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# Analysis of Mortality Improvement Based on Recent SOA Studies

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**T**he Retirement Plans Experience Committee (RPEC) of the Society of Actuaries (SOA) is a standing committee that monitors pension plan mortality experience. Most recently, the committee developed the RP-2000 mortality table. This table was the first published North American mortality table based solely upon private sector pension plan mortality experience. Previous tables developed by the RPEC such as GAR-94 and UP-94 were based primarily on a combination of group annuity, and U.S. federal employees and retirees mortality experience.

The RP-2000 table was based on 1990-1994 experience. Because the table was created to provide information to the United States Department of Treasury to assist in selecting a mortality assumption to be used to calculate current liability under IRC Section 412(l), the table's experience was based entirely on private sector plans that would be affected by the legislation. The underlying data used to develop the RP-2000 table excluded public sector, multi-employer and Canadian experience.

In 2001, the RPEC requested 1998-2002 mortality experience for general use. Data was requested from all types of pension plans, including public sector and Canadian plans. Although the RPEC did receive data from several private sector plans, 96.1 percent of the data was collected from the Civil Service Retirement System of the United States (CSRS) and the United States Military as summarized by Table 1 on page 19.

The RPEC also received 841,034 life years of active employee experience. However, this data included only 1,495 deaths and was thus deemed insufficiently credible for further analysis.

In preparing the GAR-94 and UