial profession in the United States have been Whittaker-Henderson Type B and Karup-King. Whittaker-Henderson Type B is more precise for large bodies of data. Since the data set was very large, the RPEC decided to use the Whittaker-Henderson Type B graduation method for all graduation purposes. The key parameters for this method are the number of differences, and the **h** value. In particular, higher values of **h** result in greater smoothness. [London, Dick. 1985. Graduation: The Revision of Estimates]

Figures 3-1 and 3-2 show the raw amount adjustment factors (ratios of average amount for deaths to average amount exposed) and two different graduations of the raw rates. This highlights the differences between using the "regular" graduation that is often used for final smoothing and "heavy" graduation. The heavy graduation (achieved with fewer differences and higher **h** values) produces very smooth results but masks some of the key underlying trends. In the graph, the regular graduation uses third differences and an **h** value of 1,000,000. The heavy graduation uses second differences and an **h** value of 100,000,000.

The RPEC reviewed graduation tables within all of the reasonable ranges of **h** values and differences to select the graduation method most appropriate to each purpose and each set of data. Rates for healthy annuitants needed little graduation so the lightest variables were selected. At the other extreme, since graduation for amount-adjustment purposes was only to establish a smooth range of relative factors, a much heavier graduation was used.

The RPEC used the following criteria in selection of Whittaker-Henderson variables for the final graduation process:

- There should be no or a minimum number of occurrences of $q_x < 0$
- There should be no or a minimum number of occurrences of $q_x > 1$
- There should be no or a minimum number of occurrences of $q_x > q_{x+1}$
- Variation between the smoothed q_xs and the ungraduated q_xs should be minimized

Figure 3-1
Female Retiree Raw and Graduated Amount Adjustment Factors

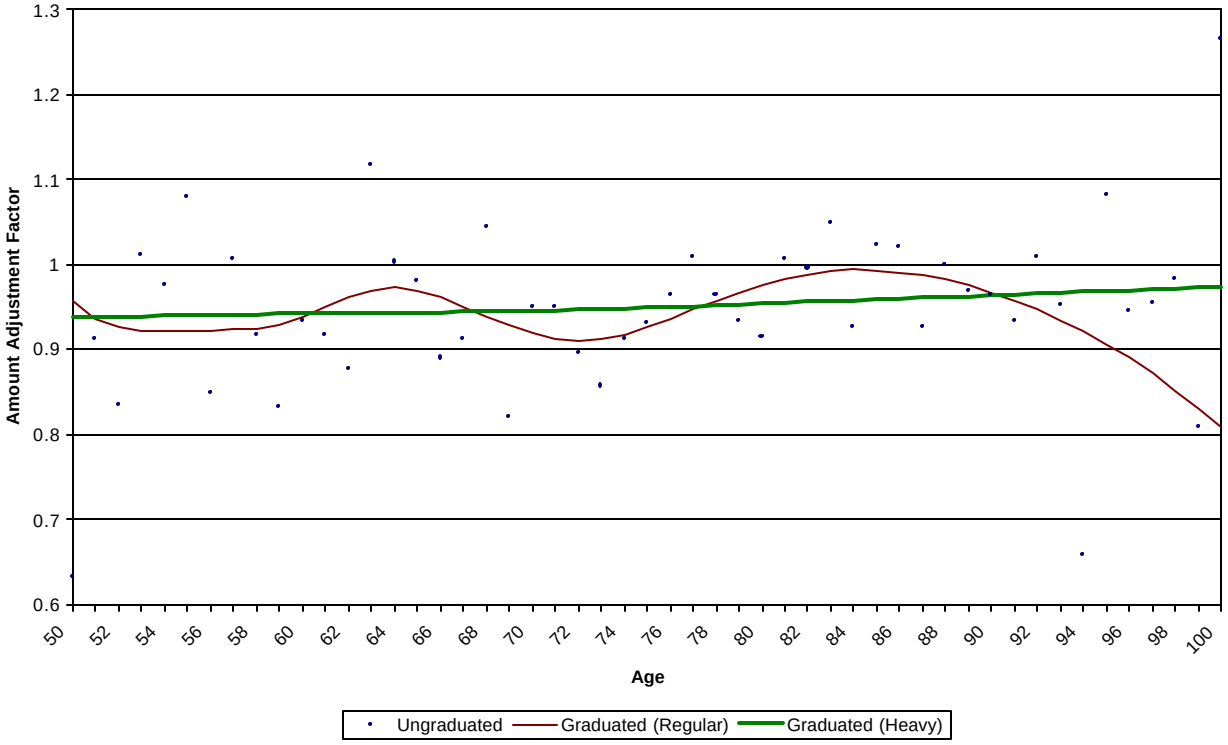
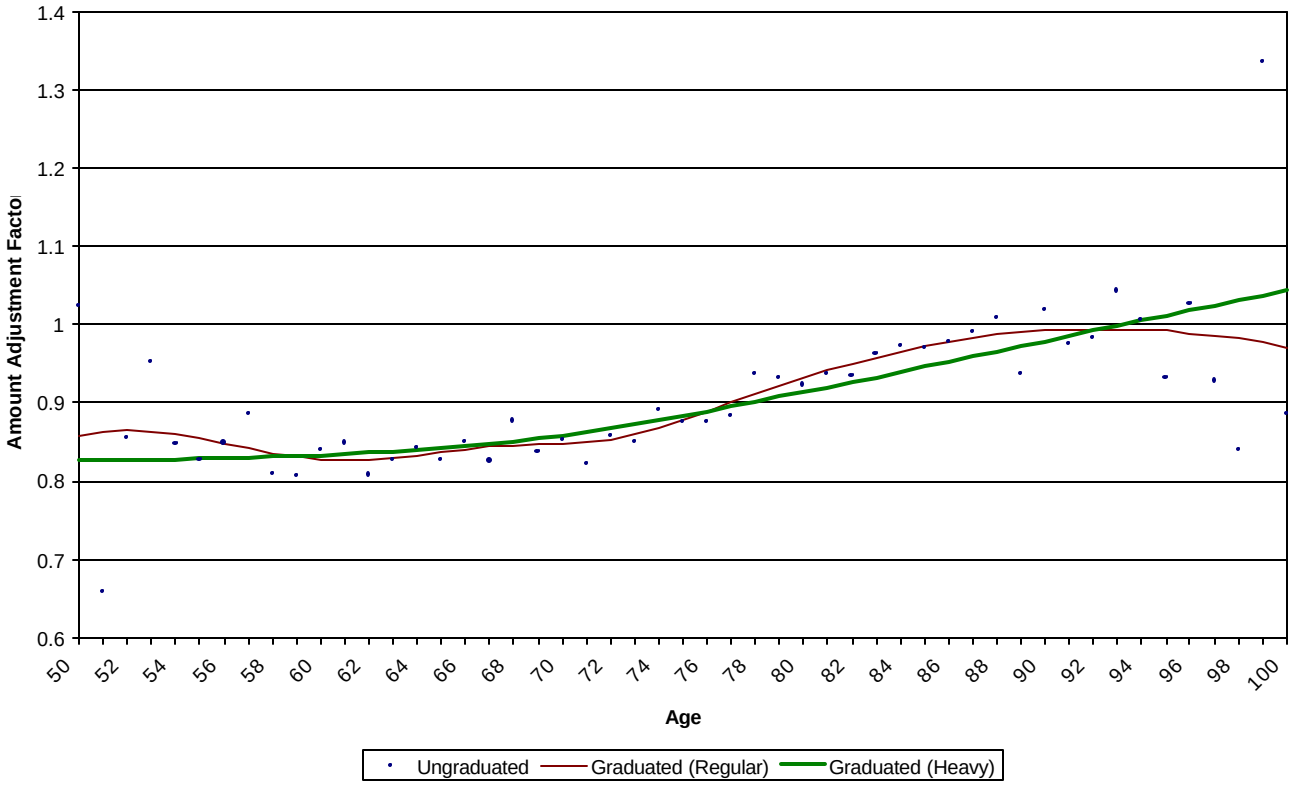


Figure 3-2
Male Retiree Raw and Graduated Amount Adjustment Factors



Determination of Raw q_xs for Lives

For each age the number of deaths was divided by the number of life-years exposed to produce the raw q_x value. Separate tables were produced by gender and status.

Amount-adjusted q_xs

As with mortality tables for life insurance, the GAM-83, GAR-94, and UP-94 mortality tables were developed using amounts rather than lives, i.e. they were determined by dividing total annuity amounts for those who died by total annuity amounts for all exposed by age. This approach is equivalent to liability weighting. Liability-weighted mortality has been the general practice in developing mortality tables for the measurement of actuarial liabilities. Life insurance tables, for instance, are developed based on face amount of insurance as the base rather than number of individuals. The reason for using liability-weighted measures can be seen through an example.

Assume that a plan covers two groups of 1,000 annuitants age 65. The members of the first group all have a monthly annuity of $100 and the members of the second group all have a monthly annuity of $1,000. If the true present value of an annuity of $1 per year is 10.0 for members of the first group and 12.0 for members of the second group (resulting from lower mortality) then the total liability for the plan will be $156 million. A table that was not adjusted for differences in amount would produce an average present value factor of 11.0, which would result in an estimated liability of $145 million, thereby understating plan liabilities by $11 million or 7 percent. A liability-weighted present value factor of 11.81 applied to the entire group would produce the correct liability of $156 million.

Since the data for previous mortality studies were gathered predominately from group annuity data supplied by insurance companies, amount data were readily available. The data for the current study presented a new problem. A substantial portion of the submitters supplied only the number of lives exposed and the number of deaths and did not supply information on amounts.

As with previous studies, the current data set shows significantly higher mortality based on number of lives than based on amount of benefits for retirees or amount of salary for employees. Liabilities for pension plans are automatically weighted by amounts. Therefore, the RPEC decided to determine the mortality rates based on amounts.

The amount of salary was included for 60 percent of the employees but only 54 percent of employee deaths. The amount of benefit was included for 38 percent of the annuitants but only 34 percent of annuitant deaths. In total, information about amounts was included for 50 percent of participants and 35 percent of deaths.

For the submissions that provided information on amounts, the RPEC determined:

a) Amount-based q_xs, which are the total annuity amounts for deaths divided by total annuity amounts exposed, and
b) Life-based q_xs, which are numbers of deaths divided by numbers of life-years exposed.

The RPEC assumed that the relationship between (a) and (b) for the subset of submissions that supplied information on amounts was representative of the entire data set (including submissions that did not provide information on amounts). After a thorough review of the data, the RPEC believed this assumption to be practical and plausible. Accordingly the RPEC adjusted the data for submissions which did not provide information on amounts.

The quotient of (a) divided by (b) is the "amount adjustment factor." The amount adjustment factor represents the difference of analyzing pension mortality data based on amounts versus analyzing only the number of deaths and exposures. Amount adjustment factors by age were determined separately for employees, healthy retirees, survivors, and disabled lives. For the submissions that only supplied the number of deaths and exposures, mortality rates were multiplied by the amount adjustment factors.

Since there was considerable variation in amount adjustment factors from one age to the next, the RPEC decided to first graduate these factors separately before applying them to the q_x values for lives. The amount adjustment factors were graduated using the Whittaker-Henderson method with second differences and an **h** value of 100,000,000.

The ungraduated mortality rates based on number of lives were then multiplied by the graduated amount adjustment factors to produce ungraduated amount-adjusted mortality rates.

Blending of Healthy Retiree and Beneficiary Data

The graduated amount adjustment factors and ungraduated amount-adjusted mortality rates were determined separately for healthy retirees and beneficiaries. The RPEC decided to combine the healthy retiree and beneficiary rates into one "healthy annuitant" table. There were not sufficient data for a separate male beneficiary table but there were sufficient data for a separate female beneficiary table. However, the RPEC believed that a separate female beneficiary table would have added unnecessary complexity to valuations without substantially increasing validity. Appendix D shows the ratios of the graduated mortality rates for beneficiaries and retirees to the graduated mortality rates for retirees and beneficiaries combined.

The ungraduated amount-adjusted mortality rates for healthy retirees and beneficiaries combined were then determined as a weighted average of the corresponding amount-adjusted mortality rates.

The weights for healthy retirees and beneficiaries, respectively, at each age were the product of the total number of lives exposed at that age times the average amount exposed for those plans that did provide data on amounts.

An example of how this blended rate is determined is given in Appendix E.

Graduation of Amount-adjusted q_xs

The resulting amount-adjusted mortality rates for employees, healthy annuitants, and disabled annuitants were graduated using Whittaker-Henderson with third differences and **h** values of 1,000,000 for healthy annuitants and 10,000,000 for employees and disabled lives.

Mortality rates for disabled annuitants were set equal to the mortality rates for healthy annuitants at and after the point at which the graduated rates for disabled annuitants dropped below those for healthy annuitants. This occurred at age 89 for males and 91 for females.

Extension to Extreme Ages

The above process produced mortality rates between the following ages:

Employee ages 30 through 70
Healthy annuitant ages 50 through 100
Disabled retiree ages 45 through 100

Mortality rates for employees were extended below age 30 to blend with the UP-94 table. Rates for ages 1 through 10 were set equal to the UP-94 table. Rates for ages 11 through 29 were interpolated from the UP-94 rate at age 10 to the current study rates at age 30 using cubic interpolation formulas that were designed to reproduce the general shape of the 1990 U.S. Life table at these ages.

The RPEC did not find any reliable data for mortality rates over age 100. However, they agreed with the developers of the GAR-94 and UP-94 tables that the mortality curve decelerates at the older ages resulting in a limiting mortality rate below 1.00.

The rate of increase in the q_xs diminishes after age 90 but the q_xs are still increasing in the late 90s. The RPEC decided that there should be an upper limit to the mortality rate that would be the same for males and females and that would form a reasonable extrapolation of the rate of increase after age 95. A limiting q_x of 0.4 fit these criteria. A cubic polynomial was selected for each gender such that the polynomial reproduced the value of q_x at age 99 and 100 and attained the limiting value of .4 at an age where the slope was 0, with no inflection points between age 100 and that age. This resulted in rates that hit the 0.4 limit at age 106 for males and 115 for females.

Since there was no discernible pattern of mortality rates for disabled retirees below age 45, these rates for disabled retirees from ages 21 to 44 were set equal to the rate at age 45. Other sets of data show that the mortality rates for young disabled retirees sometimes decline as age increases. However, this effect is usually related to the number of years after disability rather than age. As a result, the RPEC agreed that a table that used the same rate at all ages under 45 would be reasonable.

Table 3-1 shows the resulting mortality rates by age, gender, and status.

Table 3-1

1992 Base Year Rates

Age	Employees		Healthy Annuitants		Disabled Retirees	
	Males	Females	Males	Females	Males	Females
1	0.000637	0.000571				
2	0.000430	0.000372				
3	0.000357	0.000278				
4	0.000278	0.000208				
5	0.000255	0.000188				
6	0.000244	0.000176				
7	0.000234	0.000165				
8	0.000216	0.000147				
9	0.000209	0.000140				
10	0.000212	0.000141				
11	0.000219	0.000143				
12	0.000228	0.000148				
13	0.000240	0.000155				
14	0.000254	0.000162				
15	0.000269	0.000170				
16	0.000284	0.000177				
17	0.000301	0.000184				
18	0.000316	0.000188				
19	0.000331	0.000190				
20	0.000345	0.000191				
21	0.000357	0.000192			0.022571	0.007450
22	0.000366	0.000194			0.022571	0.007450
23	0.000373	0.000197			0.022571	0.007450
24	0.000376	0.000201			0.022571	0.007450
25	0.000376	0.000207			0.022571	0.007450
26	0.000378	0.000214			0.022571	0.007450
27	0.000382	0.000223			0.022571	0.007450
28	0.000393	0.000235			0.022571	0.007450
29	0.000412	0.000248			0.022571	0.007450
30	0.000444	0.000264			0.022571	0.007450
31	0.000499	0.000307			0.022571	0.007450
32	0.000562	0.000350			0.022571	0.007450
33	0.000631	0.000394			0.022571	0.007450
34	0.000702	0.000435			0.022571	0.007450
35	0.000773	0.000475			0.022571	0.007450
36	0.000841	0.000514			0.022571	0.007450
37	0.000904	0.000554			0.022571	0.007450
38	0.000964	0.000598			0.022571	0.007450
39	0.001021	0.000648			0.022571	0.007450
40	0.001079	0.000706			0.022571	0.007450
41	0.001142	0.000774			0.022571	0.007450
42	0.001215	0.000852			0.022571	0.007450
43	0.001299	0.000937			0.022571	0.007450
44	0.001397	0.001029			0.022571	0.007450
45	0.001508	0.001124			0.022571	0.007450
46	0.001629	0.001223			0.023847	0.008184
47	0.001762	0.001326			0.025124	0.008959
48	0.001905	0.001434			0.026404	0.009775

49	0.002060	0.001550			0.027687	0.010634
50	0.002225	0.001676	0.005566	0.002344	0.028975	0.011535

Table 3-1

1992 Base Year Rates						
Age	Employees		Healthy Annuitants		Disabled Retirees	
	Males	Females	Males	Females	Males	Females
51	0.002401	0.001814	0.005801	0.002459	0.030268	0.012477
52	0.002589	0.001967	0.005970	0.002647	0.031563	0.013456
53	0.002795	0.002135	0.006102	0.002895	0.032859	0.014465
54	0.003023	0.002321	0.006232	0.003190	0.034152	0.015497
55	0.003283	0.002526	0.006399	0.003531	0.035442	0.016544
56	0.003583	0.002756	0.006637	0.003925	0.036732	0.017598
57	0.003932	0.003010	0.006984	0.004385	0.038026	0.018654
58	0.004332	0.003291	0.007472	0.004921	0.039334	0.019710
59	0.004784	0.003599	0.008112	0.005531	0.040668	0.020768
60	0.005286	0.003931	0.008882	0.006200	0.042042	0.021839
61	0.005833	0.004285	0.009755	0.006919	0.043474	0.022936
62	0.006414	0.004656	0.010745	0.007689	0.044981	0.024080
63	0.007014	0.005039	0.011868	0.008509	0.046584	0.025293
64	0.007616	0.005429	0.013131	0.009395	0.048307	0.026600
65	0.008207	0.005821	0.014543	0.010364	0.050174	0.028026
66	0.008777	0.006207	0.016113	0.011413	0.052213	0.029594
67	0.009318	0.006583	0.017838	0.012540	0.054450	0.031325
68	0.009828	0.006945	0.019724	0.013771	0.056909	0.033234
69	0.010306	0.007289	0.021788	0.015153	0.059613	0.035335
70	0.010753	0.007613	0.024065	0.016742	0.062583	0.037635
71			0.026627	0.018579	0.065841	0.040140
72			0.029565	0.020665	0.069405	0.042851
73			0.032931	0.022970	0.073292	0.045769
74			0.036738	0.025458	0.077512	0.048895
75			0.041002	0.028106	0.082067	0.052230
76			0.045699	0.030966	0.086951	0.055777
77			0.050833	0.034105	0.092149	0.059545
78			0.056487	0.037595	0.097640	0.063545
79			0.062777	0.041506	0.103392	0.067793
80			0.069757	0.045879	0.109372	0.072312
81			0.077444	0.050780	0.115544	0.077135
82			0.085828	0.056294	0.121877	0.082298
83			0.094904	0.062506	0.128343	0.087838
84			0.104700	0.069517	0.134923	0.093794
85			0.115289	0.077446	0.141603	0.100203
86			0.126798	0.086376	0.148374	0.107099
87			0.139353	0.096337	0.155235	0.114512
88			0.153021	0.107303	0.162186	0.122464
89			0.167757	0.119154	0.169233	0.130972
90			0.183408	0.131682	0.183408	0.140049
91			0.199769	0.144604	0.199769	0.149698
92			0.216605	0.157618	0.216605	0.159924
93			0.233662	0.170433	0.233662	0.170433
94			0.250693	0.182799	0.250693	0.182799
95			0.267491	0.194509	0.267491	0.194509
96			0.283905	0.205379	0.283905	0.205379
97			0.299852	0.215240	0.299852	0.215240
98			0.315296	0.223947	0.315296	0.223947

99			0.330207	0.231387	0.330207	0.231387
100			0.344556	0.237467	0.344556	0.237467
101			0.358628	0.244834	0.358628	0.244834

Table 3-1

1992 Base Year Rates

Age	Employees		Healthy Annuitants		Disabled Retirees	
	Males	Females	Males	Females	Males	Females
102			0.371685	0.254498	0.371685	0.254498
103			0.383040	0.266044	0.383040	0.266044
104			0.392003	0.279055	0.392003	0.279055
105			0.397886	0.293116	0.397886	0.293116
106			0.400000	0.307811	0.400000	0.307811
107			0.400000	0.322725	0.400000	0.322725
108			0.400000	0.337441	0.400000	0.337441
109			0.400000	0.351544	0.400000	0.351544
110			0.400000	0.364617	0.400000	0.364617
111			0.400000	0.376246	0.400000	0.376246
112			0.400000	0.386015	0.400000	0.386015
113			0.400000	0.393507	0.400000	0.393507
114			0.400000	0.398308	0.400000	0.398308
115 and over			0.400000	0.400000	0.400000	0.400000

Chapter 4 - RP-2000 Tables

Projection to 2000

The rates of Table 3-1 were projected to 2000 based on a review of three sets of data. These were Social Security data, federal retiree data, and the study data.

The RPEC analyzed the data Social Security actuaries used to prepare Actuarial Study 110, "Social Security Area Population Projections 1996" from the Office of the Actuary of the Social Security Administration (SSA) [1]. Mortality rates by gender and five-year age groups through 1994 were available. The RPEC used the Social Security data covering 1990 to 1994 because that was the subset of rates that centered on 1992, the mid-year of the experience period, and ended with 1994, the latest year in the data set.

The Federal Office of Personnel Management (OPM) provided mortality experience for Federal Civil Service annuitants through 1996. These data have the advantages of spanning a long time period and containing a large number of exposures confined to pension plan participants only. The RPEC used the Federal Civil Service data covering 1988 to 1996 because that was the subset of rates that centered on 1992, the mid-year of the experience period, and ended with 1996, the latest year in the data set.

The RPEC analyzed the data collected for this study for trends in mortality rates for employees, beneficiaries, and healthy retirees separately, as well as all data combined, including only data for plans that submitted data for all five years. There were not sufficient consistent data to analyze trends for disabled retirees. The subset of study data that encompassed all years from 1990 through 1994 was approximately 8,000,000 exposures.

Even for very large data sets, such as Social Security data, clear mortality trends are difficult to observe from raw year-to-year data. To better observe the trends, the RPEC calculated least-squares regression lines through the logarithms of the raw mortality rates by year for each quinquennial age group for each gender for each data set. The best-fit log-linear mortality improvement trends were calculated using the slopes of these regression lines. For each regression line, the best-fit log-linear mortality improvement trend equals one minus the antilog of the slope.

Tables 4-1 and 4-2 compare the best-fit log-linear mortality improvement trends by data source. These tables compare recent mortality improvement from the data collected for this study on employees and healthy annuitants combined (1990-1994), from Social Security data (1990-1994), and from Federal Civil Service data (1988-1996). For illustrative purposes, these tables also include the comparable factors used to construct the GAR-94 table. As with the current study, the

[1] Death rates for ages under 65 were calculated using the number of deaths as tabulated in Vital Statistics of the United States and using the latest census estimates of the population. For ages 65 and over, records of the Medicare program were used to determine the rates by age and gender.

developers of the GAR-94 table determined that there was a difference between the short-term projection trends needed to bring the table to the date of publication and the longer-term trends needed to project the table beyond the date of publication.

Table 4-1

Annualized Recent Mortality Improvement Trends				
Male				
Age	Study Data 1990-1994	Social Security 1990-1994	Federal Civil Service 1988-1996	GAM 88-94
20-24		0.31%		1.70%
25-29	-1.07%	0.99%		-0.10%
30-34	4.83%	-1.58%		-1.00%
35-39	2.15%	-1.41%		0.70%
40-44	-1.78%	-2.85%		1.90%
45-49	2.01%	0.06%		1.70%
50-54	3.63%	0.47%		1.80%
55-59	4.48%	1.83%	1.13%	1.80%
60-64	2.45%	1.26%	1.72%	1.80%
65-69	1.50%	0.96%	0.93%	1.20%
70-74	0.75%	1.06%	1.22%	1.70%
75-79	1.10%	1.08%	1.59%	2.30%
80-84	0.32%	0.47%	1.43%	1.80%
85-89	0.18%	-0.49%	0.78%	1.30%
90-94	-0.81%	-0.82%	0.41%	0.70%
Study Data: Best-fit log-linear mortality improvement for 1990 to 1994 from combined healthy data from study.				
Social Security: Best-fit log-linear mortality improvement for 1990 to 1994 from data supplied by Social Security used to prepare Actuarial Study 110 for all employees and retirees.				
Federal Civil Service: Best-fit log-linear mortality improvement for graduated mortality tables for 1988 to 1996 based on healthy retirees.				
GAM 88-94: Factors used to project GAR-94 tables from 1988 to 1994.				

Table 4-2

Annualized Recent Mortality Improvement Trends				
Female				
Age	Study Data 1990-1994	Social Security 1990-1994	Federal Civil Service 1988-1996	GAM 88-94
20-24		0.21%		1.60%
25-29	13.88%	-0.59%		0.90%
30-34	-15.60%	-1.24%		0.50%
35-39	-7.51%	-2.19%		0.80%
40-44	-1.66%	-1.42%		1.30%
45-49	-4.61%	0.56%		1.90%
50-54	-5.72%	0.94%		0.80%
55-59	5.27%	1.09%	0.92%	0.80%
60-64	-3.23%	0.49%	0.10%	0.00%
65-69	0.38%	-0.07%	0.44%	0.70%
70-74	-1.00%	0.06%	1.07%	2.00%
75-79	-0.93%	-0.13%	1.10%	1.50%
80-84	-0.24%	-0.30%	0.64%	1.00%
85-89	-1.25%	-0.49%	0.30%	0.90%
90-94	0.15%	-0.47%	0.08%	0.90%
Study Data: Best-fit log-linear mortality improvement for 1990 to 1994 from combined healthy data from study.				
Social Security: Best-fit log-linear mortality improvement for 1990 to 1994 from data supplied by Social Security used to prepare Actuarial Study 110 for all employees and retirees.				
Federal Civil Service: Best-fit log-linear mortality improvement for graduated mortality tables for 1988 to 1996 based on healthy retirees.				
GAM 88-94: Factors used to project GAR-94 tables from 1988 to 1994.				

The five-year age groupings did not produce a pattern that could be directly applied to a graduated mortality table. However, it did enable the RPEC to develop a general pattern of mortality to project results from the mid-year of the experience, 1992, to the date of the table, 2000.

Measurement of mortality improvement requires voluminous, consistent data covering many years. While interesting, the study data were not subjected to the rigorous, consistent methodology applied by SSA and OPM in the tracking of mortality trends. The study data also were not consistently submitted for all five years and even many of those plans that did have five years of data had sharp differences in exposure through the period. Therefore, the basis for selecting mortality improvement focussed on the Social Security and Federal Civil Service data.

Mortality improvement trends for males from age 55 through age 80 for Social Security and Federal Civil Service were all significantly positive. Trends for males at other ages and trends for females at all ages produced mixed results including many negative and insignificant trends. The RPEC decided to use trends only for male employees and male healthy retirees.

The average improvement trend for males between ages 55 and 80 was close to 1.0 percent a year for the Social Security and Federal Civil Service data. The RPEC selected an annual

improvement factor of 1.0 percent for male employees and healthy retirees aged 55 through 80. Some of the improvement trends calculated for ages in that range are greater than 1.0 but the RPEC believed that use of factors that varied within that set of ages would give a false sense of precision. The 1.0 percent factor was graded down to zero below age 46 and above age 89 to avoid a discontinuity in the projected rates. The complete set of factors is shown in Table 4-3.

The improvement factors discussed here are only to project the data to the year 2000 based on recent short-term experience. Chapter 7 discusses projection beyond the year 2000 based on long-term experience. Thus the improvement factors in Table 4-3 are different from the improvement factors in Table 7-3.

Table 4-3

Male Employee and Healthy Retiree Mortality Improvement Factors Projection of Study Rates to 2000			
Age	Annual Improvement Rate	Age	Annual Improvement Rate
Under 46	0%	81	.9%
46	.1%	82	.8%
47	.2%	83	.7%
48	.3%	84	.6%
49	.4%	85	.5%
50	.5%	86	.4%
51	.6%	87	.3%
52	.7%	88	.2%
53	.8%	89	.1%
54	.9%	Over 89	0%
55 to 80	1.0%		

Combined Healthy Participant Table

The RPEC also produced a combined Healthy Participant Table by blending the employee and healthy annuitant tables, primarily to permit a direct comparison to previously published tables including the UP-94 table. Comparisons of liabilities are shown at the end of Chapter 8. The RPEC was also concerned that some computer programs and systems could not readily adopt separate employee and annuitant tables. The RPEC encourages use of the separate employee and healthy annuitant tables when possible. For employees over the age of 70, healthy annuitant mortality rates should be used.

Since many contributors submitted retiree data but no employee data, direct use of all of the study data would have weighted retiree data too heavily. Therefore, the RPEC determined the weighting factors using the subset of data for which both active and retired experience had been submitted. The resulting weights are shown in Table 4-4.

Where unisex tables are desirable, the RPEC recommends that the actuary should construct blended tables based on the proportion of each gender in the plan population.

Table 4-4

Weighting Factors to Produce Combined Healthy Participant Table				
	Accumulative Percent Retired		Percent Retiring in Year	
Age	Male	Female	Male	Female
50	0.00%	0.00%	4.98%	5.86%
51	4.98%	5.86%	1.98%	1.68%
52	6.86%	7.44%	2.87%	2.19%
53	9.53%	9.47%	3.70%	2.67%
54	12.88%	11.89%	8.93%	8.04%
55	20.66%	18.97%	13.95%	11.85%
56	31.73%	28.57%	8.89%	7.64%
57	37.80%	34.03%	9.98%	7.20%
58	44.01%	38.78%	10.45%	7.87%
59	49.86%	43.60%	12.90%	10.53%
60	56.33%	49.54%	16.14%	16.86%
61	63.38%	58.05%	20.89%	18.90%
62	71.03%	65.98%	27.58%	27.10%
63	79.02%	75.20%	21.59%	21.09%
64	83.55%	80.43%	29.00%	26.01%
65	88.32%	85.52%	41.87%	39.09%
66	93.21%	91.18%	27.84%	28.23%
67	95.10%	93.67%	26.33%	24.64%
68	96.39%	95.23%	20.78%	21.80%
69	97.14%	96.27%	100.00%	100.00%
70	100.00%	100.00%	100.00%	100.00%

RP-2000 Rates

The rates of Table 3-1, when projected to 2000, are the final RP-2000 tables shown in Tables 4-5 and 4-6. The RPEC decided to modify the age 120 rate to 1.0 to produce an artificial terminal age for the table. The tables also show the combined healthy rates. Actuaries should keep in mind that these tables were developed from experience on mortality for uninsured pension plans subject to the RPA Current Liability rules and are only recommended for use for those types of plans.

Table 4-5

Male RP-2000 Rates				
Age	Employees	Healthy Annuitant	Combined Healthy	Disabled Retiree
1	0.000637		0.000637	
2	0.000430		0.000430	
3	0.000357		0.000357	
4	0.000278		0.000278	
5	0.000255		0.000255	
6	0.000244		0.000244	
7	0.000234		0.000234	
8	0.000216		0.000216	
9	0.000209		0.000209	
10	0.000212		0.000212	
11	0.000219		0.000219	
12	0.000228		0.000228	
13	0.000240		0.000240	
14	0.000254		0.000254	
15	0.000269		0.000269	
16	0.000284		0.000284	
17	0.000301		0.000301	
18	0.000316		0.000316	
19	0.000331		0.000331	
20	0.000345		0.000345	
21	0.000357		0.000357	0.022571
22	0.000366		0.000366	0.022571
23	0.000373		0.000373	0.022571
24	0.000376		0.000376	0.022571
25	0.000376		0.000376	0.022571
26	0.000378		0.000378	0.022571
27	0.000382		0.000382	0.022571
28	0.000393		0.000393	0.022571
29	0.000412		0.000412	0.022571
30	0.000444		0.000444	0.022571
31	0.000499		0.000499	0.022571
32	0.000562		0.000562	0.022571
33	0.000631		0.000631	0.022571
34	0.000702		0.000702	0.022571
35	0.000773		0.000773	0.022571
36	0.000841		0.000841	0.022571
37	0.000904		0.000904	0.022571
38	0.000964		0.000964	0.022571
39	0.001021		0.001021	0.022571
40	0.001079		0.001079	0.022571

Table 4-5

Male RP-2000 Rates				
Age	Employees	Healthy Annuitant	Combined Healthy	Disabled Retiree
41	0.001142		0.001142	0.022571
42	0.001215		0.001215	0.022571
43	0.001299		0.001299	0.022571
44	0.001397		0.001397	0.022571
45	0.001508		0.001508	0.022571
46	0.001616		0.001616	0.023847
47	0.001734		0.001734	0.025124
48	0.001860		0.001860	0.026404
49	0.001995		0.001995	0.027687
50	0.002138	0.005347	0.002138	0.028975
51	0.002288	0.005528	0.002449	0.030268
52	0.002448	0.005644	0.002667	0.031563
53	0.002621	0.005722	0.002916	0.032859
54	0.002812	0.005797	0.003196	0.034152
55	0.003029	0.005905	0.003624	0.035442
56	0.003306	0.006124	0.004200	0.036732
57	0.003628	0.006444	0.004693	0.038026
58	0.003997	0.006895	0.005273	0.039334
59	0.004414	0.007485	0.005945	0.040668
60	0.004878	0.008196	0.006747	0.042042
61	0.005382	0.009001	0.007676	0.043474
62	0.005918	0.009915	0.008757	0.044981
63	0.006472	0.010951	0.010012	0.046584
64	0.007028	0.012117	0.011280	0.048307
65	0.007573	0.013419	0.012737	0.050174
66	0.008099	0.014868	0.014409	0.052213
67	0.008598	0.016460	0.016075	0.054450
68	0.009069	0.018200	0.017871	0.056909
69	0.009510	0.020105	0.019802	0.059613
70	0.009922	0.022206	0.022206	0.062583
71		0.024570	0.024570	0.065841
72		0.027281	0.027281	0.069405
73		0.030387	0.030387	0.073292
74		0.033900	0.033900	0.077512
75		0.037834	0.037834	0.082067
76		0.042169	0.042169	0.086951
77		0.046906	0.046906	0.092149
78		0.052123	0.052123	0.097640
79		0.057927	0.057927	0.103392
80		0.064368	0.064368	0.109372
81		0.072041	0.072041	0.115544
82		0.080486	0.080486	0.121877
83		0.089718	0.089718	0.128343

Table 4-5

Male RP-2000 Rates				
Age	Employees	Healthy Annuitant	Combined Healthy	Disabled Retiree
84		0.099779	0.099779	0.134923
85		0.110757	0.110757	0.141603
86		0.122797	0.122797	0.148374
87		0.136043	0.136043	0.155235
88		0.150590	0.150590	0.162186
89		0.166420	0.166420	0.169233
90		0.183408	0.183408	0.183408
91		0.199769	0.199769	0.199769
92		0.216605	0.216605	0.216605
93		0.233662	0.233662	0.233662
94		0.250693	0.250693	0.250693
95		0.267491	0.267491	0.267491
96		0.283905	0.283905	0.283905
97		0.299852	0.299852	0.299852
98		0.315296	0.315296	0.315296
99		0.330207	0.330207	0.330207
100		0.344556	0.344556	0.344556
101		0.358628	0.358628	0.358628
102		0.371685	0.371685	0.371685
103		0.383040	0.383040	0.383040
104		0.392003	0.392003	0.392003
105		0.397886	0.397886	0.397886
106		0.400000	0.400000	0.400000
107		0.400000	0.400000	0.400000
108		0.400000	0.400000	0.400000
109		0.400000	0.400000	0.400000
110		0.400000	0.400000	0.400000
111		0.400000	0.400000	0.400000
112		0.400000	0.400000	0.400000
113		0.400000	0.400000	0.400000
114		0.400000	0.400000	0.400000
115		0.400000	0.400000	0.400000
116		0.400000	0.400000	0.400000
117		0.400000	0.400000	0.400000
118		0.400000	0.400000	0.400000
119		0.400000	0.400000	0.400000
120		1.000000	1.000000	1.000000

Table 4-6

Female RP-2000 Rates				
Age	Employees	Healthy Annuitant	Combined Healthy	Disabled Retiree
1	0.000571		0.000571	
2	0.000372		0.000372	
3	0.000278		0.000278	
4	0.000208		0.000208	
5	0.000188		0.000188	
6	0.000176		0.000176	
7	0.000165		0.000165	
8	0.000147		0.000147	
9	0.000140		0.000140	
10	0.000141		0.000141	
11	0.000143		0.000143	
12	0.000148		0.000148	
13	0.000155		0.000155	
14	0.000162		0.000162	
15	0.000170		0.000170	
16	0.000177		0.000177	
17	0.000184		0.000184	
18	0.000188		0.000188	
19	0.000190		0.000190	
20	0.000191		0.000191	
21	0.000192		0.000192	0.007450
22	0.000194		0.000194	0.007450
23	0.000197		0.000197	0.007450
24	0.000201		0.000201	0.007450
25	0.000207		0.000207	0.007450
26	0.000214		0.000214	0.007450
27	0.000223		0.000223	0.007450
28	0.000235		0.000235	0.007450
29	0.000248		0.000248	0.007450
30	0.000264		0.000264	0.007450
31	0.000307		0.000307	0.007450
32	0.000350		0.000350	0.007450
33	0.000394		0.000394	0.007450
34	0.000435		0.000435	0.007450
35	0.000475		0.000475	0.007450
36	0.000514		0.000514	0.007450
37	0.000554		0.000554	0.007450
38	0.000598		0.000598	0.007450
39	0.000648		0.000648	0.007450
40	0.000706		0.000706	0.007450

Table 4-6

Female RP-2000 Rates				
Age	Employees	Healthy Annuitant	Combined Healthy	Disabled Retiree
41	0.000774		0.000774	0.007450
42	0.000852		0.000852	0.007450
43	0.000937		0.000937	0.007450
44	0.001029		0.001029	0.007450
45	0.001124		0.001124	0.007450
46	0.001223		0.001223	0.008184
47	0.001326		0.001326	0.008959
48	0.001434		0.001434	0.009775
49	0.001550		0.001550	0.010634
50	0.001676	0.002344	0.001676	0.011535
51	0.001814	0.002459	0.001852	0.012477
52	0.001967	0.002647	0.002018	0.013456
53	0.002135	0.002895	0.002207	0.014465
54	0.002321	0.003190	0.002424	0.015497
55	0.002526	0.003531	0.002717	0.016544
56	0.002756	0.003925	0.003090	0.017598
57	0.003010	0.004385	0.003478	0.018654
58	0.003291	0.004921	0.003923	0.019710
59	0.003599	0.005531	0.004441	0.020768
60	0.003931	0.006200	0.005055	0.021839
61	0.004285	0.006919	0.005814	0.022936
62	0.004656	0.007689	0.006657	0.024080
63	0.005039	0.008509	0.007648	0.025293
64	0.005429	0.009395	0.008619	0.026600
65	0.005821	0.010364	0.009706	0.028026
66	0.006207	0.011413	0.010954	0.029594
67	0.006583	0.012540	0.012163	0.031325
68	0.006945	0.013771	0.013445	0.033234
69	0.007289	0.015153	0.014860	0.035335
70	0.007613	0.016742	0.016742	0.037635
71		0.018579	0.018579	0.040140
72		0.020665	0.020665	0.042851
73		0.022970	0.022970	0.045769
74		0.025458	0.025458	0.048895
75		0.028106	0.028106	0.052230
76		0.030966	0.030966	0.055777
77		0.034105	0.034105	0.059545
78		0.037595	0.037595	0.063545
79		0.041506	0.041506	0.067793
80		0.045879	0.045879	0.072312
81		0.050780	0.050780	0.077135
82		0.056294	0.056294	0.082298

Table 4-6

Female RP-2000 Rates				
Age	Employees	Healthy Annuitant	Combined Healthy	Disabled Retiree
83		0.062506	0.062506	0.087838
84		0.069517	0.069517	0.093794
85		0.077446	0.077446	0.100203
86		0.086376	0.086376	0.107099
87		0.096337	0.096337	0.114512
88		0.107303	0.107303	0.122464
89		0.119154	0.119154	0.130972
90		0.131682	0.131682	0.140049
91		0.144604	0.144604	0.149698
92		0.157618	0.157618	0.159924
93		0.170433	0.170433	0.170433
94		0.182799	0.182799	0.182799
95		0.194509	0.194509	0.194509
96		0.205379	0.205379	0.205379
97		0.215240	0.215240	0.215240
98		0.223947	0.223947	0.223947
99		0.231387	0.231387	0.231387
100		0.237467	0.237467	0.237467
101		0.244834	0.244834	0.244834
102		0.254498	0.254498	0.254498
103		0.266044	0.266044	0.266044
104		0.279055	0.279055	0.279055
105		0.293116	0.293116	0.293116
106		0.307811	0.307811	0.307811
107		0.322725	0.322725	0.322725
108		0.337441	0.337441	0.337441
109		0.351544	0.351544	0.351544
110		0.364617	0.364617	0.364617
111		0.376246	0.376246	0.376246
112		0.386015	0.386015	0.386015
113		0.393507	0.393507	0.393507
114		0.398308	0.398308	0.398308
115		0.400000	0.400000	0.400000
116		0.400000	0.400000	0.400000
117		0.400000	0.400000	0.400000
118		0.400000	0.400000	0.400000
119		0.400000	0.400000	0.400000
120		1.000000	1.000000	1.000000

Figure 4-1
Comparison of RP-2000 Mortality Rates by Participant Status
Males Ages 50 - 69

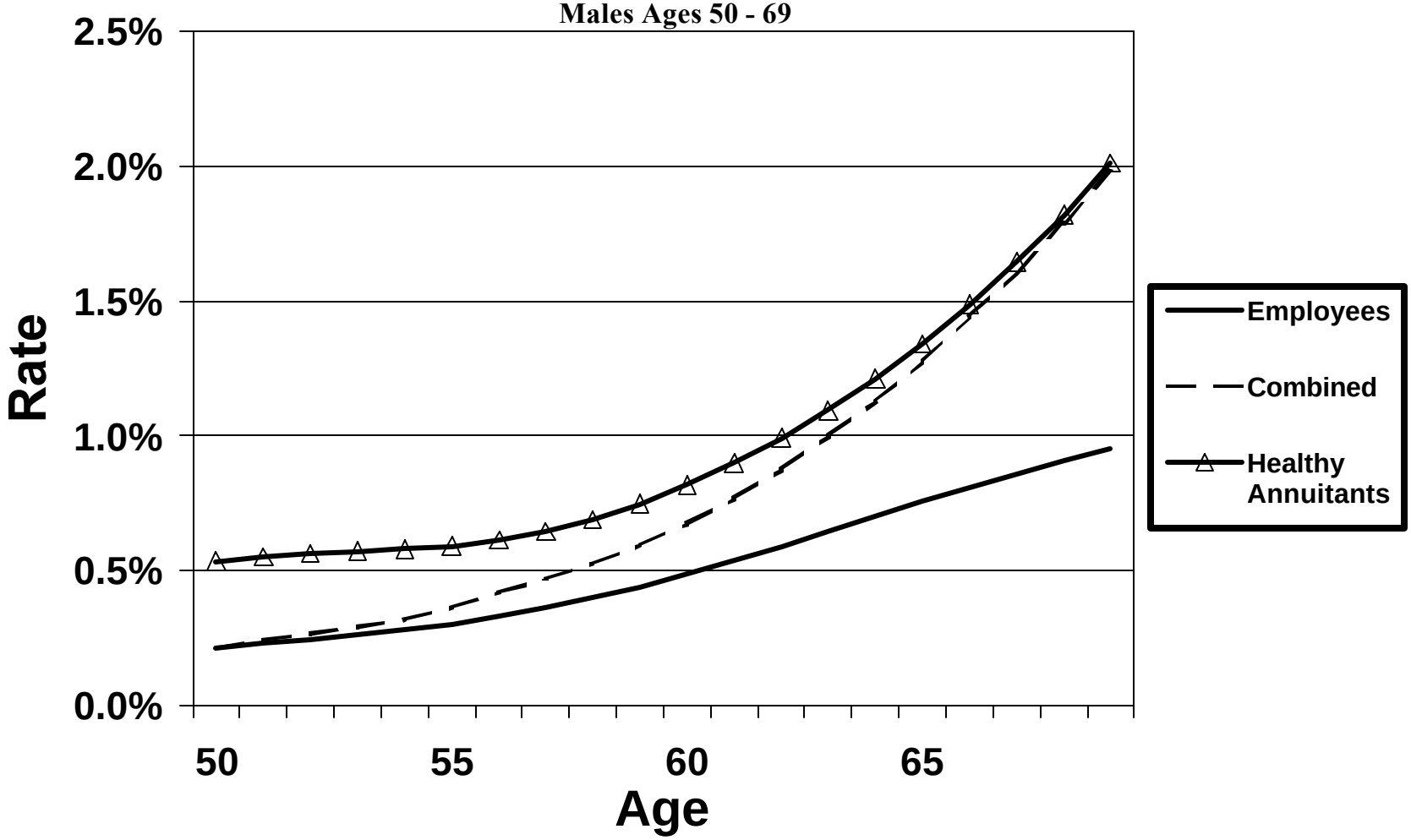
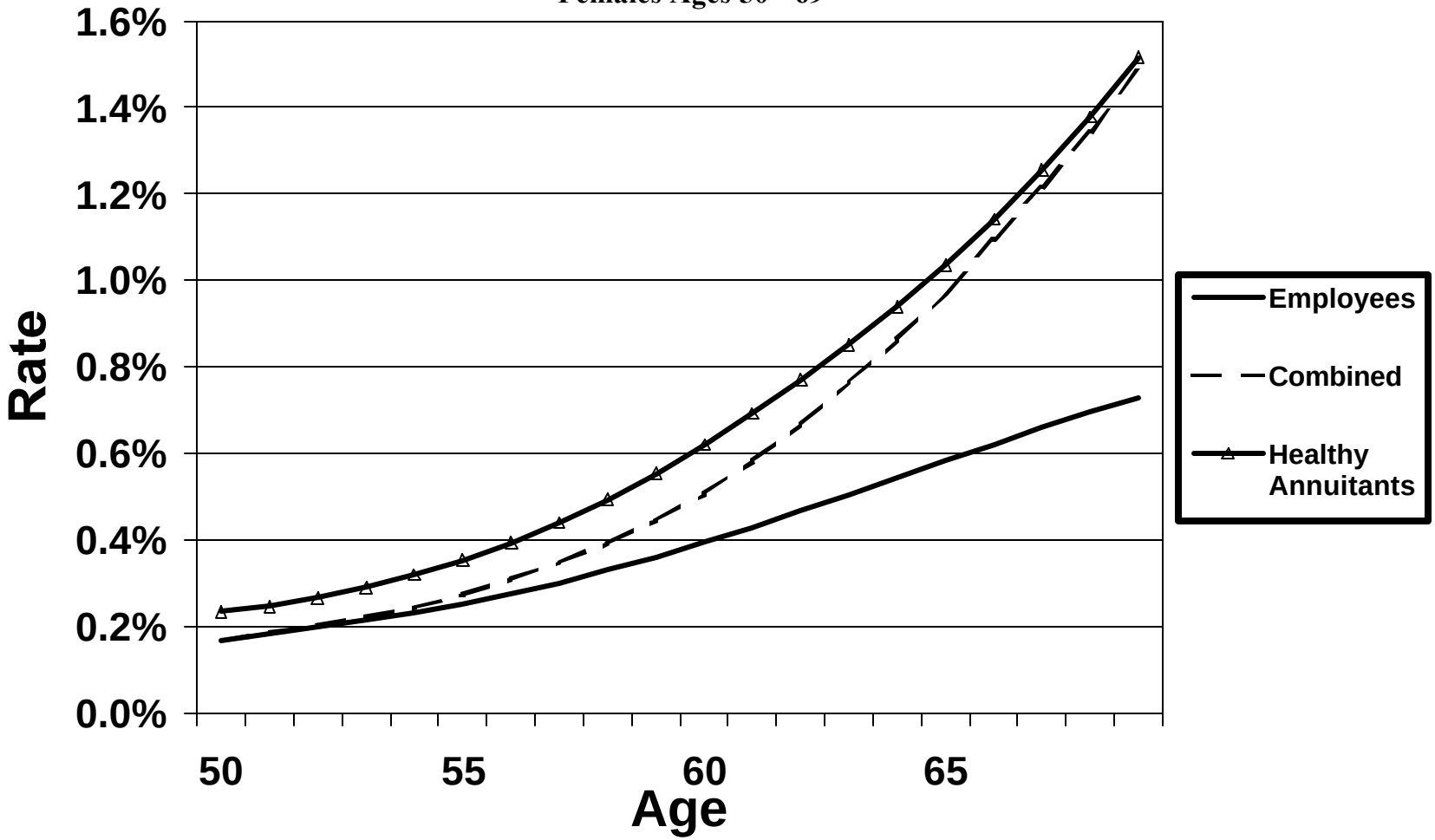


Figure 4-2
Comparison of RP-2000 Mortality Rates by Participant Status
Females Ages 50 - 69



Chapter 5 - Relative Mortality

Differences by Collar and Amount

The RPEC performed a number of analyses that showed a significant difference in mortality by collar type and amount of annuity, but found that industry code (first two digits of SIC) was not a consistent predictor of differences. The RPEC defined collar type based on information from the data contributors about whether participants were hourly or salaried and union or non-union. If more than 70 percent of the participants were hourly or union then the type was set as blue collar. If more than 70 percent of the participants were salaried and non-union then the type was set as white collar. If the type could not be determined, either by these rules or by contacting the submitting actuary, it was set as mixed collar. Data contributors were asked to stratify their annuitant data by amount of annuity. The RPEC defined small amounts to be less than $6,000 a year and large amounts to be more than $14,400 a year. Contributors split their annuitant data into separate cells for large, medium, and small amounts based on this definition.

The RPEC was not able to either determine the correlation between collar and amount or to produce a practical approach to using the two factors together to adjust mortality. As a result, the RPEC contracted with a research team from the University of Connecticut to analyze the statistical relationship between mortality and the characteristics of plan beneficiaries. Their investigation considered collar type, annuity amount group, and industry code.

The researchers confirmed that both collar type and annuity amount groupings are statistically significant indicators of differences in annuitant mortality experience and that industry is not a consistent indicator of differences. The researchers were unable to find a practical model to apply the combined effect of collar and amount. The RPEC recommends that the Society of Actuaries conduct further research on multivariate models for variations in mortality. [See "Multivariate Analysis of Pension Plan Mortality Data" by G. Rasoanaivo, N. Ravishankar, J. Vadiveloo, and C. Vinsonhaler, *North American Actuarial Journal*, Volume 4, Number 4, October 2000.]

The RPEC reviewed extensive data on mortality controlled for amount and collar variables. Appendix F shows, by gender, for quinquennial age groups from 60 to 79, the ratios of mortality rates by collar (white, blue, and mixed) and by annuity amount group (small, medium, and large) to the mortality rate for the entire healthy annuitant population. It also shows for each cell the average amount of the annuity, the total number of lives exposed, and the percentage of exposure by amounts. These tables are based on data for all healthy annuitants from plans with amounts reported. The percentage of exposure by amounts for each cell is shown to better indicate the relative degree to which the mortality for each cell is reflected in the overall mortality rate for the entire age group.

As an example, Table 5-1 compares the amount-weighted mortality for male healthy annuitants ages 65 to 69 by amount and collar. The table illustrates the correlation of large amounts with white collar and smaller amounts with blue collar. Large annuities account for 68 percent of the exposure by amounts for healthy white collar annuitants compared to 26 percent of the

exposure by amounts for healthy blue collar annuitants. Only 5 percent of the exposure by amounts for healthy white collar annuitants is for small annuities compared to 15 percent for healthy blue collar annuitants. Similarly, healthy white collar annuitants account for 64 percent of the exposure by amount for large annuities but only 34 percent of the exposure by amount for small annuities. Healthy blue collar annuitants account for only 15 percent of the exposure by amount for large annuities yet account for 56 percent of the exposure by amount for small annuities.

Table 5-1
Relative Amount – Weighted Mortality by Collar and Amount*
Male Healthy Annuitants, Ages 65 to 69

	Annuity Amount Category			
	Small	Medium	Large	Total
White Collar				
Mortality Ratio	1.260	1.063	0.781	0.881
Average Amount	$2,428	$10,221	$22,993	$12,933
Number Exposed	33,918	41,002	46,466	121,386
Percent of Exposure	2.70%	13.70%	34.80%	51.20%
Blue Collar				
Mortality Ratio	1.516	1.367	0.869	1.258
Average Amount	$3,107	$8,927	$23,754	$8,032
Number Exposed	45,741	64,096	10,683	120,520
Percent of Exposure	4.60%	18.60%	8.30%	31.60%
Mixed Collar				
Mortality Ratio	1.181	1.066	0.787	0.880
Average Amount	$2,828	$10,308	$25,375	$15,046
Number Exposed	6,287	14,762	14,208	35,257
Percent of Exposure	0.60%	5.00%	11.70%	17.30%
Total				
Mortality Ratio	1.405	1.215	0.795	1.000
Average Amount	$2,819	$9,540	$23,581	$11,071
Number Exposed	85,946	119,860	71,357	277,163
Percent of Exposure	7.90%	37.30%	54.80%	100.00%

***Small amounts are less than $6,000 a year and large amounts are more than $14,400 a year.**

Table 5-2 shows that mortality for small amounts is significantly greater than for medium and large amounts at all age groups. Differences are smaller for females than for males. Table 5-3 shows similar results for blue and white collar. The differences by amount had been expected because of a number of prior studies that show a clear inverse correlation between income and mortality. The differences by collar had also been expected because, to a large extent, white collar annuitants have greater income than blue collar annuitants and there are differences in the health environment of the categories of employment.

Table 5-2

Relative Mortality by Size of Pension*				
Age Group	**Small**	**Medium**	**Large**	**Small/Large**
Male				
60-64	1.602	1.346	.827	1.94
65-69	1.405	1.215	.795	1.77
70-74	1.308	1.183	.740	1.77
75-79	1.190	1.089	.755	1.57
Female				
60-64	1.172	1.002	.906	1.29
65-69	1.172	.942	.890	1.32
70-74	1.120	.954	.756	1.48
75-79	1.062	.891	.995	1.07

Note: All healthy annuitants with amounts

***Small pensions are less than $6,000 a year and large pensions are more than $14,400 a year.**

Table 5-3

Relative Mortality by Blue or White Collar			
Age Group	**Blue Collar**	**White Collar**	**Blue/White**
Male			
60-64	1.371	.871	1.57
65-69	1.258	.881	1.43
70-74	1.184	.896	1.32
75-79	1.128	.912	1.24
Female			
60-64	1.216	.912	1.33
65-69	1.026	.927	1.11
70-74	1.088	.895	1.22
75-79	1.029	.943	1.09

Note: All healthy annuitants with amounts

For the eight industry codes with the largest exposures, Table 5-4 shows the ratios of industry healthy annuitant mortality to overall healthy annuitant mortality by gender and quinquennial age groups from 60 to 79. These are the ratios of the raw quinquennial death rates (based on number of lives) by industry to the overall quinquennial death rates shown in Tables 2-5 and 2-6. The industries are ranked by the number of lives in the database for the industry.

Table 5-4 shows that the mortality ratios by industry are not consistent across age and gender. It is difficult to draw conclusions from Table 5-4, since comparisons of these ratios are confounded by differences in factors other than industry, such as collar type and amount of annuity. Furthermore, for some industries, the ratios are heavily influenced by the experience of a single plan. Therefore, the RPEC does not believe that these ratios should be used to adjust plan valuation mortality assumptions.

Table 5-4
Relative Mortality for Healthy Annuitants by Industry Code

	Age Band			
Industry – Code and Name	**60-64**	**65-69**	**70-74**	**75-79**
Male				
37 Transportation	1.140	1.091	1.022	1.041
36 Electronic Equipment	0.993	0.940	0.978	0.980
48 Communications	0.925	1.018	0.975	0.942
29 Petroleum	0.786	0.804	0.871	0.906
33 Primary Metal Industries	1.250	1.322	1.305	1.184
28 Chemicals	1.026	0.993	0.952	1.011
26 Paper	0.936	1.078	1.045	1.090
13 Oil and Gas Extraction	0.778	0.806	0.836	0.732
Female				
37 Transportation	1.174	1.010	1.025	1.105
36 Electronic Equipment	1.027	0.839	0.796	1.042
48 Communications	0.953	0.914	1.006	0.911
29 Petroleum	1.195	0.433	0.600	0.778
33 Primary Metal Industries	1.484	1.152	1.047	0.895
28 Chemicals	0.919	1.249	1.120	1.052
26 Paper	0.305	0.800	1.054	0.840
13 Oil and Gas Extraction	1.421	0.932	1.158	0.972

The actuary should consider collar and amount differences as possible explanatory factors but should not adopt them for a specific group without careful consideration of whether the particular difference is the best predictor of mortality for that group. While collar is easier to observe than amount, it is recognized that both factors are only indicators of possible mortality differences. In particular, the relationship between collar and mortality level may be offset by other factors. For example, a substantial portion of the data for Petroleum is for blue collar plans with amounts. These plans have amounts that are significantly higher than average, and also have mortality that is significantly lower than blue collar mortality generally.

There are several concerns about the validity of using amount as an indicator of differences of mortality for annuitants. For example, some annuitants, including deferred vested annuitants, would have lower amounts not because of lower salary but because of shorter service or other factors. Another concern was that use of an absolute dollar amount does not reflect the fact that annuities tend to decrease in real value as age increases because few employers provide full automatic cost-of-living adjustments. Furthermore, benefits indexed to inflation still decrease relative to benefits for new retirees since inflation does not fully reflect increases in real wages. For example, Appendix F shows that the proportion of large amounts of annuities declines with age. Finally, annuity amount differences are related to plan design.

The RPEC was fortunate to have a detailed database on Federal Civil Service annuitants to help analyze these effects. The series of reports by the RPEC and its predecessors since 1958 have shown that Federal Civil Service mortality is very close to the mortality of private sector

uninsured pensioners. When short service and duration since retirement were controlled for using this data set, the RPEC found that very significant differences in mortality by amount were still observed. [See "Earn More, Live Longer – Variation in Mortality by Income Level" by M. Virga, *Pension Section News,* Number 28, March 1996.] This extensive analysis convinced the RPEC that mortality does differ by amount throughout the retirement years until the very oldest ages. At the oldest ages, mortality differences based on any variable except gender (e.g. health, amount, or collar) tend to disappear.

Table 5-5 shows ratios of graduated mortality rates by collar to overall mortality rates for employees from age 30 to age 70 separately for males and females. Comparable ratios by amount could not be calculated since the RPEC did not collect stratified data by amount for employees.

Tables 5-6 and 5-7 show ratios of graduated mortality rates by collar and amount categories to overall mortality rates for healthy annuitants from age 50 to age 95. Each of the sets of data was graduated separately by the method used for the entire table and explained in Chapter 3. The table shows that white collar mortality is generally below average except at the youngest ages. Blue collar mortality is generally above average except at the oldest ages for males and youngest ages for females. The greatest differences are observed for males in the 60s with white collar almost 20 percent below average and blue collar almost 30 percent above average.

The mortality ratios for white and blue collar can both be less than 1.000 for two reasons: First, there is also a mixed collar category for which results are not shown. Second, the rates are graduated so the relationships at one age can be affected by relationships at other ages. This is especially due to the "heavy" graduation of the amount adjustment factors. Since the exposures are small at the youngest and oldest ages, the graduated amount adjustment factors are influenced by trends at the middle ages where the exposures are much larger. The exposures at the very youngest and oldest ages may be too small to provide statistically significant results.

The mortality ratios for small, medium, and large amounts can all be less than 1.000 because of the graduation as explained above and also because the mortality rates for small, medium, and large amounts are only based on data for plans that provided amounts. As shown in Table 2-11, the plans that provided amounts accounted for only 40% of exposures for healthy annuitants. The overall amount-adjusted mortality rates for these plans could be less than the amount-adjusted mortality rates for all healthy annuitants.

Large amount mortality is below average at all points and small amount mortality is above average except at the older ages. For males in the 50s and early 60s, the large amount mortality is between 18% and 41% below average and small amount mortality is between 34% and 53% above average. Large amount female mortality is between 4% and 20% below average and small amount female mortality is between 9% and 92% above average at ages in the 50s and 60s.

Conclusion

The RPEC recommends that the individual characteristics and experience of a retirement plan be considered in selecting the mortality table. In certain cases either collar or amount may be appropriate factors to consider subject to the theoretical concerns outlined earlier in this chapter. The RPEC's research has found that both factors are statistically significant indicators of differences in mortality for this data set. Use of either of these indicators may be inappropriate for certain plans. In the absence of a rigorous but practical multivariate model, approximation methods could be used to reflect differences in mortality by plan.

The RPEC recognizes that for the majority of the plans subject to RPA legislation, adjustment of the standard mortality tables in a manner consistent with the data collection method and results of this study will be considerably more practical if the collar factor is used. An adjustment of the standard mortality tables to reflect the collar factor would be to multiply the standard rates by the adjustment factors in Tables 5-5 through 5-7.

An adjustment of the standard mortality tables to reflect the level of a plan's annuities in a manner consistent with the data collection method and results of this study would be considerably more complex. It would require stratification of the underlying data as well as potential adjustments of that data for items such as retirement dates, plan formulas, and inflation levels.

Table 5-5
Ratio of Graduated Mortality Rates by Collar
To Overall Mortality for Employees

	Males		Females	
	White	Blue	White	Blue
Age	Collar	Collar	Collar	Collar
30	0.795	1.635	1.075	1.108
31	0.778	1.603	1.058	1.067
32	0.767	1.557	1.038	1.049
33	0.762	1.504	1.018	1.049
34	0.761	1.452	0.999	1.065
35	0.764	1.406	0.982	1.092
36	0.772	1.367	0.967	1.126
37	0.782	1.334	0.952	1.162
38	0.795	1.309	0.939	1.196
39	0.810	1.288	0.925	1.224
40	0.825	1.271	0.913	1.244
41	0.839	1.256	0.903	1.255
42	0.852	1.241	0.895	1.259
43	0.865	1.225	0.893	1.255
44	0.877	1.207	0.896	1.246
45	0.890	1.189	0.904	1.234
46	0.902	1.172	0.915	1.220
47	0.913	1.157	0.927	1.207
48	0.920	1.144	0.937	1.194
49	0.924	1.135	0.944	1.182
50	0.925	1.128	0.948	1.171
51	0.923	1.126	0.948	1.160
52	0.919	1.125	0.947	1.149
53	0.915	1.126	0.944	1.136
54	0.911	1.126	0.942	1.122
55	0.907	1.126	0.940	1.106
56	0.901	1.123	0.940	1.087
57	0.895	1.117	0.941	1.066
58	0.887	1.110	0.944	1.042
59	0.880	1.101	0.949	1.018
60	0.874	1.091	0.955	0.993
61	0.870	1.079	0.964	0.969
62	0.869	1.067	0.975	0.947
63	0.871	1.055	0.988	0.927
64	0.877	1.044	1.003	0.910
65	0.888	1.034	1.021	0.896
66	0.902	1.025	1.042	0.886
67	0.919	1.018	1.066	0.880
68	0.940	1.011	1.093	0.877
69	0.964	1.005	1.123	0.877
70	0.990	1.000	1.156	0.881

Table 5-6
Ratio of Graduated Mortality Rates by Collar and Amount*
To Overall Mortality for Healthy Annuitants

Male Lives

	White Collar	Blue Collar	Small Amount	Medium Amount	Large Amount
50	1.119	1.046	1.440	0.832	0.595
51	1.078	1.076	1.373	0.853	0.613
52	1.039	1.111	1.345	0.892	0.642
53	0.999	1.148	1.347	0.946	0.678
54	0.959	1.185	1.370	1.008	0.715
55	0.920	1.221	1.406	1.072	0.749
56	0.883	1.252	1.447	1.132	0.776
57	0.850	1.276	1.483	1.183	0.792
58	0.825	1.290	1.508	1.222	0.798
59	0.809	1.292	1.519	1.248	0.798
60	0.806	1.288	1.522	1.265	0.799
61	0.813	1.280	1.521	1.275	0.803
62	0.827	1.270	1.512	1.277	0.810
63	0.843	1.257	1.494	1.272	0.816
64	0.857	1.245	1.468	1.259	0.819
65	0.867	1.234	1.437	1.242	0.818
66	0.872	1.226	1.402	1.222	0.810
67	0.872	1.221	1.369	1.203	0.797
68	0.870	1.217	1.340	1.187	0.782
69	0.867	1.212	1.315	1.176	0.765
70	0.868	1.205	1.296	1.170	0.752
71	0.871	1.194	1.280	1.166	0.741
72	0.875	1.180	1.264	1.161	0.735
73	0.879	1.165	1.246	1.151	0.732
74	0.884	1.152	1.227	1.136	0.733
75	0.889	1.140	1.208	1.118	0.737
76	0.896	1.131	1.191	1.097	0.746
77	0.903	1.123	1.175	1.077	0.757
78	0.911	1.115	1.159	1.057	0.769
79	0.918	1.106	1.144	1.037	0.781
80	0.923	1.096	1.128	1.019	0.792
81	0.927	1.085	1.111	1.003	0.801
82	0.931	1.073	1.095	0.989	0.810
83	0.936	1.061	1.081	0.979	0.818
84	0.940	1.049	1.068	0.971	0.825
85	0.945	1.039	1.055	0.964	0.831
86	0.951	1.029	1.043	0.958	0.835
87	0.957	1.019	1.030	0.952	0.836
88	0.962	1.009	1.015	0.946	0.836
89	0.968	0.999	0.999	0.940	0.834
90	0.972	0.991	0.983	0.934	0.832
91	0.976	0.983	0.966	0.929	0.830
92	0.979	0.977	0.950	0.925	0.830
93	0.982	0.973	0.934	0.922	0.832
94	0.983	0.970	0.919	0.920	0.837
95	0.984	0.970	0.905	0.919	0.844

***Small amounts are less than $6,000 a year and large amounts are more than $14,400 a year.**

Table 5-7

Ratio of Graduated Mortality Rates by Collar and Amount*
To Overall Mortality for Healthy Annuitants

Female Lives

	White Collar	Blue Collar	Small Amount	Medium Amount	Large Amount
50	1.044	0.852	1.916	1.025	0.958
51	1.029	0.815	1.940	1.136	0.859
52	1.013	0.787	1.902	1.197	0.804
53	1.001	0.774	1.828	1.219	0.786
54	0.993	0.776	1.739	1.215	0.793
55	0.988	0.793	1.648	1.194	0.813
56	0.981	0.820	1.559	1.164	0.833
57	0.970	0.853	1.472	1.128	0.847
58	0.952	0.890	1.390	1.091	0.852
59	0.929	0.930	1.316	1.058	0.850
60	0.906	0.970	1.253	1.031	0.843
61	0.888	1.009	1.202	1.011	0.836
62	0.876	1.041	1.162	0.995	0.829
63	0.872	1.066	1.132	0.982	0.824
64	0.874	1.081	1.112	0.970	0.820
65	0.879	1.088	1.099	0.958	0.817
66	0.886	1.091	1.093	0.948	0.817
67	0.894	1.094	1.094	0.943	0.821
68	0.900	1.100	1.101	0.941	0.828
69	0.905	1.107	1.108	0.940	0.836
70	0.907	1.113	1.112	0.937	0.843
71	0.908	1.116	1.112	0.932	0.848
72	0.909	1.116	1.105	0.926	0.853
73	0.910	1.113	1.093	0.922	0.860
74	0.912	1.107	1.079	0.922	0.869
75	0.915	1.099	1.064	0.928	0.882
76	0.920	1.091	1.050	0.940	0.896
77	0.925	1.082	1.036	0.954	0.909
78	0.930	1.075	1.024	0.970	0.920
79	0.934	1.069	1.014	0.985	0.928
80	0.939	1.067	1.007	0.999	0.934
81	0.944	1.068	1.002	1.010	0.938
82	0.948	1.070	0.999	1.016	0.938
83	0.952	1.072	0.998	1.018	0.936
84	0.955	1.074	0.999	1.014	0.930
85	0.958	1.073	0.998	1.004	0.922
86	0.959	1.069	0.997	0.988	0.910
87	0.960	1.063	0.995	0.967	0.897
88	0.960	1.056	0.991	0.944	0.883
89	0.959	1.047	0.985	0.919	0.870
90	0.958	1.038	0.980	0.894	0.859
91	0.958	1.028	0.974	0.870	0.851
92	0.958	1.018	0.971	0.850	0.848
93	0.959	1.009	0.969	0.832	0.849
94	0.960	0.999	0.971	0.816	0.856
95	0.961	0.990	0.976	0.804	0.867

***Small amounts are less than $6,000 a year and large amounts are more than $14,400 a year.**

Figure 5-1
Relative Mortality by Collar for Male Employees

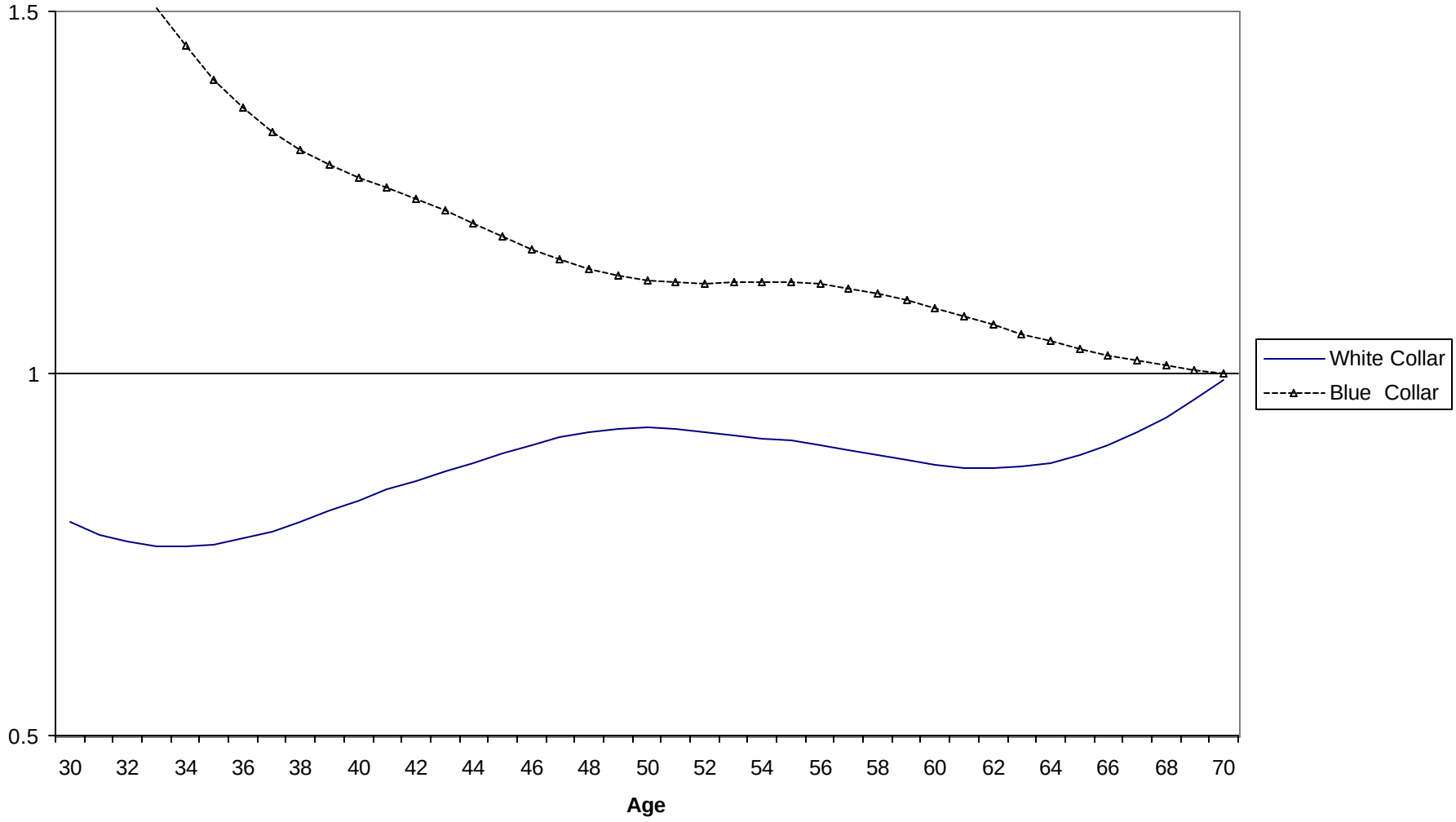


Figure 5-2
Relative Mortality by Collar for Male Retirees

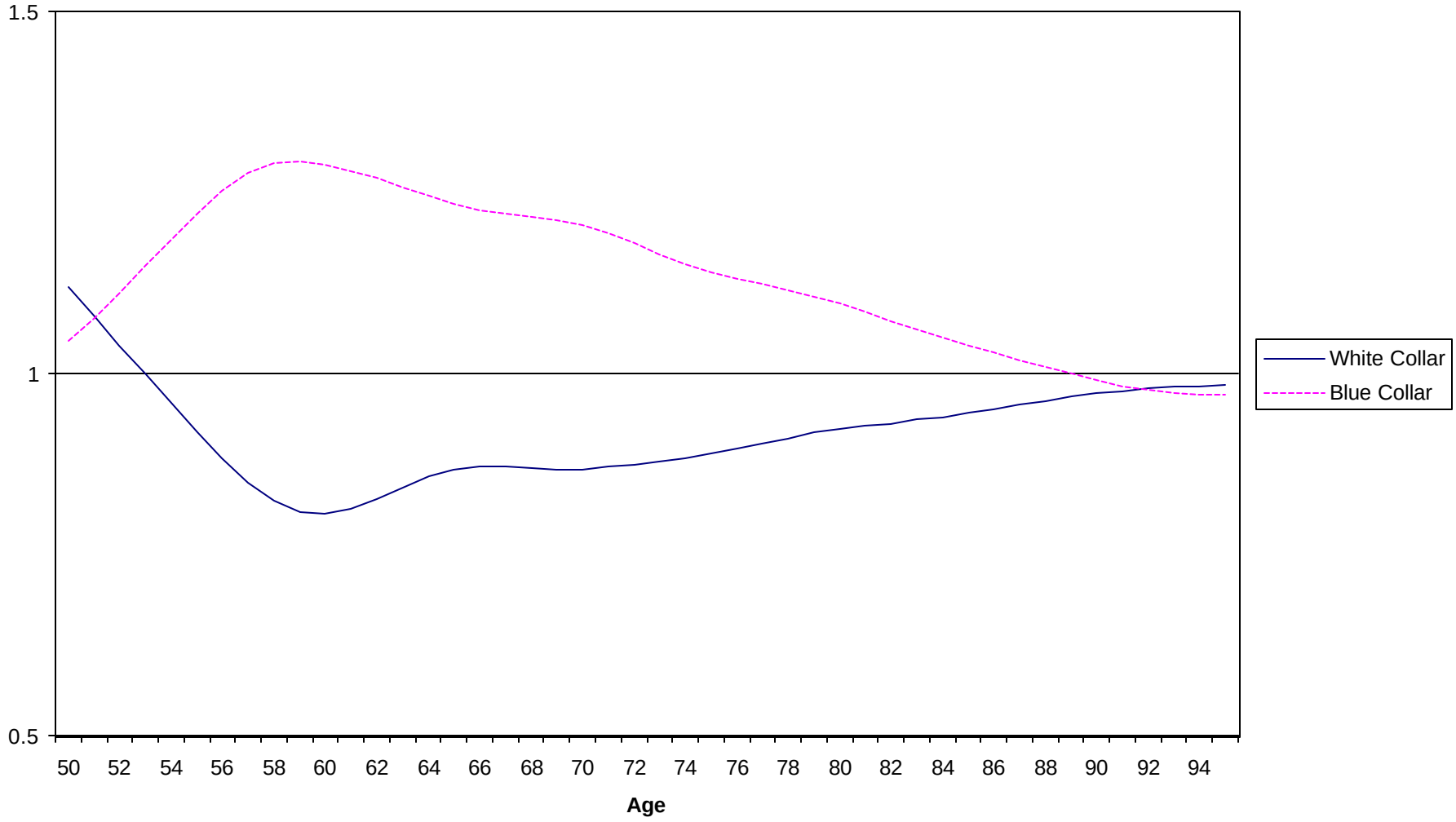


Figure 5-3
Relative Mortality by Collar for Female Employees

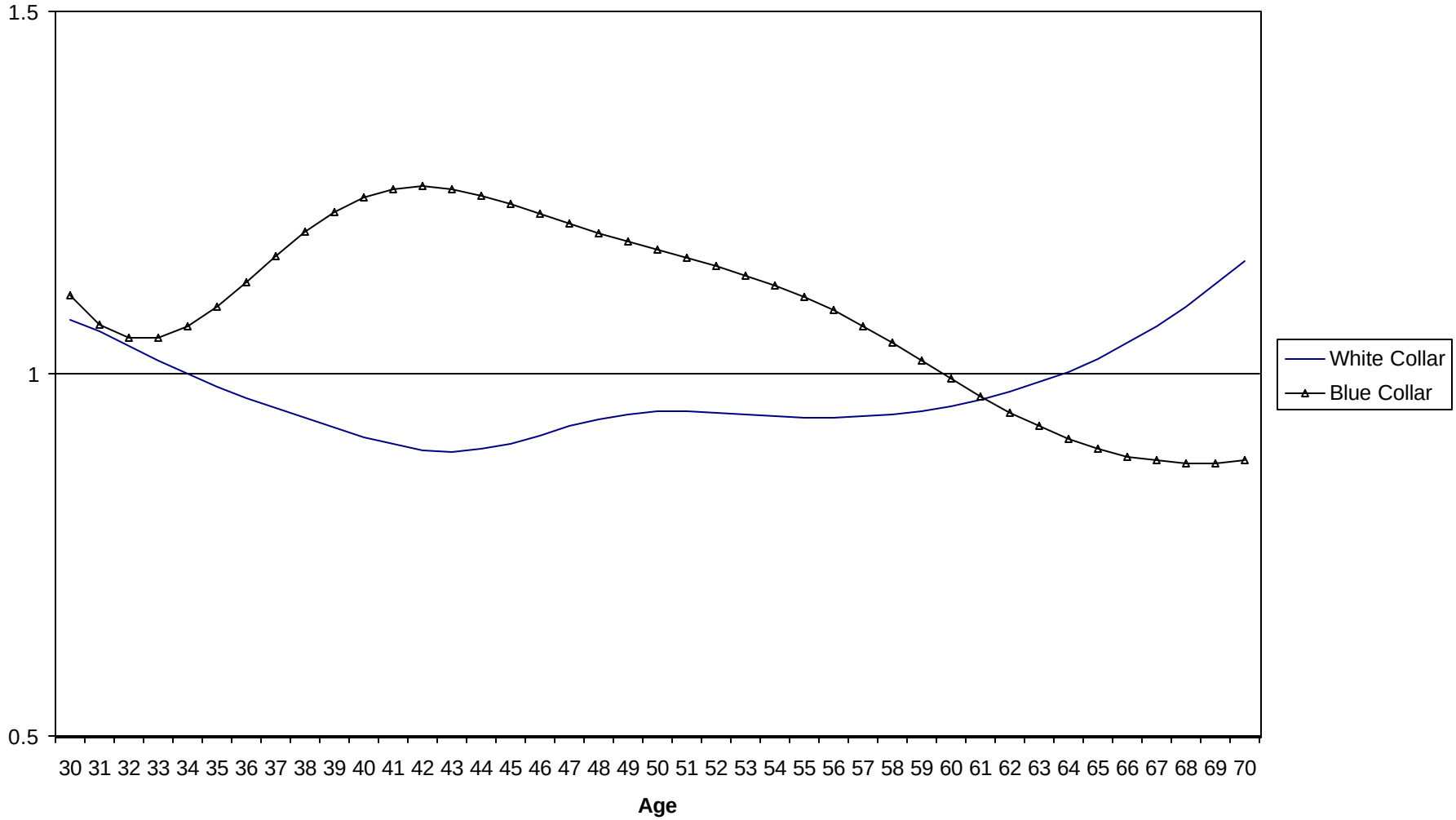


Figure 5-4
Relative Mortality by Collar for Female Retirees

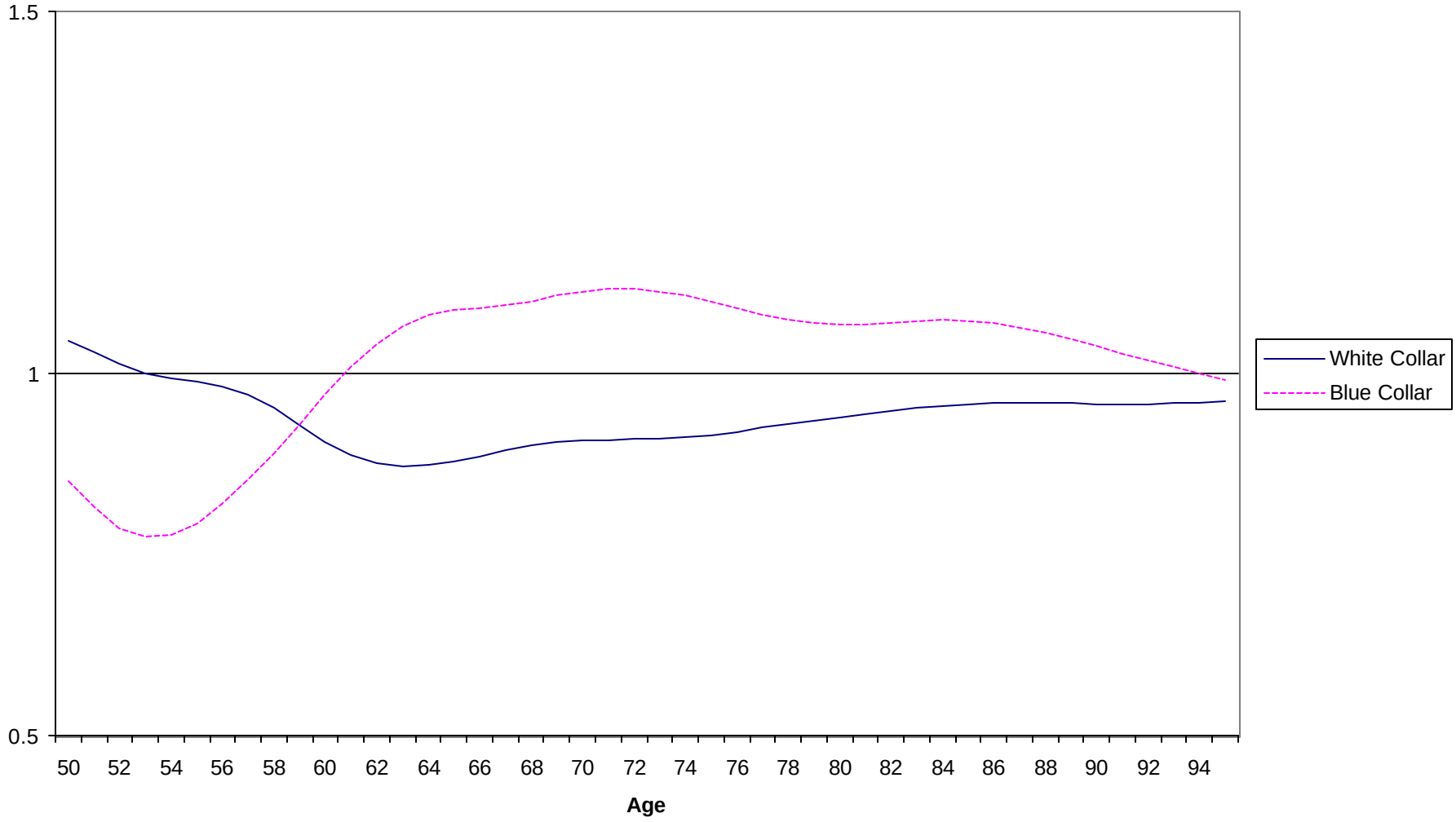


Figure 5-5
Relative Mortality by Amount for Male Retirees

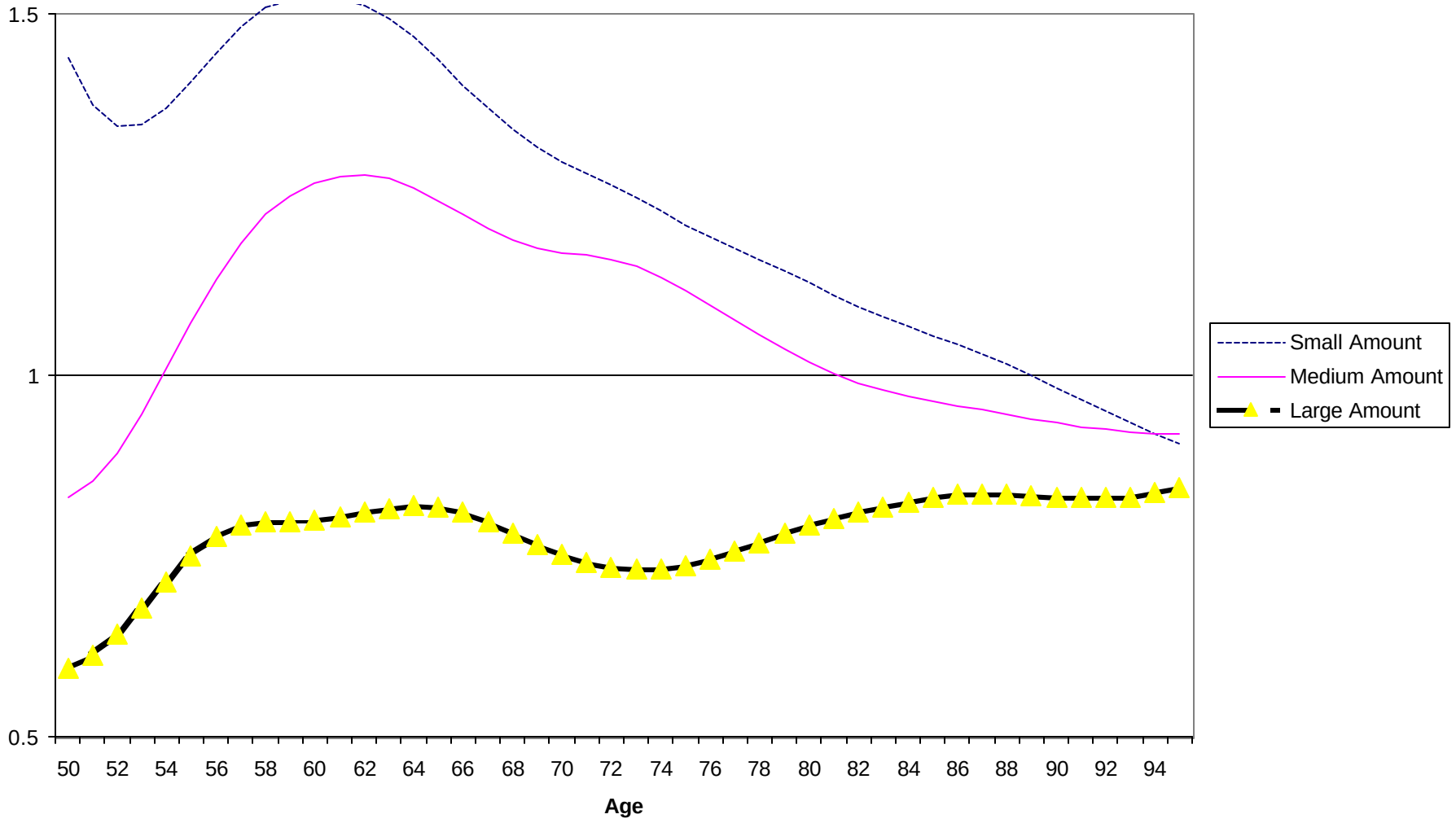
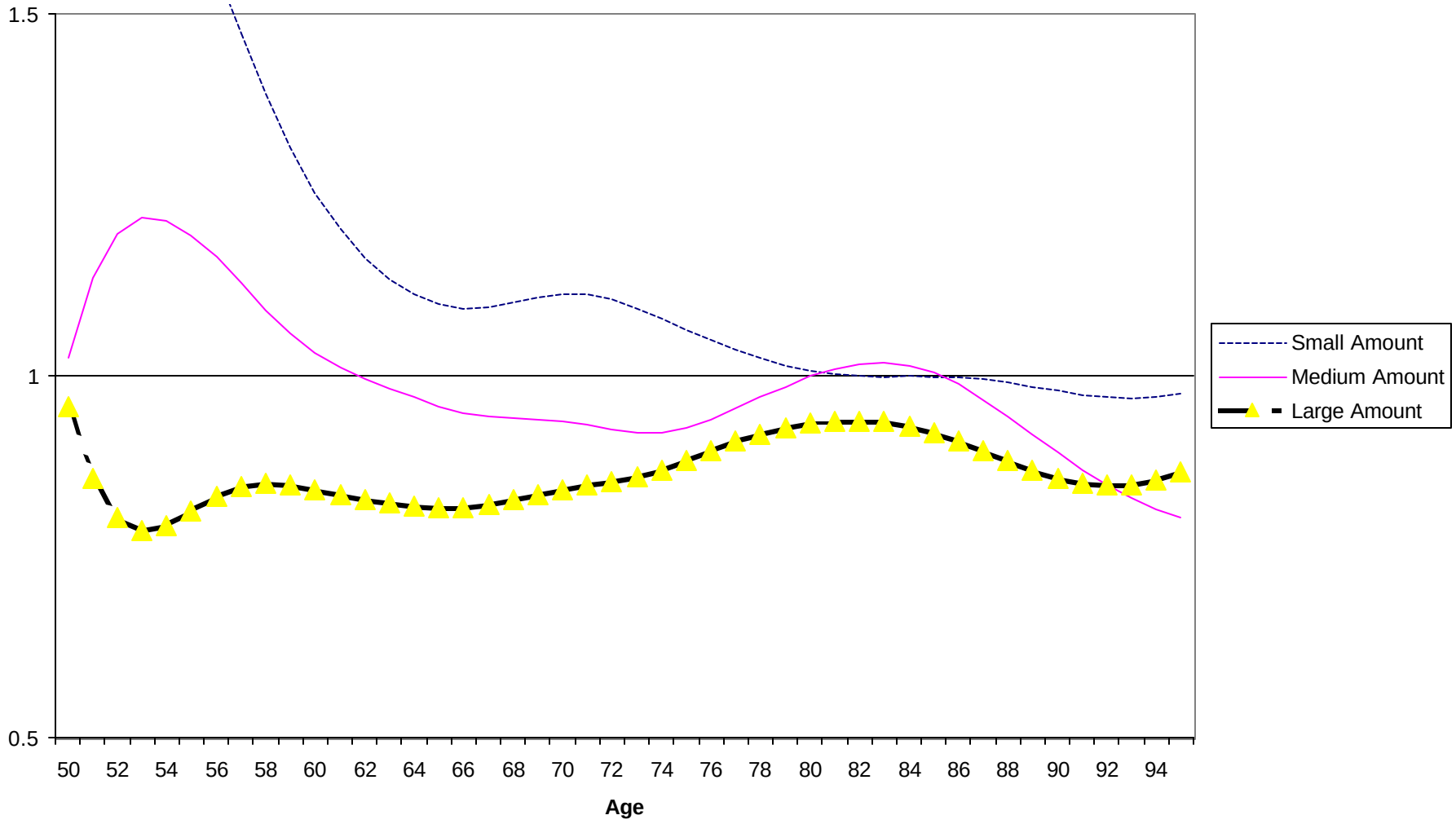


Figure 5-6
Relative Mortality by Amount for Female Retirees



Chapter 6 - Differences in Mortality Rates by Plan within Industry

The RPEC also investigated the question of whether or not plans in the same industry could have significantly different mortality. Statistically significant differences were found between plans in each of four industries investigated. These differences could not be explained by the collar types of the plans or any other available variables. Due to the confidentiality agreements with the data contributors, this investigation was done by Society of Actuaries (SoA) staff.

Process

SoA staff extracted the data for four SIC codes from the database collected for the Pension Plan Mortality Study: 3710 (motor vehicle manufacturing), 3725 (aircraft and missile manufacturing), 4210 (trucking), and 4825 (telephone, telegraph, and other communications services). These SIC codes were selected because each of them included data from at least two very large employers. SoA staff reassembled the data for the auto manufacturers into six plans, a blue collar and a white collar plan for each of the Big Three. The resulting dataset had 23 plans with the number of plans in each industry varying from two to eleven. All 23 plans were clearly identified as either white collar or blue collar; there were no mixed collar plans in this dataset.

For each industry the exposures and deaths were summed by age, gender, and participant status (healthy annuitants, employees, and disabled) to create six raw mortality tables. The exposures and deaths for each industry were also subtotaled by collar type, resulting in 18 raw experience mortality tables for each industry. No attempt was made to graduate the 72 raw tables in any way.

The mortality experience of each plan was then compared to the average experience for its own industry. Expected deaths were calculated by applying the raw q_x values from the appropriate raw experience mortality tables to the exposures of the plan by gender and participant status. The variance of the expected deaths at each age was calculated by multiplying the expected deaths by the corresponding value of p_x. The expected deaths and their variance were summed for each plan, with subtotals by gender and participant status. This process was repeated using the collar-specific raw experience mortality tables for the industry instead of the overall average raw experience mortality tables for the industry.

Analysis

The ratio of the actual deaths for the plan to the expected deaths was calculated and called the "Plan to Industry Ratio" (P/I). The probability, *p*, that the actual deaths would deviate from the expected deaths by at least as much as the Plan to Industry Ratio was then calculated assuming that the actual deaths were normally distributed with the mean and variance of the expected deaths. These calculations were first done using the overall average experience for the industry ("industry average") and then repeated using the collar-specific raw mortality rates for the industry.

After calculating these probabilities for all 23 plans on both mortality bases (industry average and collar-specific), the plans were stratified into four groups based on the value of *p*. Since the value of *p* can also be interpreted as the probability that the experience of the plan is due to random fluctuations from the mortality basis, a small value of *p* indicates strong statistical significance.

The number of plans in each stratum was counted and the range of Plan to Industry Ratios was noted. Table 6-1 presents the results of this summarization. For each of the mortality bases, the number of plans, the lowest Plan to Industry Ratio, and the highest Plan to Industry Ratio are shown for each of the four strata.

Table 6-1
Variation of Mortality by Plan Within Industry
23 Plans in 4 Industries

Mortality Basis		Significance Stratum			
		p <= .0001	p <= .01 p > .0001	.01< p <= .1	p > .1
Industry Average	# plans	13		4	6
	Lowest P/I	82.0%		91.5%	92.9%
	Highest P/I	129.5%		108.7%	101.4%
Collar Specific	# plans	6	5	3	9
	Lowest P/I	90.2%	86.3%	97.2%	97.3%
	Highest P/I	110.3%	106.0%	115.7%	108.4%

It is worth noting here that these calculations assumed that the raw experience mortality tables represent the true underlying mortality for each plan. In fact these raw experience mortality tables are actually only estimates of the true underlying mortality. For any given plan, the experience of the plan was combined with the experience of other plans from the same industry to calculate this estimate of the true underlying mortality. This results in "overfitting" the model to the data. Therefore, the calculations tend to overstate the probability that actual deaths would deviate from expected by as much as it did and therefore understate the statistical significance of the difference.

Table 6-1 shows that there is less than a 10% probability that the mortality experience of 17 of the 23 plans was due to random fluctuations from the industry average. For 13 of these plans, the probability of the differences being random was less than 0.01%. Even when collar-specific raw experience mortality tables are used, for 14 of the 23 plans the probability that the differences are purely random is less than 10% and for 6 of the plans this probability is less than 0.01%. Using collar-specific tables narrows the range of Plan to Industry Ratios from 82-130% to 86-116%.

This provides very strong evidence that mortality does vary substantially by plan within industry, and that this variation is not purely random. Even mortality tables that are specific for the collar type and industry of the plan are unlikely to match the true underlying mortality of the plan.

Effect of Size of Annuity

Most of the plans in this extract did not provide information on annuity amounts. However, in one of the industries there were nine plans (five white collar, four blue collar) that provided complete information on annuity amounts. For this industry, the exposures and deaths of annuitants from these plans were subtotaled by annuity size group (small, medium, and large) and the healthy annuitants were separated into beneficiaries and retirees. This resulted in a refined mortality basis for comparing the experience of the plans. The mean and variance of the expected deaths for these plans were then calculated using these refined raw experience mortality tables. The results of this analysis are shown in Table 6-2.

The comments made above concerning "overfitting" apply here as well, and the magnitude of the potential overstatement of p is even greater. Furthermore the difference between actual and expected deaths on the industry average basis was significant for only four of the nine plans in this extract. Therefore, the fact that two of these nine plans show significant differences between actual and expected deaths on this refined "fully adjusted" basis is noteworthy.

Table 6-2
Variation of Mortality by Plan Within Industry
9 Plans with Amount Information in One Industry

Mortality Basis		Significance Stratum			
		p <= .0001	p <= .01 p > .0001	.01< p <= .1	p > .1
Industry Average	# plans	2		2	5
	Lowest P/I	118.4%		91.5%	92.9%
	Highest P/I	129.5%		108.7%	99.1%
Collar Specific	# plans		3	1	5
	Lowest P/I		86.3%	115.7%	98.4%
	Highest P/I		106.0%	115.7%	108.4%
Fully Adjusted *	# plans			2	7
	Lowest P/I			88.4%	97.4%
	Highest P/I			111.7%	101.0%

* Adjusted for gender, status, collar, and annuity size group

Conclusion

Statistically significant differences in mortality between plans were found in all four of the industries investigated. The majority of plans had mortality experience that differed from the average experience of plans of the same collar type in the same industry. Adjusting for differences in annuity size explained some of the variation, but statistically significant differences of about plus or minus 12% were still found even after this adjustment.

Chapter 7 - Projections of Mortality Improvement after 2000

Chapter 4 discusses short term projection to the year 2000 based on recent experience. This chapter discusses projection beyond the year 2000 based on long-term experience. Thus the improvement factors observed and recommended in Chapter 4 are different from the improvement factors observed and recommended in this chapter.

Data Sources

The RPEC examined available data on long term trends in non-disabled mortality rates from four sources as bases for projecting future mortality improvements. These trends were compared with Scale AA which had been used to create the GAR-94 generational tables and recommended by the UP-94 Committee for projections of mortality from the basic tables. The results, shown in Table 7-1, are from the following sources:

- Federal Civil Service healthy retiree mortality, 1980 through 1997
- Social Security, all lives, 1980 through 1994
- Railroad Retirement healthy annuitant mortality, 1979 through 1994
- Healthy annuitant and employee mortality from the SoA group annuity mortality studies, 1981 through 1994, based on number of lives
- Healthy annuitant and employee mortality from the SoA group annuity mortality studies, 1981 through 1994, based on amount of benefits
- Scale AA

The Social Security, Railroad Retirement, and SoA group annuity mortality study trends were computed directly using the data for each five-year age group. The underlying Federal Civil Service improvement trends were for individual ages, but were averaged into five-year age groups using a weighted average of the trends for individual ages, where the weights are the expected deaths at the individual ages using Federal Civil Service mortality rates and exposures. Scale AA trend rates were averaged into 5 year age groups beginning at age 20 using a weighted average of the trends for individual ages, where the weights are the number of deaths that would occur for a closed group under the UP-94 mortality table.

Table 7-1
Annualized Long Term Mortality Improvement Trends - Male

Ages	Federal Civil Service	Social Security	Railroad Retirement	Group Annuitant Lives	Group Annuitant Amounts	Scale AA
20-24		0.88%				1.58%
25-29		-0.02%				0.58%
30-34		-1.87%				0.50%
35-39		-2.00%				0.57%
40-44		-0.51%				1.02%
45-49		1.16%				1.51%
50-54		1.87%				1.94%
55-59	0.82%	1.86%		1.87%	2.44%	1.70%
60-64	1.26%	1.49%	2.69%	1.49%	1.35%	1.45%
65-69	1.17%	1.28%	2.00%	1.22%	1.61%	1.36%
70-74	1.58%	1.52%	1.35%	1.40%	2.10%	1.50%
75-79	1.51%	1.21%	0.92%	1.10%	1.59%	1.28%
80-84	1.13%	0.72%	0.62%	0.60%	0.74%	0.85%
85-89	0.64%	0.29%	0.32%	0.24%	0.45%	0.61%
90-94	0.32%	-0.19%		-0.07%	0.47%	0.35%
95-99	0.08%			-1.29%	-1.02%	0.18%

Federal Civil Service: Best-fit log-linear mortality improvement for graduated mortality tables for 1980 to 1997 based on healthy retirees.
Social Security: Best-fit log-linear mortality improvement for 1980 to 1994 from data supplied by Social Security used to prepare Actuarial Study 110 for all employees and retirees.
Railroad Retirement: Best-fit log-linear mortality improvement for 1979 to 1994 from data on healthy annuitants supplied by the Railroad Retirement Board.
Group Annuitant Lives: Best-fit log-linear mortality improvement for 1981 to 1994 from the SoA group annuity mortality studies, based on number of lives.
Group Annuitant Amounts: Best fit log linear mortality improvement for 1981 to 1994 from the SoA group annuity mortality studies, based on amount of benefits.
Scale AA: Weighted average of individual age improvement factors.

Table 7-2
Annualized Long Term Mortality Improvement Trends – Female

Ages	Federal Civil Service	Social Security	Railroad Retirement	Group Annuitant Lives	Group Annuitant Amounts	Scale AA
20-24		1.09%				1.62%
25-29		0.04%				1.22%
30-34		-0.67%				0.90%
35-39		-0.02%				1.32%
40-44		1.09%				1.50%
45-49		1.51%				1.74%
50-54		1.36%				1.39%
55-59	0.22%	0.94%		1.50%	1.90%	0.57%
60-64	-0.67%	0.65%	-0.24%	1.51%	1.90%	0.50%
65-69	0.08%	0.34%	0.69%	0.26%	0.82%	0.50%
70-74	0.48%	0.60%	0.38%	-0.08%	0.84%	0.62%
75-79	0.68%	0.61%	0.08%	-0.27%	0.31%	0.74%
80-84	0.75%	0.74%	1.13%	-0.31%	0.07%	0.70%
85-89	0.29%	0.69%	-0.57%	-0.24%	0.29%	0.45%
90-94	0.00%	0.28%		-0.73%	0.17%	0.27%
95-99	-0.11%			-1.77%	-1.63%	0.16%

Federal Civil Service: Best-fit log-linear mortality improvement for graduated mortality tables for 1980 to 1997 based on healthy retirees.
Social Security: Best-fit log-linear mortality improvement for 1980 to 1994 from data supplied by Social Security used to prepare Actuarial Study 110 for all employees and retirees.
Railroad Retirement: Best-fit log-linear mortality improvement for 1979 to 1994 from data on healthy annuitants supplied by the Railroad Retirement Board.
Group Annuitant Lives: Best-fit log-linear mortality improvement for 1981 to 1994 from the SoA group annuity mortality studies, based on number of lives.
Group Annuitant Amounts: Best fit log linear mortality improvement for 1981 to 1994 from the SoA group annuity mortality studies, based on amount of benefits.
Scale AA: Weighted average of individual age improvement factors

Scale AA had been based on a blend of Federal Civil Service and Social Security experience from 1977 through 1993, with the following adjustments in addition to smoothing the trends:

- A minimum improvement trend of 0.5 percent per year before age 85.
- A maximum improvement trend of 2.0 percent per year.
- Trend graded to 0.1 percent at age 100

The RPEC noted that Scale AA mortality improvement trends are close to the Social Security trends and reasonably consistent with the data for the other groups. The RPEC questioned the validity of a trend greater than zero at ages older than 95, but decided that the data were too limited to make an accurate assessment at these ages. While minor adjustments could have been made, the RPEC concluded that these adjustments were not significant enough to justify a new mortality improvement scale, especially since Scale AA was fairly new. Scale AA is reproduced on the next page as Table 7-3.

The RPEC recommends that, in view of the long history of improvement in non-disabled mortality rates in all of these sets of data, pension valuations should take trends in long term mortality improvement into account. From a theoretical standpoint, the RPEC believes that the use of generational mortality improvement, as in the GAR-94 table, is an appropriate way of reflecting this improvement. In cases where it is not material or cost effective to incorporate generational mortality improvement into a calculation, the actuary should project mortality improvement on a comparable static basis.

The production of a generational table is performed by selecting values from a series of static tables. The static table for year 2000 is the base table shown in this report. The static table for year 2001 is the base table projected one year by Scale AA, and so forth. Mortality rates are selected from the series of static tables based on the year in which an individual reaches the specified age. For example, the mortality rate for an annuitant reaching age 80 in 2010 would be the rate defined by those two parameters. A fuller explanation of the generational mortality process can be found in the report on the 1994 Group Annuity Mortality Table and 1994 Group Annuity Reserving Table in Volume XLVII of the Transactions of the Society of Actuaries.

Table 7-3
Mortality Projection Scale AA

Age	Male	Female	Age	Male	Female	Age	Male	Female
1	0.020	0.020	41	0.009	0.015	81	0.009	0.007
2	0.020	0.020	42	0.010	0.015	82	0.008	0.007
3	0.020	0.020	43	0.011	0.015	83	0.008	0.007
4	0.020	0.020	44	0.012	0.015	84	0.007	0.007
5	0.020	0.020	45	0.013	0.016	85	0.007	0.006
6	0.020	0.020	46	0.014	0.017	86	0.007	0.005
7	0.020	0.020	47	0.015	0.018	87	0.006	0.004
8	0.020	0.020	48	0.016	0.018	88	0.005	0.004
9	0.020	0.020	49	0.017	0.018	89	0.005	0.003
10	0.020	0.020	50	0.018	0.017	90	0.004	0.003
11	0.020	0.020	51	0.019	0.016	91	0.004	0.003
12	0.020	0.020	52	0.020	0.014	92	0.003	0.003
13	0.020	0.020	53	0.020	0.012	93	0.003	0.002
14	0.019	0.018	54	0.020	0.010	94	0.003	0.002
15	0.019	0.016	55	0.019	0.008	95	0.002	0.002
16	0.019	0.015	56	0.018	0.006	96	0.002	0.002
17	0.019	0.014	57	0.017	0.005	97	0.002	0.001
18	0.019	0.014	58	0.016	0.005	98	0.001	0.001
19	0.019	0.015	59	0.016	0.005	99	0.001	0.001
20	0.019	0.016	60	0.016	0.005	100	0.001	0.001
21	0.018	0.017	61	0.015	0.005	101	0.000	0.000
22	0.017	0.017	62	0.015	0.005	102	0.000	0.000
23	0.015	0.016	63	0.014	0.005	103	0.000	0.000
24	0.013	0.015	64	0.014	0.005	104	0.000	0.000
25	0.010	0.014	65	0.014	0.005	105	0.000	0.000
26	0.006	0.012	66	0.013	0.005	106	0.000	0.000
27	0.005	0.012	67	0.013	0.005	107	0.000	0.000
28	0.005	0.012	68	0.014	0.005	108	0.000	0.000
29	0.005	0.012	69	0.014	0.005	109	0.000	0.000
30	0.005	0.010	70	0.015	0.005	110	0.000	0.000
31	0.005	0.008	71	0.015	0.006	111	0.000	0.000
32	0.005	0.008	72	0.015	0.006	112	0.000	0.000
33	0.005	0.009	73	0.015	0.007	113	0.000	0.000
34	0.005	0.010	74	0.015	0.007	114	0.000	0.000
35	0.005	0.011	75	0.014	0.008	115	0.000	0.000
36	0.005	0.012	76	0.014	0.008	116	0.000	0.000
37	0.005	0.013	77	0.013	0.007	117	0.000	0.000
38	0.006	0.014	78	0.012	0.007	118	0.000	0.000
39	0.007	0.015	79	0.011	0.007	119	0.000	0.000
40	0.008	0.015	80	0.010	0.007	120	0.000	0.000

Approximation of Generational Mortality

One method for approximating the effect of full generational mortality improvement is to project the current table for a specified number of years and use the resulting table without further projection. In order to arrive at a similar liability amount, the number of years of projection is approximately equal to (a) the years to the valuation date plus (b) the duration of the liabilities. The "duration" of the liabilities is the negative of the first derivative of the liability with respect to the valuation interest rate, divided by the liability. It can be approximated by the following formula:

$$\text{Duration} \approx \frac{pvb(i) - pvb(i+.001)}{pvb(i) \times .001},$$

where *pvb(i)* is the present value of benefits at the valuation interest rate *i*, and *pvb(i+.001)* is the present value of benefits determined with the interest rate increased by one-tenth of one percentage point, that is, by ten basis points. This calculation should be done separately for male and female.

While a direct theoretical connection between duration of liabilities and mortality projection under Scale AA has not been established, the duration of liabilities for different plans moves in the same direction as the years for projecting mortality. For example, if participants are young with mainly deferred annuities, the duration will be higher than for an older, longer-service group. This corresponds to the additional number of years of mortality improvement that a younger group will experience before receiving benefits. Similarly, a retired group with immediate annuity payments will not experience as many years of mortality improvement as an employee group.

The effect of future mortality will also vary inversely with the investment return rate. In a low interest environment, the impact of future mortality improvement is greater, due to smaller discounts for deferred payments. On the other hand, increasing payments, such as under an automatic COLA plan or post-retirement medical plan, greatly increase the effect of mortality improvement.

When projecting the RP-2000 base table using Scale AA, use of this approximation technique involving duration generally results in present values that are within 0.5 percent of the values using full generational mortality improvement. Although this particular approximation technique works fairly well for Scale AA, it may not be as accurate for other mortality improvement scales, or for populations with very unusual age distributions.

Use of this static projection method would normally result in the need to project the mortality table a different number of years each time the valuation is performed. To avoid this, it would be appropriate for the actuary to consider how long the table is expected to be in use after 2000, and, for purposes of the static projection, to assume a valuation date that is the midpoint of this period.

For example, suppose that a valuation is done each year for a group of retired lives, where the duration of liabilities is 7 years. Assume that the actuary expects to use the RP-2000 Table for valuations to be done in the years 2001 through 2005. The midpoint of this period is 2003, which is three years beyond 2000. Assuming that the composition of the group is not expected to change significantly over this period, the duration of liabilities would remain about the same. The RP-2000 Table could be projected on a static basis for the duration of seven years plus the three years period, or a total of ten years, and this projected table would then be used for the valuations for each year, 2001 through 2005. Appendix G contains a projection of the RP-2000 table for ten years using Scale AA.

Chapter 8 - Comparison of RP-2000 to Other Tables

Comparison to GAM-83 and UP-94 Tables

Tables 8-1 through 8-3 compare annuity values at ten-year age intervals from age 30 to age 90, and at age 65, for the GAM-83, UP-94 without projection, UP-94 projected to 2000, and the RP-2000 with and without projection. Tables 8-1A through 8-3A use the RP2000 combined healthy table. Tables 8-1B through 8-3B use the RP-2000 employee table for ages below 65 and the healthy annuitant tables for ages 65 and older. The lower section of each table gives the percentage change in the annuity values if the mortality assumption for non-disabled lives was changed to the RP-2000 table without projection. Comparisons are also made between the RP-2000 without projection and the RP-2000 with generational projection. The annuities in the table are annuities due, paid monthly. Before age 65, the annuities are deferred to age 65. At and above age 65, the annuities are immediate. Values are presented at 5, 7, and 9 percent interest rates.

In general, the RP-2000 values are between 2 and 11 percent higher for males and between 3 and 5 percent lower for females than the GAM-83 values. The RP-2000 values for males under age 80 are within 4 percent of the values based on the UP-94 table projected to 2000. For males at ages 80 and 90 the RP-2000 values are substantially lower than the projected UP-94 values. For females the RP-2000 values are lower than the projected UP-94 values by about 2 to 4 percent. On average, the male mortality experience used to develop the RP-2000 Table is similar to that of the UP-94 table with projection Scale AA. The female mortality is higher than the projected UP-94 table. This suggests that the mortality improvement predicted by Scale AA between the mid-point of the two female tables did not occur.

The GAM-83 table included a 10 percent margin for mortality improvement so the differences between GAM-83 and RP-2000 are lower than would be produced by applying the full mortality improvement for the 17 years between the two tables. Also, the GAM-83 female mortality rates were estimated based on relatively little actual experience so these are not as comparable to the RP-2000 tables as are the male rates.

Table 8-1A

Comparison of GAM-83, UP-94, UP-94 Projected to 2000, and Combined Healthy RP-2000 Annuity Values

5% Interest

Monthly Annuity Due, Deferred to Age 65

Age	GAM-83	UP-94	UP-94 Projected to 2000	RP-2000 Combined Healthy	RP-2000 Generational Combined Healthy
Males					
30	1.6719	1.7381	1.7945	1.8200	2.1210
40	2.7461	2.8578	2.9496	2.9865	3.3639
50	4.5723	4.7355	4.8813	4.9376	5.3588
60	7.9085	8.0932	8.3013	8.3474	8.7291
65	10.6849	10.9212	11.1488	11.1405	11.4608
70	9.0686	9.3717	9.5971	9.4778	9.7162
80	5.9748	6.2075	6.3437	6.0918	6.1763
90	3.6941	3.6067	3.6564	3.3759	3.3914
Females					
30	2.1306	2.0757	2.0996	2.0270	2.1835
40	3.4866	3.3986	3.4365	3.3168	3.5108
50	5.7373	5.5942	5.6511	5.4623	5.6820
60	9.5875	9.3480	9.4312	9.1490	9.3672
65	12.5635	12.3187	12.4164	12.0795	12.2786
70	10.9401	10.7937	10.9026	10.5153	10.6821
80	7.5385	7.3818	7.4803	7.2304	7.3054
90	4.5369	4.2686	4.3079	4.3052	4.3213

Percent Change in Monthly Annuity Due

Age	From GAM-83 to RP-2000	From UP-94 to RP-2000	From UP-94 Projected to 2000 to RP-2000	From RP-2000 to RP-2000 Generational	
Males					
30	8.86%	4.71%	1.42%	16.54%	
40	8.75%	4.50%	1.25%	12.64%	
50	7.99%	4.27%	1.15%	8.53%	
60	5.55%	3.14%	0.56%	4.57%	
65	4.26%	2.01%	-0.07%	2.88%	
70	4.51%	1.13%	-1.24%	2.52%	
80	1.96%	-1.86%	-3.97%	1.39%	
90	-8.61%	-6.40%	-7.67%	0.46%	
Females					
30	-4.86%	-2.35%	-3.46%	7.72%	
40	-4.87%	-2.41%	-3.48%	5.85%	
50	-4.79%	-2.36%	-3.34%	4.02%	
60	-4.57%	-2.13%	-2.99%	2.38%	
65	-3.85%	-1.94%	-2.71%	1.65%	
70	-3.88%	-2.58%	-3.55%	1.59%	
80	-4.09%	-2.05%	-3.34%	1.04%	
90	-5.11%	0.86%	-0.06%	0.37%	

Table 8-1B

Comparison of GAM-83, UP-94, UP-94 Projected to 2000, and Employee/Healthy Annuitant RP-2000 Annuity Values

5% Interest

Monthly Annuity Due, Deferred to Age 65

Age	GAM-83	UP-94	UP-94 Projected to 2000	RP2000 Employee/ Healthy Annuitant	RP-2000 Generational Employee/ Healthy Annuitant
Males					
30	1.6719	1.7381	1.7945	1.8560	2.1470
40	2.7461	2.8578	2.9496	3.0455	3.4123
50	4.5723	4.7355	4.8813	5.0350	5.4491
60	7.9085	8.0932	8.3013	8.4575	8.8410
65	10.6849	10.9212	11.1488	11.1203	11.4403
70	9.0686	9.3717	9.5971	9.4778	9.7162
80	5.9748	6.2075	6.3437	6.0918	6.1763
90	3.6941	3.6067	3.6564	3.3759	3.3914
Females					
30	2.1306	2.0757	2.0996	2.0504	2.2049
40	3.4866	3.3986	3.4365	3.3551	3.5472
50	5.7373	5.5942	5.6511	5.5253	5.7439
60	9.5875	9.3480	9.4312	9.2292	9.4485
65	12.5635	12.3187	12.4164	12.0578	12.2567
70	10.9401	10.7937	10.9026	10.5153	10.6821
80	7.5385	7.3818	7.4803	7.2304	7.3054
90	4.5369	4.2686	4.3079	4.3052	4.3213

Percent Change in Monthly Annuity Due

Age	From GAM-83 to RP-2000	From UP-94 to RP-2000	From UP-94 Projected to 2000 to RP-2000	From RP-2000 to RP-2000 Generational	
Males					
30	11.01%	6.78%	3.43%	15.68%	
40	10.90%	6.57%	3.25%	12.04%	
50	10.12%	6.33%	3.15%	8.22%	
60	6.94%	4.50%	1.88%	4.53%	
65	4.08%	1.82%	-0.26%	2.88%	
70	4.51%	1.13%	-1.24%	2.52%	
80	1.96%	-1.86%	-3.97%	1.39%	
90	-8.61%	-6.40%	-7.67%	0.46%	
Females					
30	-3.76%	-1.22%	-2.34%	7.53%	
40	-3.77%	-1.28%	-2.37%	5.72%	
50	-3.70%	-1.23%	-2.23%	3.96%	
60	-3.74%	-1.27%	-2.14%	2.38%	
65	-4.02%	-2.12%	-2.89%	1.65%	
70	-3.88%	-2.58%	-3.55%	1.59%	
80	-4.09%	-2.05%	-3.34%	1.04%	
90	-5.11%	0.86%	-0.06%	0.37%	

Table 8-2A

Comparison of GAM-83, UP-94, UP-94 Projected to 2000, and Combined Healthy RP-2000 Annuity Values

7% Interest

Monthly Annuity Due, Deferred to Age 65

Age	GAM-83	UP-94	UP-94 Projected to 2000	RP-2000 Combined Healthy	RP-2000 Generational Combined Healthy
Males					
30	0.7471	0.7740	0.7971	0.8100	0.9280
40	1.4820	1.5370	1.5823	1.6052	1.7830
50	2.9800	3.0757	3.1622	3.2049	3.4410
60	6.2247	6.3481	6.4946	6.5434	6.7940
65	9.2421	9.4138	9.5853	9.5968	9.8220
70	8.0059	8.2450	8.4238	8.3430	8.5210
80	5.4804	5.6845	5.8012	5.5945	5.6640
90	3.4933	3.4179	3.4631	3.2074	3.2210
Females					
30	0.9307	0.9088	0.9181	0.8899	0.9483
40	1.8394	1.7969	1.8147	1.7585	1.8451
50	3.6554	3.5720	3.6037	3.4973	3.6136
60	7.3769	7.2084	7.2632	7.0742	7.2100
65	10.6232	10.4390	10.5083	10.2643	10.3974
70	9.4502	9.3420	9.4243	9.1227	9.2420
80	6.7936	6.6724	6.7551	6.5402	6.6000
90	4.2524	4.0113	4.0465	4.0321	4.0459

Percent Change in Monthly Annuity Due

Age	From GAM-83 to RP-2000	From UP-94 to RP-2000	From UP-94 Projected to 2000 to RP-2000	From RP-2000 to RP-2000 Generational	
Males					
30	8.42%	4.65%	1.62%	14.57%	
40	8.31%	4.44%	1.45%	11.08%	
50	7.55%	4.20%	1.35%	7.37%	
60	5.12%	3.08%	0.75%	3.83%	
65	3.84%	1.94%	0.12%	2.35%	
70	4.21%	1.19%	-0.96%	2.13%	
80	2.08%	-1.58%	-3.56%	1.24%	
90	-8.18%	-6.16%	-7.38%	0.42%	
Females					
30	-4.38%	-2.08%	-3.07%	6.56%	
40	-4.40%	-2.14%	-3.10%	4.92%	
50	-4.33%	-2.09%	-2.95%	3.33%	
60	-4.10%	-1.86%	-2.60%	1.92%	
65	-3.38%	-1.67%	-2.32%	1.30%	
70	-3.47%	-2.35%	-3.20%	1.31%	
80	-3.73%	-1.98%	-3.18%	0.91%	
90	-5.18%	0.52%	-0.36%	0.34%	

Table 8-2B

Comparison of GAM-83, UP-94, UP-94 Projected to 2000, and Employee/Healthy Annuitant RP-2000 Annuity Values

7% Interest

Monthly Annuity Due, Deferred to Age 65

Age	GAM-83	UP-94	UP-94 Projected to 2000	RP2000 Employee/ Healthy Annuitant	RP-2000 Generational Employee/ Healthy Annuitant
Males					
30	0.7471	0.7740	0.7971	0.8261	0.9392
40	1.4820	1.5370	1.5823	1.6370	1.8084
50	2.9800	3.0757	3.1622	3.2684	3.4994
60	6.2247	6.3481	6.4946	6.6300	6.8818
65	9.2421	9.4138	9.5853	9.5799	9.8049
70	8.0059	8.2450	8.4238	8.3430	8.5210
80	5.4804	5.6845	5.8012	5.5945	5.6640
90	3.4933	3.4179	3.4631	3.2074	3.2210
Females					
30	0.9307	0.9088	0.9181	0.9002	0.9576
40	1.8394	1.7969	1.8147	1.7789	1.8642
50	3.6554	3.5720	3.6037	3.5379	3.6532
60	7.3769	7.2084	7.2632	7.1366	7.2730
65	10.6232	10.4390	10.5083	10.2464	10.3795
70	9.4502	9.3420	9.4243	9.1227	9.2420
80	6.7936	6.6724	6.7551	6.5402	6.6000
90	4.2524	4.0113	4.0465	4.0321	4.0459

Percent Change in Monthly Annuity Due

Age	From GAM-83 to RP-2000	From UP-94 to RP-2000	From UP-94 Projected to 2000 to RP-2000	From RP-2000 to RP-2000 Generational	
Males					
30	10.57%	6.73%	3.63%	13.69%	
40	10.46%	6.50%	3.45%	10.47%	
50	9.68%	6.26%	3.36%	7.07%	
60	6.51%	4.44%	2.08%	3.80%	
65	3.65%	1.76%	-0.06%	2.35%	
70	4.21%	1.19%	-0.96%	2.13%	
80	2.08%	-1.58%	-3.56%	1.24%	
90	-8.18%	-6.16%	-7.38%	0.42%	
Females					
30	-3.28%	-0.95%	-1.95%	6.38%	
40	-3.29%	-1.00%	-1.97%	4.80%	
50	-3.22%	-0.96%	-1.83%	3.26%	
60	-3.26%	-1.00%	-1.74%	1.91%	
65	-3.55%	-1.85%	-2.49%	1.30%	
70	-3.47%	-2.35%	-3.20%	1.31%	
80	-3.73%	-1.98%	-3.18%	0.91%	
90	-5.18%	0.52%	-0.36%	0.34%	

Table 8-3A

Comparison of GAM-83, UP-94, UP-94 Projected to 2000, and Combined Healthy RP-2000 Annuity Values

9% Interest

Monthly Annuity Due, Deferred to Age 65

Age	GAM-83	UP-94	UP-94 Projected to 2000	RP-2000 Combined Healthy	RP-2000 Generational Combined Healthy
Males					
30	0.3432	0.3546	0.3644	0.3708	0.4187
40	0.8194	0.8473	0.8705	0.8842	0.9707
50	1.9829	2.0407	2.0936	2.1247	2.2613
60	4.9846	5.0688	5.1745	5.2204	5.3896
65	8.1189	8.2458	8.3779	8.3993	8.5609
70	7.1532	7.3445	7.4889	7.4338	7.5685
80	5.0608	5.2410	5.3420	5.1706	5.2277
90	3.3148	3.2495	3.2908	3.0567	3.0688
Females					
30	0.4197	0.4105	0.4144	0.4029	0.4257
40	0.9983	0.9769	0.9856	0.9583	0.9984
50	2.3875	2.3371	2.3554	2.2936	2.3573
60	5.7986	5.6759	5.7131	5.5833	5.6702
65	9.1603	9.0171	9.0675	8.8870	8.9782
70	8.2903	8.2076	8.2710	8.0323	8.1192
80	6.1758	6.0813	6.1515	5.9658	6.0141
90	4.0020	3.7844	3.8162	3.7936	3.8056

Percent Change in Monthly Annuity Due

Age	From GAM-83 to RP-2000	From UP-94 to RP-2000	From UP-94 Projected to 2000 to RP-2000	From RP-2000 to RP-2000 Generational	
Males					
30	8.04%	4.57%	1.76%	12.92%	
40	7.91%	4.36%	1.57%	9.78%	
50	7.15%	4.12%	1.49%	6.43%	
60	4.73%	2.99%	0.89%	3.24%	
65	3.45%	1.86%	0.26%	1.92%	
70	3.92%	1.22%	-0.74%	1.81%	
80	2.17%	-1.34%	-3.21%	1.10%	
90	-7.79%	-5.93%	-7.11%	0.40%	
Females					
30	-4.00%	-1.85%	-2.78%	5.66%	
40	-4.01%	-1.90%	-2.77%	4.18%	
50	-3.93%	-1.86%	-2.62%	2.78%	
60	-3.71%	-1.63%	-2.27%	1.56%	
65	-2.98%	-1.44%	-1.99%	1.03%	
70	-3.11%	-2.14%	-2.89%	1.08%	
80	-3.40%	-1.90%	-3.02%	0.81%	
90	-5.21%	0.24%	-0.59%	0.32%	

Table 8-3B

Comparison of GAM-83, UP-94, UP-94 Projected to 2000, and Employee/Healthy Annuitant RP-2000 Annuity Values

9% Interest

Monthly Annuity Due, Deferred to Age 65

Age	GAM-83	UP-94	UP-94 Projected to 2000	RP2000 Employee/ Healthy Annuitant	RP-2000 Generational Employee/ Healthy Annuitant
Males					
30	0.3432	0.3546	0.3644	0.3781	0.4238
40	0.8194	0.8473	0.8705	0.9018	0.9847
50	1.9829	2.0407	2.0936	2.1669	2.2996
60	4.9846	5.0688	5.1745	5.2898	5.4592
65	8.1189	8.2458	8.3779	8.3850	8.5465
70	7.1532	7.3445	7.4889	7.4338	7.5685
80	5.0608	5.2410	5.3420	5.1706	5.2277
90	3.3148	3.2495	3.2908	3.0567	3.0688
Females					
30	0.4197	0.4105	0.4144	0.4076	0.4299
40	0.9983	0.9769	0.9856	0.9694	1.0089
50	2.3875	2.3371	2.3554	2.3203	2.3833
60	5.7986	5.6759	5.7131	5.6328	5.7199
65	9.1603	9.0171	9.0675	8.8720	8.9631
70	8.2903	8.2076	8.2710	8.0323	8.1192
80	6.1758	6.0813	6.1515	5.9658	6.0141
90	4.0020	3.7844	3.8162	3.7936	3.8056

Percent Change in Monthly Annuity Due

Age	From GAM-83 to RP-2000	From UP-94 to RP-2000	From UP-94 Projected to 2000 to RP-2000	From RP-2000 to RP-2000 Generational	
Males					
30	10.18%	6.64%	3.77%	12.08%	
40	10.06%	6.43%	3.60%	9.19%	
50	9.28%	6.18%	3.50%	6.13%	
60	6.12%	4.36%	2.23%	3.20%	
65	3.28%	1.69%	0.08%	1.93%	
70	3.92%	1.22%	-0.74%	1.81%	
80	2.17%	-1.34%	-3.21%	1.10%	
90	-7.79%	-5.93%	-7.11%	0.40%	
Females					
30	-2.87%	-0.69%	-1.63%	5.46%	
40	-2.89%	-0.76%	-1.64%	4.07%	
50	-2.81%	-0.72%	-1.49%	2.71%	
60	-2.86%	-0.76%	-1.40%	1.55%	
65	-3.15%	-1.61%	-2.16%	1.03%	
70	-3.11%	-2.14%	-2.89%	1.08%	
80	-3.40%	-1.90%	-3.02%	0.81%	
90	-5.21%	0.24%	-0.59%	0.32%	

Comparison of Blended and Separate Employee and Healthy Annuitant Tables

The RPEC suggests that a blended healthy lives mortality table can be used if it is not practical to use the separate employee and healthy retiree tables. This section shows the effect of using the blended tables. The section also compares both results to those using the GAM-83 table without projection.

Tables 8-4 to 8-6 compare the present value of accrued benefits using the RP-2000 with separate active and annuitant tables to values using the RP-2000 blended table for different interest rates and proportion female. For comparison, present values assuming GAM-83 and UP-94 mortality are also included.

The sample population and accrued benefits were obtained from PBGC's Pension Information Management System (PIMS) Model. The PIMS model was developed based on Form 5500 data for 265 large pension plans. The following assumptions were selected with variations for interest and the proportion of females:

- Terminated vested employees were valued using the employee mortality table.
- Retirement rates were 2 percent a year for ages 50-54, 3 percent a year for ages 55-59, 10 percent a year for ages 60-61, 15 percent a year for ages 62-64, and 100 percent at age 65.
- Early retirement reductions were 1/15 for each of the first 5 years before age 65 and 1/30 for each of the next 5 years, i.e., half of the accrued benefit is paid at age 55.

The liabilities for the RP-2000 blended are quite close to the results of using the RP-2000 separate tables for all variations of interest and male/female mix. The RP-2000 results are also close to the GAM-83 and UP-94 tables for a 50% male/female mix. The RP-2000 results are higher than the earlier tables for the 75% male population and lower for the 75% female population.

Table 8-4
Comparison of Current Liabilities
Using PIMS Census Assuming 50% Male 50% Female

	Interest 7.5%			
	Active/Retiree	Blended	GAM-83 w/o projection	UP-94 w/o projection
Current Liability Actives (4599)	168,742,000	168,461,000	167,644,000	167,650,000
Current Liability Retirees & Terms (4625)	303,373,000	303,475,000	304,212,000	304,965,000
Current Liability Total (9224)	472,115,000	471,936,000	471,856,000	472,615,000
	Interest 7%			
	Active/Retiree	Blended	GAM-83 w/o projection	UP-94 w/o projection
Current Liability Actives	183,610,000	183,297,000	182,405,000	182,434,000
Current Liability Retirees & Terms	314,864,000	314,968,000	315,778,000	316,559,000
Current Liability Total	498,474,000	498,265,000	498,183,000	498,993,000
	Interest 8%			
	Active/Retiree	Blended	GAM-83 w/o projection	UP-94 w/o projection
Current Liability Actives	155,438,000	155,201,000	154,449,000	154,436,000
Current Liability Retirees & Terms	292,687,000	292,809,000	293,462,000	294,189,000
Current Liability Total	448,125,000	448,010,000	447,911,000	448,625,000
	Interest 9%			
	Active/Retiree	Blended	GAM-83 w/o projection	UP-94 w/o projection
Current Liability Actives	132,802,000	132,623,000	131,992,000	131,948,000
Current Liability Retirees & Terms	273,441,000	273,573,000	274,102,000	274,778,000
Current Liability Total	406,243,000	406,196,000	406,094,000	406,726,000

Table 8-5
Comparison of Current Liabilities
Using PIMS Census Assuming 75% Male 25% Female

Interest 7.5%

	Active/Retiree	Blended	GAM-83 w/o projection	UP-94 w/o projection
Current Liability Actives (4599)	166,162,182	165,813,163	161,684,505	163,244,113
Current Liability Retireds & Terms (4625)	296,554,801	296,652,769	292,276,674	295,998,275
Current Liability Total (9224)	462,716,983	462,465,932	453,961,179	459,242,388

Table 8-6
Comparison of Current Liabilities
Using PIMS Census Assuming 75% Female 25% Male

Interest 7.5%

	Active/Retiree	Blended	GAM-83 w/o projection	UP-94 w/o projection
Current Liability Actives (4599)	171,300,936	171,106,546	173,584,205	172,041,624
Current Liability Retireds & Terms (4625)	310,196,356	310,327,549	316,150,942	313,937,623
Current Liability Total (9224)	481,497,292	481,434,095	489,735,147	485,979,247

Appendix A

SOCIETY OF ACTUARIES

475 N. MARTINGALE RD., SUITE 800, SCHAUMBURG, IL 60173-2226 847/706-3500
847/706-3599 *FAX*

September 29, 1995

Dear Pension Section Member:

The Retirement Plans Experience Committee of the Society of Actuaries is collecting pension mortality data to evaluate mortality experience in the first half of the 1990s. The Committee hopes to gather sufficient data from each type of plan to determine if the mortality for that type of plan is significantly different from mortality for other types of plans. The Committee will develop adjustments to a standard, which could be a new table developed by the Committee.

The Retirement Protection Act of 1994 [RPA], passed as part of the GATT legislation, imposes the requirement to use a prescribed mortality table for certain pension funding calculations. Current liability for affected plans must be calculated using the 1983 GAM table through 1999. The Secretary of Treasury can promulgate a new table in the year 2000. Thereafter, the Secretary will be able to change the mortality standard every five years. During the legislative debate leading up to enactment of RPA, federal regulators argued that a standard mortality table was needed to minimize a company's ability to reduce its minimum funding obligation by using inappropriate tables. Industry groups pointed out that a standard table would have the effect of overstating calculated liabilities for some plans while understating them for others. The Society of Actuaries believes it is in everyone's best interests to have "standard" mortality tables that credibly reflect the expected experience of the participant population. This suggests having different tables for groups with significant differences in mortality experience such as hourly and salaried groups, for example.

As part of an ongoing effort, the Society of Actuaries Retirement Plans Experience Committee is collecting pension data to evaluate trends in mortality experience. The Committee is periodically briefing federal regulators on its work and will complete this round of analysis in 1997. In addition to providing pension actuaries with current mortality information, the Committee hopes that federal regulators will consider its work product in developing the next RPA mortality tables.

For previous mortality experience review cycles the Committee has had relatively little private employer data and has had to rely largely on data provided by the U.S. Civil Service retirement

programs. In order to measure mortality differences between types of workers and types of industries, the Committee will need a large volume of data for each. Companies that sponsor plans affected by the current liability funding provisions would be well advised to send their data. The likely alternative to "tailored" tables is a one-size-fits-all table that will overstate or understate calculated liabilities for many plans. For example, an overstatement would result in front-loading minimum funding requirements.

The enclosed Data Submission Instructions describe the data and format being requested. As noted, a separate "chart" for each year, gender and participant status group [for example, employee and retiree or beneficiary] for each plan should be submitted. Please submit data both on hardcopy and IBM PC compatible diskette (ASCII text), if possible. Submissions with all requested data are preferred but partial submissions are acceptable. The most important data is the non-disabled retiree data with an indication of the hourly, salaried and union composition of the group and the sponsor's Standard Industrial Code applicable to the participant group.

Data should be mailed by December 31, 1995, to Mr. Thomas Edwalds, Society of Actuaries, 475 N. Martingale Road, Suite 800, Schaumburg, IL 60173-2226 [708-706-3578]. He will record submissions received and then forward them to an outside contractor for analysis. The contractor will likely be a university, the assigned staff employees of which will sign confidentiality agreements, and the identity of the data will be masked—the Committee will not have access to information that could be used to link specific data to a contributing company.

If you have any question about the data submission process or would like to discuss alternatives, call the Committee chairman, Edwin Hustead at 202-637-6640.

Sincerely,

Edwin Hustead, Chairman
Retirement Plans Experience Committee

Society of Actuaries Retirement Plans Experience Committee
Mortality Rate Research Project

INSTRUCTIONS FOR DATA SUBMISSION

I. Information on participants covered by plan
See Sample Data Submission Chart attached.

A separate cell is defined by:

- Plan Number - assigned by Data Contributor.
- Participant Type (Salaried, Hourly, Union, or any combination) - if plan covers more than one type of participant, separate data is preferred. If not possible, indicate approximate percentages of each type:

	Salaried	Hourly	Unknown
Union	_____	_____	_____
Non-union	_____	_____	_____
Unknown	_____	_____	_____

- Valuation date (see II below) - determine exposure data as of valuation date and deaths during the 12-month period following valuation date.
- Age - provide age nearest valuation date (indicate if other method used).
- Sex.
- Participant Status in Valuation (Employee, Non-Disabled Retiree, Disabled Retiree or Beneficiary) - if two or more categories are grouped together, identify which ones are included. The data should not include terminated vested and disabled employees not in pay status. Separate information on the latter two categories would be useful if available.
- Annuity Size (Small, Medium, or Large) - for non-employee cells only, provide data separately for small annuities (less than $6,000 per year), medium annuities ($6,000-$14,400 per year), and large annuities (more than $14,400 per year). If possible, the straight life equivalent of an optional form of annuity should be used.

For each cell, show:

- o Number of Participants at valuation date.

- o Total Annual Pay of Group (Employee cells only), if available
  - total pay for all individuals in the cell
  - if possible, pay should reflect the plan definition and be restricted by 401(a)(17) or other plan limitations.

- o Total Annual Benefit for Group (Non-Employee cells only), if available
  - total benefits for all individuals in the cell
  - if available, payable as a straight life annuity (or its equivalent for inactives who selected an optional payment form).

- o Deaths during 12-month period following valuation date (even if not first day of plan year). Report number and total annual pay for employee deaths, or, number and total annual benefits for annuitant deaths. Exclude deaths of those not included in valuation date.

II. Measurement Period

The preferred period is plan years ending in 1990-1994, but other periods will be useful if these years are not available. For example, if valuation date is **not** the first day of plan year, 1994 deaths may not yet be available. In that case, the preferred period would be plan years ending in 1989-1993. In general, partial year data submissions with gaps in earlier years are preferable to submissions with gaps in more recent years.

Example 1
Plan year 1991: 1/1/91 - 12/31/91 Valuation date: 1/1/91
Action: Report participant exposure information as of 1/1/91 and information for deaths occurring 1/1/91 - 12/31/91.

Example 2
Plan year 1991: 1/1/91 - 12/31/91 Valuation date: 12/31/91
Action: Report participant exposure information as of 12/31/91 and information for deaths occurring 12/31/91 - 12/30/92.

Example 3
Plan year 1991: 10/1/90 - 9/30/91 Valuation date: 4/1/91
Action: Report participant exposure information as of 4/1/91 and information for deaths occurring 4/1/91 - 3/31/92.

III. General Information

For each plan, provide the following by cell group:

- o Plan Sponsor's Business Code (see attached codes and select the one which appears on Plan's Form 5500).

IV. Additional Information

Please provide a brief summary of plan eligibility and benefits formula. It is particularly important to state the disability provisions of the plan.

Should your file possess additional data which would be valuable for mortality analysis, additional fields with appropriate explanation would be helpful.

We encourage Data Contributors to provide summarized information as shown in the Sample Data Submission Chart attached, but will accept seriatim data as an alternative, if necessary.

SAMPLE DATA SUBMISSION CHART

Census of Participants of Plan 001 submitted by ABC Consultants
for Year ending 12/31/90 - Male Non-Disabled Retirees (Small Annuities)

Age Nearest as of 1/1/90	PARTICIPANTS		DEATHS	
	Number	Total Annual Benefit	Number	Total Annual Benefit
50	100	500,000	1	4,000
51	50	200,000	0	0
52	150	450,000	1	5,000
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
85	25	50,000	2	6,000
86	20	80,000	1	2,000
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
Total	10,000	40,000,000	50	200,000

Codes for Principal Business Activity and Principal Product or Service

These industry titles and definitions are based, in general, on the Enterprise Standard Industrial Classification System authorized by the Regulatory and Statistical Analysis Division, Office of Information and Regulatory Affairs, Office of Management and Budget, to classify enterprises by type of activity in which they are engaged.

AGRICULTURE, FORESTRY, AND FISHING

Code
0120 Field crop.
0150 Fruit, tree nut, and vegetable.
0180 Horticultural specialty.
0230 Livestock.
0270 Animal specialty.

Agricultural services and forestry:

0740 Veterinary services.
0750 Animal services, except veterinary.
0780 Landscape and horticultural services.
0790 Other agricultural services.
0800 Forestry.

Farms:

Fishing, hunting, and trapping:

0930 Commercial fishing, hatcheries, and preserves.
0970 Hunting, trapping, and game propagation.

MINING

Metal mining:

1010 Iron ores.
1070 Copper, lead and zinc, gold and silver ores.
1098 Other metal mining.
1150 Coal mining.

Oil and gas extraction:

1330 Crude petroleum, natural gas, and natural gas liquids.
1380 Oil and gas field services.

Nonmetallic minerals (except fuels) mining:

1430 Dimension, crushed and broken stone; sand and gravel.
1498 Other nonmetallic minerals, except fuels.

CONSTRUCTION

General building contractors and operative builders:

1510 General building contractors.
1531 Operative builders.

Heavy construction contractors:

1611 Highway and street construction.
1620 Heavy construction, except highway.

Special trade contractors:

1711 Plumbing, heating, and air conditioning.
1721 Painting, paperhanging, and decorating.
1731 Electrical work.
1740 Masonry, stonework, and plastering.
1750 Carpentering and flooring.
1761 Roofing and sheet metal work.
1771 Concrete work.
1781 Water well drilling.
1790 Miscellaneous special trade contractors.

MANUFACTURING

Food and kindred products:

2010 Meat products.
2020 Dairy products.
2030 Preserved fruits and vegetables.
2040 Grain mill products.
2050 Bakery products.
2060 Sugar and confectionary products.
2081 Malt liquors and malt.
2088 Alcoholic beverages, except malt liquors and malt.
2089 Bottled soft drinks and flavorings.
2096 Other food and kindred products.
2100 Tobacco manufacturers.

Textile mill products:

2228 Weaving mills and textile finishing.
2250 Knitting mills.
2298 Other textile mill products.

Apparel and other textile products:

2315 Men's and boys' clothing.

Code
2345 Women's and children's clothing.
2388 Hats, caps, millinery, fur goods, and other apparel and accessories.
2390 Misc. fabricated textile products.

Lumber and wood products:

2415 Logging camps and logging contractors, sawmills, and planing mills.
2430 Millwork, plywood, and related products.
2498 Other wood products, including wood buildings and mobile homes.
2500 Furniture and fixtures.

Paper and allied products:

2625 Pulp, paper, and board mills.
2699 Other paper products.

Printing, publishing, and allied industries:

2710 Newspapers.
2720 Periodicals.
2735 Books, greeting cards, and miscellaneous publishing.
2799 Commercial and other printing, and printing trade services.

Chemical and allied products:

2815 Industrial chemicals, plastics materials, and synthetics.
2830 Drugs.
2840 Soap, cleaners, and toilet goods.
2850 Paints and allied products.
2898 Agricultural and other chemical products.

Petroleum refining and related industries (including those integrated with extraction):

2910 Petroleum refining (including those integrated with extraction).
2998 Other petroleum and coal products.

Rubber and miscellaneous plastics products:

3050 Rubber products, plastics footwear, hose, and belting.
3070 Misc. plastics products.

Leather and leather products:

3140 Footwear, except rubber.
3198 Other leather and leather products.

Stone, clay, glass, and concrete products:

3225 Glass products.
3240 Cement, hydraulic.
3270 Concrete, gypsum, and plaster products.
3298 Other nonmetallic mineral products.

Primary metal industries:

3370 Ferrous metal industries; miscellaneous primary metal products.
3380 Nonferrous metal industries.

Fabricated metal products, except machinery and transportation equipment:

3410 Metal cans and shipping containers.
3428 Cutlery, hand tools, and hardware; screw machine products, bolts, and similar products.
3430 Plumbing and heating, except electric and warm air.
3440 Fabricated structural metal products.
3460 Metal forgings and stampings.
3470 Coating, engraving, and allied services.
3480 Ordnance and accessories, except vehicles and guided missiles.
3490 Miscellaneous fabricated metal products.

Machinery, except electrical:

3520 Farm machinery.
3530 Construction, mining and materials handling machinery, and equipment.
3540 Metalworking machinery.
3550 Special industry machinery, except metalworking machinery.
3560 General industrial machinery.
3570 Office, computing, and accounting machines.

Code
3598 Engines and turbines, service industry machinery, and other machinery, except electrical.

Electrical and electronic machinery, equipment, and supplies:

3630 Household appliances.
3665 Radio, television, and communication equipment.
3670 Electronic components and accessories.
3698 Other electric equipment.

Transportation equipment:

3710 Motor vehicles and equipment.
3725 Aircraft, guided missiles, and parts.
3730 Ship and boat building and repairing.
3798 Other transportation equipment.

Measuring and controlling instruments; photographic and medical goods, watches and clocks:

3815 Scientific instruments and measuring devices; watches and clocks.
3845 Optical, medical, and ophthalmic goods.
3860 Photographic equipment and supplies.
3998 Other manufacturing products.

TRANSPORTATION, COMMUNICATION, ELECTRIC, GAS, SANITARY SERVICES

Transportation:

4000 Railroad transportation.

Local and interurban passenger transit:

4121 Taxicabs.
4189 Other passenger transportation.

Trucking and warehousing:

4210 Trucking, local and long distance.
4289 Public warehousing and trucking terminals.

Other transportation including transportation services:

4400 Water transportation.
4500 Transportation by air.
4600 Pipelines, except natural gas.
4722 Passenger transportation arrangement.
4723 Freight transportation arrangement.
4799 Other transportation services.

Communication:

4825 Telephone, telegraph, and other communication services.
4830 Radio and television broadcasting.

Electric, gas, and sanitary services:

4910 Electric services.
4920 Gas production and distribution.
4930 Combination utility services.
4990 Water supply and other sanitary services.

WHOLESALE TRADE

Durable:

5010 Motor vehicles and automotive equipment.
5020 Furniture and home furnishings.
5030 Lumber and construction materials.
5040 Sporting, recreational, photographic, and hobby goods, toys, and supplies.
5050 Metals and minerals, except petroleum and scrap.
5060 Electrical goods.
5070 Hardware, plumbing, and heating equipment.
5083 Farm machinery and equipment.
5089 Other machinery, equipment, and supplies.
5098 Other durable goods.

Nondurable:

5110 Paper and paper products.
5129 Drugs, drug proprietaries, and druggists' sundries.
5130 Apparel, piece goods, and notions.
5140 Groceries and related products, except meats and meat products.
5147 Meats and meat products.
5150 Farm product raw materials.
5160 Chemicals and allied products.
5170 Petroleum and petroleum products.
5180 Alcoholic beverages.
5190 Miscellaneous nondurable goods.

RETAIL TRADE

Code

Building materials hardware, garden supply, and mobile home dealers:

5211 Lumber and other building materials dealers.
5231 Paint, glass, and wallpaper stores.
5251 Hardware stores.
5261 Retail nurseries and garden stores.
5271 Mobile home dealers.

General merchandise:

5331 Variety stores.
5398 Other general merchandise stores.

Food stores:

5411 Grocery stores.
5420 Meat and fish markets and freezer provisioners.
5431 Fruit stores and vegetable markets.
5441 Candy, nut, and confectionary stores.
5451 Dairy products stores.
5460 Retail bakeries.
5490 Other food stores.

Automotive dealers and service stations:

5511 New car dealers (franchised).
5521 Used car dealers.
5531 Auto and home supply stores.
5541 Gasoline service stations.
5551 Boat dealers.
5561 Recreational vehicle dealers.
5571 Motorcycle dealers.
5599 Aircraft and other automotive dealers.

Apparel and accessory stores:

5611 Men's and boys' clothing and furnishings.
5621 Women's ready-to-wear stores.
5631 Women's accessory and specialty stores.
5641 Children's and infants' wear stores.
5651 Family clothing stores.
5661 Shoe stores.
5681 Furriers and fur shops.
5699 Other apparel and accessory stores.

Furniture, home furnishings, and equipment stores:

5712 Furniture stores.
5713 Floor covering stores.
5714 Drapery, curtain, and upholstery stores.
5719 Home furnishings, except appliances.
5722 Household appliance stores.
5732 Radio and television stores.
5733 Music stores.

Eating and drinking places:

5812 Eating places.
5813 Drinking places.

Miscellaneous retail stores:

5912 Drug stores and proprietary stores.
5921 Liquor stores.
5931 Used merchandise stores.
5941 Sporting goods stores and bicycle shops.
5942 Book stores.
5943 Stationery stores.
5944 Jewelry stores.
5945 Hobby, toy, and game shops.
5946 Camera and photographic supply stores.
5947 Gift, novelty, and souvenir shops.
5948 Luggage and leather goods stores.
5949 Sewing, needlework, and piece goods stores.
5961 Mail order houses.

Code

5962 Merchandising machine operators.
5963 Direct selling organizations.
5982 Fuel and ice dealers (except fuel oil and bottle gas dealers).
5983 Fuel oil dealers.
5984 Liquefied petroleum gas (bottled gas).
5992 Florists.
5993 Cigar stores and stands.
5994 News dealers and newsstands.
5996 Other miscellaneous retail stores.

FINANCE, INSURANCE, AND REAL ESTATE

Banking:

6030 Mutual savings banks.
6060 Banking holding companies.
6090 Banks, except mutual savings banks and bank holding companies.

Credit agencies other than banks:

6120 Savings and loan associations.
6140 Personal credit institutions.
6150 Business credit institutions.
6199 Other credit agencies.

Security, commodity brokers, dealers, exchanges, and services:

6212 Security underwriting syndicates.
6218 Security brokers and dealers, except underwriting syndicates.
6299 Commodity contract brokers and dealers; security and commodity exchanges; and allied services.

Insurance:

6355 Life insurance.
6356 Mutual insurance, except life or marine and certain fire or flood insurance companies.
6359 Other insurance companies.
6411 Insurance agents, brokers, and services.

Real estate:

6511 Real estate operators (except developers) and lessors of buildings.
6516 Lessors of mining, oil, and similar property.
6518 Lessors of railroad property and other real property.
6531 Real estate agents, brokers, and managers.
6541 Title abstract offices.
6552 Subdividers and developers, except cemeteries.
6553 Cemetery subdividers and developers.
6599 Other real estate.
6611 Combined real estate, insurance, loans, and law offices.

Holding and other investment companies:

6742 Regulated investment companies.
6743 Real estate investment trusts.
6744 Small business investment companies.
6749 Holding and other investment companies, except bank holding companies.

SERVICES

Hotels and other lodging places:

7012 Hotels.
7013 Motels, motor hotels, and tourist courts.
7021 Rooming and boarding houses.
7032 Sporting and recreational camps.
7033 Trailer parks and camp sites.
7041 Organizational hotels and lodging houses on a membership basis.

Code

Personal services:

7215 Coin-operated laundries and dry cleaning.
7219 Other laundry, cleaning, and garment services.
7221 Photographic studios, portrait.
7231 Beauty shops.
7241 Barber shops.
7251 Shoe repair and hat cleaning shops.
7261 Funeral services and crematories.
7299 Miscellaneous personal services.

Business services:

7310 Advertising.
7340 Services to buildings.
7370 Computer and data processing services.
7392 Management, consulting, and public relations services.
7394 Equipment rental and leasing.
7398 Other business services.

Automotive repair and services:

7510 Automotive rentals and leasing, without drivers.
7520 Automobile parking.
7531 Automobile top and body repair shops.
7538 General automobile repair shops.
7539 Other automobile repair shops.
7540 Automobile services, except repair.

Miscellaneous repair services:

7622 Radio and TV repair shops.
7628 Electrical repair shops, except radio and TV.
7641 Reupholstery and furniture repair.
7680 Other miscellaneous repair shops.

Motion pictures:

7812 Motion picture production, distribution, and services.
7830 Motion picture theaters.

Amusement and recreation services:

7920 Producers, orchestras, and entertainers.
7932 Billiard and pool establishments.
7933 Bowling alleys.
7980 Other amusement and recreation services.

Medical and health services:

8011 Offices of physicians.
8021 Offices of dentists.
8031 Offices of osteopathic physicians.
8041 Offices of chiropractors.
8042 Offices of optometrists.
8048 Registered and practical nurses.
8050 Nursing and personal care facilities.
8060 Hospitals.
8071 Medical laboratories.
8072 Dental laboratories.
8098 Other medical and health services.

Other services:

8111 Legal services.
8200 Educational services.
8911 Engineering and architectural services.
8932 Certified public accountants.
8933 Other accounting, auditing, and bookkeeping services.
8999 Other services not classified elsewhere.

TAX-EXEMPT ORGANIZATIONS

9002 Church plans making an election under section 410(d) of the Internal Revenue Code.
9319 Other tax-exempt organizations.
9904 Governmental instrumentality or agency.

Appendix B
Effect of Auto Manufacturers Data

Table B-1						
Volume Summary						
	Data Excluding Auto		Auto as % of Total Data		% of Data Excluding Auto with Amounts	
	Exposures	Deaths	Exposures	Deaths	Exposures	Deaths
Employees						
Male	2,842,144	5,202	26.6%	34.2%	76.0%	77.4%
Female	1,670,376	1,658	10.3%	13.2%	77.5%	79.0%
Total	4,512,520	6,860	21.3%	30.2%	76.5%	77.8%
Healthy Retirees						
Male	2,057,171	69,086	36.8%	39.5%	64.0%	60.9%
Female	661,714	15,258	23.5%	27.1%	51.3%	44.0%
Total	2,718,885	84,344	34.0%	37.6%	60.9%	57.8%
Beneficiaries						
Male	14,464	651	37.2%	42.8%	80.4%	76.3%
Female	278,840	8,852	60.7%	65.4%	87.1%	86.4%
Total	293,304	9,503	59.9%	64.5%	86.8%	85.7%
Disabled Retirees						
Male	103,033	6,472	64.7%	61.0%	65.8%	64.7%
Female	27,396	1,072	64.6%	59.6%	84.5%	86.7%
Total	130,429	7,544	64.7%	60.8%	69.7%	67.8%
Total Annuitants	3,142,618	101,391	39.8%	44.0%	63.7%	61.2%

Table B-2

Raw Employee Death Rates
Database Excluding Auto Industry Compared to Total Database

	Males				Females			
	Data Excluding Auto			Total Data	Data Excluding Auto			Total Data
Age	Exposures	Deaths	Death Rate	Death Rate	Exposures	Deaths	Death Rate	Death Rate
Under 20	3,550	1	0.0003	0.0002	5,217	0	0	0
20 – 24	71,503	25	0.0003	0.0005	82,107	8	0.0001	0.0001
25 –29	241,527	92	0.0004	0.0004	209,034	41	0.0002	0.0002
30 – 34	398,865	255	0.0006	0.0006	286,081	113	0.0004	0.0004
35 – 39	482,135	502	0.0010	0.0011	298,335	179	0.0006	0.0006
40 – 44	489,401	642	0.0013	0.0014	296,708	255	0.0009	0.0009
45 – 49	471,336	890	0.0019	0.0020	221,190	304	0.0014	0.0014
50 – 54	363,978	1,008	0.0028	0.0031	142,855	289	0.0020	0.0020
55 – 59	210,447	906	0.0043	0.0044	80,948	231	0.0029	0.0029
60 – 64	91,211	684	0.0075	0.0072	38,424	166	0.0043	0.0045
65 – 69	14,695	155	0.0105	0.0107	7,874	60	0.0076	0.0072
70 – 74	2,704	28	0.0104	0.0116	1,373	10	0.0073	0.0078
75 – 79	528	7	0.0133	0.0130	183	2	0.0109	0.0099
80 – 84	141	5	0.0355	0.0243	26	0	0	0
85 – 89	57	2	0.0351	0.0253	3	0	0	0
90 – 94	66	0	0	0	18	0	0	0
95 & Over	0	0	0	0	0	0	0	0
Total	2,842,144	5,202			1,670,376	1,658		

Table B-3

Raw Healthy Retiree Death Rates
Database Excluding Auto Industry Compared To Total Database

	Males				Females			
	Data Excluding Auto			Total Data	Data Excluding Auto			Total Data
Age	Exposures	Deaths	Death Rate	Death Rate	Exposures	Deaths	Death Rate	Death Rate
Under 30	5	0	0	0	9	0	0	0
30 – 34	20	0	0	0	35	0	0	0
35 – 39	167	2	0.0120	0.0120	69	1	0.0145	0.0130
40 – 44	846	1	0.0012	0.0011	245	1	0.0041	0.0076
45 - 49	6,647	31	0.0047	0.0052	2,849	7	0.0025	0.0023
50 – 54	51,882	285	0.0055	0.0072	17,876	56	0.0031	0.0029
55 – 59	207,370	1,711	0.0083	0.0086	62,213	307	0.0049	0.0044
60 – 64	443,793	5,720	0.0129	0.0133	134,378	1,125	0.0084	0.0079
65 – 69	471,718	9,737	0.0206	0.0212	147,829	1,813	0.0123	0.0126
70 – 74	392,978	12,932	0.0329	0.0339	126,878	2,551	0.0201	0.0205
75 – 79	263,802	14,334	0.0543	0.0563	84,538	2,837	0.0336	0.0339
80 – 84	140,203	12,219	0.0872	0.0909	50,573	2,769	0.0548	0.0563
85 – 89	57,686	7,847	0.1360	0.1403	24,537	2,226	0.0907	0.0940
90 – 94	16,540	3,349	0.2025	0.2104	8,002	1,221	0.1526	0.1575
95 & over	3,514	918	0.2612	0.2882	1,683	345	0.2050	0.1989
Total	2,057,171	69,086			661,714	15,259		

Table B-4

Raw Beneficiary Death Rates
Database Excluding Auto Industry Compared To Total Database

	Males				Females			
	Data Excluding Auto			Total Data	Data Excluding Auto			Total Data
Age	Exposures	Deaths	Death Rate	Death Rate	Exposures	Deaths	Death Rate	Death Rate
Under 20	13	0	0	0	17	0	0	0
20 – 24	29	1	0.0345	0.0345	45	1	0.0222	0.0192
25 – 29	35	1	0.0286	0.0263	106	2	0.0189	0.0165
30 – 34	77	4	0.0519	0.0476	268	9	0.0336	0.0175
35 – 39	118	6	0.0508	0.0385	747	5	0.0067	0.0030
40 – 44	234	3	0.0128	0.0098	1,772	18	0.0102	0.0048
45 – 49	386	9	0.0233	0.0213	3,386	23	0.0068	0.0035
50 – 54	628	11	0.0175	0.0176	8,280	63	0.0076	0.0045
55 – 59	1,021	21	0.0206	0.0212	16,471	164	0.0100	0.0075
60 – 64	1,716	41	0.0239	0.0202	31,628	391	0.0124	0.0121
65 – 69	2,760	96	0.0348	0.0319	49,565	867	0.0175	0.0181
70 – 74	2,921	125	0.0428	0.0478	60,816	1,549	0.0255	0.0262
75 – 79	2,212	125	0.0565	0.0694	52,308	1,847	0.0353	0.0382
80 – 84	1,379	105	0.0761	0.0857	32,592	1,782	0.0547	0.0600
85 – 89	637	60	0.0942	0.1146	15,036	1,326	0.0882	0.0966
90 – 94	274	36	0.1314	0.1383	4,943	654	0.1323	0.1516
95 & over	24	7	0.2917	0.1944	860	151	0.1756	0.2248
Total	14,464	651			278,840	8,852		

Table B-5

Raw Disabled Retiree Death Rates
Database Excluding Auto Industry Compared To Total Database

	Males				Females			
	Data Excluding Auto			Total Data	Data Excluding Auto			Total Data
Age	Exposures	Deaths	Death Rate	Death Rate	Exposures	Deaths	Death Rate	Death Rate
Under 30	5	0	0	0	2	0	0	0
30 – 34	20	1	0.0500	0.0308	10	0	0	0
35 – 39	280	10	0.0357	0.0124	166	3	0.0181	0.0030
40 – 44	1,414	38	0.0269	0.0167	840	9	0.0107	0.0056
45 – 49	3,499	116	0.0332	0.0235	1,647	31	0.0188	0.0091
50 – 54	6,356	192	0.0302	0.0293	2,072	29	0.0140	0.0100
55 – 59	10,501	380	0.0362	0.0368	2,765	65	0.0235	0.0198
60 – 64	17,443	748	0.0429	0.0445	4,122	100	0.0243	0.0236
65 – 69	22,330	1,203	0.0539	0.0550	5,206	154	0.0296	0.0282
70 – 74	20,316	1,407	0.0693	0.0714	4,304	172	0.0400	0.0418
75 – 79	12,931	1,220	0.0943	0.0957	2,465	155	0.0629	0.0611
80 – 84	5,707	737	0.1291	0.1338	2,105	154	0.0732	0.0778
85 – 89	1,693	292	0.1725	0.1734	1,314	130	0.0989	0.0980
90 - 94	422	94	0.2227	0.2042	336	59	0.1756	0.1829
95 & Over	116	34	0.2931	0.3077	42	11	0.2619	0.2593
Total	103,033	6,472			27,396	1,072		

Appendix C
Multiemployer Mortality Rates

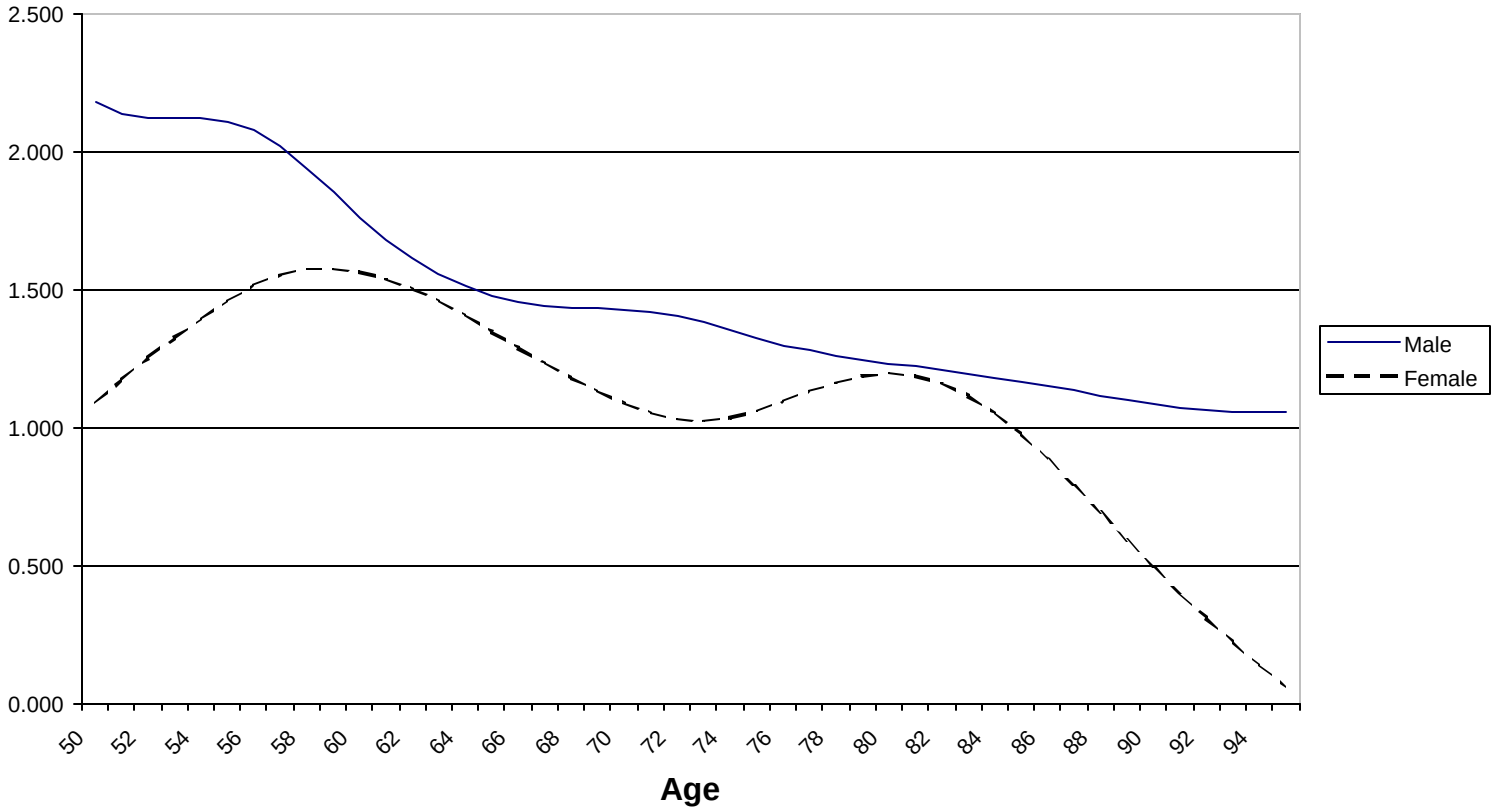
Table C-1 shows graduated ratios of multiemployer healthy annuitant mortality to the 1992 base year mortality rates underlying the RP-2000 Mortality Tables. Only two multiemployer plans submitted data for this study, so these results may not be representative of all multiemployer plans. Both of these plans were from SIC code 4210 (trucking). While the total exposure is large, the exposure for females is much smaller than the exposure for males.

Table C-1

Ratios of Multiemployer Mortality to RP-2000 Base Healthy Annuitants

Age	Male	Female	Age	Male	Female
50	2.181	1.092	73	1.384	1.026
51	2.140	1.176	74	1.356	1.036
52	2.124	1.254	75	1.327	1.061
53	2.123	1.327	76	1.301	1.096
54	2.123	1.397	77	1.280	1.133
55	2.111	1.462	78	1.263	1.165
56	2.080	1.517	79	1.248	1.188
57	2.025	1.556	80	1.234	1.197
58	1.947	1.577	81	1.222	1.189
59	1.855	1.579	82	1.209	1.163
60	1.764	1.566	83	1.197	1.118
61	1.684	1.542	84	1.184	1.056
62	1.615	1.506	85	1.170	0.978
63	1.557	1.462	86	1.155	0.889
64	1.513	1.410	87	1.138	0.793
65	1.481	1.351	88	1.120	0.693
66	1.460	1.291	89	1.102	0.593
67	1.446	1.235	90	1.086	0.495
68	1.438	1.182	91	1.073	0.401
69	1.434	1.133	92	1.064	0.311
70	1.431	1.090	93	1.058	0.224
71	1.423	1.055	94	1.057	0.140
72	1.407	1.033	95	1.061	0.058

Figure C-1
Ratios of Multiemployer Mortality to RP-2000 Base
Healthy Annuitants



Appendix D
Ratios of Graduated Mortality Rates for Beneficiaries and Retirees to All Healthy Annuitants

	Female		Male	
	Beneficiaries	Retirees	Beneficiaries	Retirees
50	1.301	0.915	2.400	0.991
51	1.331	0.917	2.231	0.994
52	1.350	0.918	2.124	0.996
53	1.364	0.920	2.059	0.997
54	1.377	0.924	2.022	0.998
55	1.391	0.930	1.999	0.999
56	1.402	0.936	1.980	0.999
57	1.405	0.941	1.955	0.999
58	1.399	0.944	1.919	0.999
59	1.387	0.945	1.874	0.999
60	1.374	0.945	1.828	0.999
61	1.361	0.943	1.790	1.000
62	1.348	0.940	1.757	0.999
63	1.336	0.936	1.727	0.999
64	1.321	0.931	1.700	0.999
65	1.303	0.927	1.674	0.999
66	1.284	0.925	1.650	0.999
67	1.266	0.926	1.627	0.999
68	1.247	0.929	1.607	0.999
69	1.225	0.933	1.587	0.999
70	1.199	0.937	1.566	0.999
71	1.170	0.941	1.540	0.999
72	1.140	0.944	1.507	0.999
73	1.113	0.946	1.468	0.999
74	1.092	0.949	1.424	0.999
75	1.079	0.952	1.379	0.999
76	1.070	0.953	1.335	0.999
77	1.064	0.953	1.292	0.999
78	1.060	0.953	1.250	0.999
79	1.058	0.954	1.207	0.999
80	1.057	0.956	1.163	0.999
81	1.056	0.960	1.121	1.000
82	1.055	0.965	1.080	1.000
83	1.054	0.972	1.042	1.000
84	1.052	0.977	1.006	1.000
85	1.049	0.982	0.972	1.000
86	1.043	0.985	0.939	1.000
87	1.036	0.987	0.907	1.001
88	1.029	0.986	0.876	1.001
89	1.022	0.982	0.846	1.001
90	1.017	0.978	0.819	1.001
91	1.015	0.972	0.794	1.001
92	1.018	0.966	0.774	1.001
93	1.025	0.960	0.756	1.001
94	1.036	0.955	0.743	1.001
95	1.053	0.952	0.733	1.001

Appendix E
Determination and Blending of Mortality Rates

The following is an example of how the mortality rates for healthy retirees and beneficiaries were determined and blended.

Healthy Retirees (Male age 70)

Entire Population			**Portion of Population Submitting Data by Amount**	
	Number		Number	Average Amount
Deaths:	3860		1360	$8,470
Exposure:	137060		50260	$9,923

Ungraduated Amount Adjustment Factor
(The mortality rate based on total amount of benefits divided by the mortality rate based on numbers, for the plans submitting data with amounts)

$$\frac{1360 \cdot \$8470}{50260 \cdot \$9923} \Big/ \frac{1360}{50260}$$

$$= \frac{\$8470}{\$9923}$$

Let GR represent the heavily graduated value of the amount adjustment factor ($8470 / $9923), where “heavy graduation” means a smoothing coefficient of 100,000,000 and second differences

Ungraduated Amount-Adjusted Mortality Rate
(The mortality rate based on numbers times the heavily graduated amount adjustment factor)

$$\frac{3860}{137060} \bullet GR$$

Beneficiaries (Male age 70)

Entire Population			**Portion of Population Submitting Data by Amount**	
	Number		Number	Average Amount
Deaths:	42		16	$2,648
Exposure:	995		500	$2,902

Ungraduated Amount Adjustment Factor

(The mortality rate based on total amount of benefits divided by the mortality rate based on numbers, for the plans submitting data with amounts)

$$\frac{16 \cdot \$2648}{500 \cdot \$2902} \Big/ \frac{16}{500}$$

$$= \frac{\$2648}{\$2902}$$

Let GS represent the heavily graduated value of the amount adjustment factor ($2648 / $2902) where "heavy graduation" means a smoothing coefficient of 100,000,000 and second differences

Ungraduated Amount-Adjusted Mortality Rate

(The mortality rate based on numbers times the heavily graduated amount adjustment factor)

$$\frac{42}{995} \bullet GS$$

Blended Healthy Retiree and Beneficiary Rate:

(The weighted average of the ungraduated amount-adjusted mortality rates for annuitants and beneficiaries, where the weights are are the total number of exposures for all plans times the average amount exposed for those plans with amounts)

$$\frac{\frac{3860}{137060} \bullet GR \bullet (137060 \bullet \$9923) + \frac{42}{995} \bullet GS \bullet (995 \bullet \$2902)}{(137060 \bullet \$9923) + (995 \bullet \$2902)}$$

Appendix F
Mortality Comparisons by Collar and Amount

Table F-1					
Mortality Comparison for Males Age 60-64					
		Small	Medium	Large	Total
White Collar	Mortality Ratio	1.472	1.216	0.789	0.871
	Average Amount	$2,597	$10,639	$23,869	$17,553
	Number Exposed	20795	42379	95620	158794
	Amount of Exposure	1.2%	10.2%	51.5%	62.9%
Blue Collar	Mortality Ratio	1.669	1.511	1.001	1.371
	Average Amount	$3,000	$9,348	$22,697	$8,908
	Number Exposed	28342	48332	10601	87275
	Amount of Exposure	1.9%	10.2%	5.4%	17.6%
Mixed Collar	Mortality Ratio	1.725	1.299	0.920	1.083
	Average Amount	$2,879	$11,214	$22,652	$15,106
	Number Exposed	3928	30933	22316	57177
	Amount of Exposure	0.3%	7.8%	11.4%	19.5%
Total Collar	Mortality Ratio	1.602	1.346	0.827	1.000
	Average Amount	$2,833	$10,272	$23,561	$14,603
	Number Exposed	53065	121644	128537	303246
	Amount of Exposure	3.4%	28.2%	68.4%	100.0%

Table F-2					
Mortality Comparison for Males Age 65-69					
		Small	Medium	Large	Total
White Collar	Mortality Ratio	1.260	1.063	0.781	0.881
	Average Amount	$2,428	$10,221	$22,993	$12,933
	Number Exposed	33918	41002	46466	121386
	Amount of Exposure	2.7%	13.7%	34.8%	51.2%
Blue Collar	Mortality Ratio	1.516	1.367	0.869	1.258
	Average Amount	$3,107	$8,927	$23,754	$8,032
	Number Exposed	45741	64096	10683	120520
	Amount of Exposure	4.6%	18.6%	8.3%	31.6%
Mixed Collar	Mortality Ratio	1.181	1.066	0.787	0.880
	Average Amount	$2,828	$10,308	$25,375	$15,046
	Number Exposed	6287	14762	14208	35257
	Amount of Exposure	0.6%	5.0%	11.7%	17.3%
Total Collar	Mortality Ratio	1.405	1.215	0.795	1.000
	Average Amount	$2,819	$9,540	$23,581	$11,071
	Number Exposed	85946	119860	71357	277163
	Amount of Exposure	7.9%	37.3%	54.8%	100.0%

Table F-3					
Mortality Comparison for Males Age 70-74					
		Small	Medium	Large	Total
White Collar	Mortality Ratio	1.114	1.033	0.757	0.896
	Average Amount	$2,442	$9,819	$22,348	$9,829
	Number Exposed	35752	34297	21123	91172
	Amount of Exposure	4.1%	16.0%	22.4%	42.5%
Blue Collar	Mortality Ratio	1.429	1.290	0.729	1.184
	Average Amount	$3,258	$8,557	$24,620	$7,313
	Number Exposed	49421	52853	7783	110057
	Amount of Exposure	7.6%	21.4%	9.1%	38.2%
Mixed Collar	Mortality Ratio	1.146	1.126	0.717	0.865
	Average Amount	$2,960	$10,194	$24,173	$14,040
	Number Exposed	5393	12896	10790	29079
	Amount of Exposure	0.8%	6.2%	12.4%	19.4%
Total Collar	Mortality Ratio	1.308	1.173	0.740	1.000
	Average Amount	$2,918	$9,201	$23,289	$9,158
	Number Exposed	90566	100046	39696	230308
	Amount of Exposure	12.5%	43.6%	43.8%	100.0%

Table F-4					
Mortality Comparison for Males Age 75-79					
		Small	Medium	Large	Total
White Collar	Mortality Ratio	1.009	0.927	0.854	0.912
	Average Amount	$2,517	$9,234	$23,773	$7,674
	Number Exposed	27118	19707	6778	53603
	Amount of Exposure	5.9%	15.6%	13.9%	35.4%
Blue Collar	Mortality Ratio	1.266	1.183	0.714	1.128
	Average Amount	$3,383	$8,085	$24,218	$6,105
	Number Exposed	47647	32101	3654	83402
	Amount of Exposure	13.9%	22.3%	7.6%	43.8%
Mixed Collar	Mortality Ratio	1.205	1.141	0.661	0.880
	Average Amount	$3,094	$9,865	$23,889	$12,491
	Number Exposed	4030	9792	5578	19400
	Amount of Exposure	1.1%	8.3%	11.5%	20.8%
Total Collar	Mortality Ratio	1.190	1.089	0.755	1.000
	Average Amount	$3,070	$8,736	$23,915	$7,435
	Number Exposed	78795	61600	16010	156405
	Amount of Exposure	20.8%	46.3%	32.9%	100.0%

Table F-5					
Mortality Comparison for Females Age 60-64					
		Small	Medium	Large	Total
White Collar	Mortality Ratio	1.054	0.842	0.947	0.912
	Average Amount	$2,609	$9,763	$19,682	$8,982
	Number Exposed	17539	18425	9102	45066
	Amount of Exposure	5.5%	21.6%	21.5%	48.5%
Blue Collar	Mortality Ratio	1.436	1.194	0.837	1.216
	Average Amount	$2,513	$8,923	$18,809	$5,721
	Number Exposed	19545	15099	1096	35740
	Amount of Exposure	5.9%	16.2%	2.5%	24.5%
Mixed Collar	Mortality Ratio	0.904	1.019	0.729	0.961
	Average Amount	$3,300	$8,964	$19,419	$7,909
	Number Exposed	8486	18185	1732	28403
	Amount of Exposure	3.4%	19.5%	4.0%	26.9%
Total Collar	Mortality Ratio	1.172	1.002	0.906	1.000
	Average Amount	$2,696	$9,237	$19,563	$7,635
	Number Exposed	45570	51709	11930	109209
	Amount of Exposure	14.7%	57.3%	28.0%	100.0%

Table F-6					
Mortality Comparison for Females Age 65-69					
		Small	Medium	Large	Total
White Collar	Mortality Ratio	1.097	0.846	0.923	0.927
	Average Amount	$2,499	$9,223	$19,226	$6,230
	Number Exposed	25937	14409	4129	44475
	Amount of Exposure	10.8%	22.1%	13.2%	46.1%
Blue Collar	Mortality Ratio	1.194	0.980	0.572	1.026
	Average Amount	$2,455	$8,827	$18,391	$4,714
	Number Exposed	32955	15129	893	48977
	Amount of Exposure	13.5%	22.2%	2.7%	38.4%
Mixed Collar	Mortality Ratio	1.268	1.108	1.049	1.152
	Average Amount	$2,610	$9,055	$19,000	$5,202
	Number Exposed	12070	5019	866	17955
	Amount of Exposure	5.2%	7.6%	2.7%	15.5%
Total Collar	Mortality Ratio	1.172	0.942	0.890	1.000
	Average Amount	$2,497	$9,025	$19,066	$5,398
	Number Exposed	70962	34557	5888	111407
	Amount of Exposure	29.5%	51.9%	18.7%	100.0%

Table F-7					
Mortality Comparison for Females Age 70-74					
		Small	Medium	Large	Total
White Collar	Mortality Ratio	0.982	0.850	0.847	0.895
	Average Amount	$2,324	$8,846	$19,869	$4,732
	Number Exposed	28471	9929	1830	40230
	Amount of Exposure	15.1%	20.0%	8.3%	43.4%
Blue Collar	Mortality Ratio	1.184	1.035	0.620	1.088
	Average Amount	$2,263	$8,470	$19,016	$3,558
	Number Exposed	36724	8200	472	45396
	Amount of Exposure	18.9%	15.8%	2.0%	36.8%
Mixed Collar	Mortality Ratio	1.221	1.048	0.567	1.065
	Average Amount	$2,508	$8,981	$18,585	$4,299
	Number Exposed	15522	4150	585	20257
	Amount of Exposure	8.9%	8.5%	2.5%	19.8%
Total Collar	Mortality Ratio	1.120	0.954	0.756	1.000
	Average Amount	$2,332	$8,733	$19,469	$4,146
	Number Exposed	80717	22279	2887	105883
	Amount of Exposure	42.9%	44.3%	12.8%	100.0%

Table F-8					
Mortality Comparison for Females Age 75-79					
		Small	Medium	Large	Total
White Collar	Mortality Ratio	1.008	0.883	0.867	0.943
	Average Amount	$2,161	$8,385	$20,060	$3,566
	Number Exposed	22709	4670	570	27949
	Amount of Exposure	19.9%	15.9%	4.6%	40.4%
Blue Collar	Mortality Ratio	1.091	0.891	0.548	1.029
	Average Amount	$2,108	$7,762	$18,027	$2,652
	Number Exposed	30450	2958	95	33503
	Amount of Exposure	26.0%	9.3%	0.7%	36.0%
Mixed Collar	Mortality Ratio	1.085	0.907	1.576	1.054
	Average Amount	$2,254	$8,655	$20,475	$3,333
	Number Exposed	14837	2405	187	17429
	Amount of Exposure	13.6%	8.4%	1.6%	23.6%
Total Collar	Mortality Ratio	1.062	0.891	0.995	1.000
	Average Amount	$2,157	$8,266	$19,924	$3,126
	Number Exposed	67996	10033	852	78881
	Amount of Exposure	59.5%	33.6%	6.9%	100.0%

Appendix G
RP-2000 Projected 10 Years using Projection Scale AA

Age	Male				Female			
	Employees	Healthy Annuitant	Combined Healthy	Disabled	Employees	Healthy Annuitant	Combined Healthy	Disabled
1	0.000520		0.000520		0.000467		0.000467	
2	0.000351		0.000351		0.000304		0.000304	
3	0.000292		0.000292		0.000227		0.000227	
4	0.000227		0.000227		0.000170		0.000170	
5	0.000208		0.000208		0.000154		0.000154	
6	0.000199		0.000199		0.000144		0.000144	
7	0.000191		0.000191		0.000135		0.000135	
8	0.000176		0.000176		0.000120		0.000120	
9	0.000171		0.000171		0.000114		0.000114	
10	0.000173		0.000173		0.000115		0.000115	
11	0.000179		0.000179		0.000117		0.000117	
12	0.000186		0.000186		0.000121		0.000121	
13	0.000196		0.000196		0.000127		0.000127	
14	0.000210		0.000210		0.000135		0.000135	
15	0.000222		0.000222		0.000145		0.000145	
16	0.000234		0.000234		0.000152		0.000152	
17	0.000248		0.000248		0.000160		0.000160	
18	0.000261		0.000261		0.000163		0.000163	
19	0.000273		0.000273		0.000163		0.000163	
20	0.000285		0.000285		0.000163		0.000163	
21	0.000298		0.000298	0.022571	0.000162		0.000162	0.007450
22	0.000308		0.000308	0.022571	0.000163		0.000163	0.007450
23	0.000321		0.000321	0.022571	0.000168		0.000168	0.007450
24	0.000330		0.000330	0.022571	0.000173		0.000173	0.007450
25	0.000340		0.000340	0.022571	0.000180		0.000180	0.007450
26	0.000356		0.000356	0.022571	0.000190		0.000190	0.007450
27	0.000363		0.000363	0.022571	0.000198		0.000198	0.007450
28	0.000374		0.000374	0.022571	0.000208		0.000208	0.007450
29	0.000392		0.000392	0.022571	0.000220		0.000220	0.007450
30	0.000422		0.000422	0.022571	0.000239		0.000239	0.007450
31	0.000475		0.000475	0.022571	0.000283		0.000283	0.007450
32	0.000535		0.000535	0.022571	0.000323		0.000323	0.007450
33	0.000600		0.000600	0.022571	0.000360		0.000360	0.007450
34	0.000668		0.000668	0.022571	0.000393		0.000393	0.007450
35	0.000735		0.000735	0.022571	0.000425		0.000425	0.007450
36	0.000800		0.000800	0.022571	0.000456		0.000456	0.007450
37	0.000860		0.000860	0.022571	0.000486		0.000486	0.007450
38	0.000908		0.000908	0.022571	0.000519		0.000519	0.007450
39	0.000952		0.000952	0.022571	0.000557		0.000557	0.007450

Age	Male				Female			
	Employees	Healthy Annuitant	Combined Healthy	Disabled	Employees	Healthy Annuitant	Combined Healthy	Disabled
40	0.000996		0.000996	0.022571	0.000607		0.000607	0.007450
41	0.001043		0.001043	0.022571	0.000665		0.000665	0.007450
42	0.001099		0.001099	0.022571	0.000732		0.000732	0.007450
43	0.001163		0.001163	0.022571	0.000806		0.000806	0.007450
44	0.001238		0.001238	0.022571	0.000885		0.000885	0.007450
45	0.001323		0.001323	0.022571	0.000957		0.000957	0.007450
46	0.001403		0.001403	0.023847	0.001030		0.001030	0.008184
47	0.001491		0.001491	0.025124	0.001106		0.001106	0.008959
48	0.001583		0.001583	0.026404	0.001196		0.001196	0.009775
49	0.001681		0.001681	0.027687	0.001293		0.001293	0.010634
50	0.001783	0.004459	0.001783	0.028975	0.001412	0.001975	0.001412	0.011535
51	0.001889	0.004563	0.002022	0.030268	0.001544	0.002093	0.001576	0.012477
52	0.002000	0.004612	0.002179	0.031563	0.001708	0.002299	0.001753	0.013456
53	0.002142	0.004675	0.002383	0.032859	0.001892	0.002566	0.001956	0.014465
54	0.002298	0.004737	0.002611	0.034152	0.002099	0.002885	0.002192	0.015497
55	0.002500	0.004874	0.002991	0.035442	0.002331	0.003258	0.002507	0.016544
56	0.002757	0.005107	0.003502	0.036732	0.002595	0.003696	0.002910	0.017598
57	0.003056	0.005429	0.003954	0.038026	0.002863	0.004171	0.003308	0.018654
58	0.003402	0.005868	0.004488	0.039334	0.003130	0.004680	0.003731	0.019710
59	0.003756	0.006370	0.005059	0.040668	0.003423	0.005261	0.004224	0.020768
60	0.004151	0.006975	0.005742	0.042042	0.003739	0.005897	0.004808	0.021839
61	0.004627	0.007738	0.006599	0.043474	0.004076	0.006581	0.005530	0.022936
62	0.005088	0.008524	0.007529	0.044981	0.004428	0.007313	0.006332	0.024080
63	0.005621	0.009511	0.008695	0.046584	0.004793	0.008093	0.007274	0.025293
64	0.006104	0.010524	0.009797	0.048307	0.005164	0.008936	0.008198	0.026600
65	0.006577	0.011654	0.011062	0.050174	0.005536	0.009857	0.009231	0.028026
66	0.007106	0.013044	0.012642	0.052213	0.005904	0.010855	0.010418	0.029594
67	0.007543	0.014441	0.014103	0.054450	0.006261	0.011927	0.011568	0.031325
68	0.007876	0.015807	0.015521	0.056909	0.006605	0.013098	0.012788	0.033234
69	0.008259	0.017461	0.017198	0.059613	0.006933	0.014412	0.014133	0.035335
70	0.008530	0.019091	0.019091	0.062583	0.007241	0.015923	0.015923	0.037635
71		0.021124	0.021124	0.065841		0.017494	0.017494	0.040140
72		0.023454	0.023454	0.069405		0.019458	0.019458	0.042851
73		0.026125	0.026125	0.073292		0.021412	0.021412	0.045769
74		0.029145	0.029145	0.077512		0.023731	0.023731	0.048895
75		0.032859	0.032859	0.082067		0.025937	0.025937	0.052230
76		0.036624	0.036624	0.086951		0.028576	0.028576	0.055777
77		0.041153	0.041153	0.092149		0.031791	0.031791	0.059545
78		0.046195	0.046195	0.097640		0.035045	0.035045	0.063545
79		0.051861	0.051861	0.103392		0.038690	0.038690	0.067793
80		0.058213	0.058213	0.109372		0.042767	0.042767	0.072312
81		0.065814	0.065814	0.115544		0.047335	0.047335	0.077135

Age	Male				Female			
	Employees	Healthy Annuitant	Combined Healthy	Disabled	Employees	Healthy Annuitant	Combined Healthy	Disabled
82		0.074274	0.074274	0.121877		0.052475	0.052475	0.082298
83		0.082794	0.082794	0.128343		0.058266	0.058266	0.087838
84		0.093010	0.093010	0.134923		0.064801	0.064801	0.093794
85		0.103244	0.103244	0.141603		0.072923	0.072923	0.100203
86		0.114467	0.114467	0.148374		0.082153	0.082153	0.107099
87		0.128097	0.128097	0.155235		0.092552	0.092552	0.114512
88		0.143228	0.143228	0.162186		0.103087	0.103087	0.122464
89		0.158284	0.158284	0.169233		0.115627	0.115627	0.130972
90		0.176202	0.176202	0.183408		0.127784	0.127784	0.140049
91		0.191921	0.191921	0.199769		0.140324	0.140324	0.149698
92		0.210194	0.210194	0.216605		0.152953	0.152953	0.159924
93		0.226746	0.226746	0.233662		0.167055	0.167055	0.170433
94		0.243273	0.243273	0.250693		0.179176	0.179176	0.182799
95		0.262189	0.262189	0.267491		0.190654	0.190654	0.194509
96		0.278278	0.278278	0.283905		0.201308	0.201308	0.205379
97		0.293909	0.293909	0.299852		0.213097	0.213097	0.215240
98		0.312157	0.312157	0.315296		0.221718	0.221718	0.223947
99		0.326920	0.326920	0.330207		0.229084	0.229084	0.231387
100		0.341126	0.341126	0.344556		0.235103	0.235103	0.237467
101		0.358628	0.358628	0.358628		0.244834	0.244834	0.244834
102		0.371685	0.371685	0.371685		0.254498	0.254498	0.254498
103		0.383040	0.383040	0.383040		0.266044	0.266044	0.266044
104		0.392003	0.392003	0.392003		0.279055	0.279055	0.279055
105		0.397886	0.397886	0.397886		0.293116	0.293116	0.293116
106		0.400000	0.400000	0.400000		0.307811	0.307811	0.307811
107		0.400000	0.400000	0.400000		0.322725	0.322725	0.322725
108		0.400000	0.400000	0.400000		0.337441	0.337441	0.337441
109		0.400000	0.400000	0.400000		0.351544	0.351544	0.351544
110		0.400000	0.400000	0.400000		0.364617	0.364617	0.364617
111		0.400000	0.400000	0.400000		0.376246	0.376246	0.376246
112		0.400000	0.400000	0.400000		0.386015	0.386015	0.386015
113		0.400000	0.400000	0.400000		0.393507	0.393507	0.393507
114		0.400000	0.400000	0.400000		0.398308	0.398308	0.398308
115		0.400000	0.400000	0.400000		0.400000	0.400000	0.400000
116		0.400000	0.400000	0.400000		0.400000	0.400000	0.400000
117		0.400000	0.400000	0.400000		0.400000	0.400000	0.400000
118		0.400000	0.400000	0.400000		0.400000	0.400000	0.400000
119		0.400000	0.400000	0.400000		0.400000	0.400000	0.400000
120		1.000000	1.000000	1.000000		1.000000	1.000000	1.000000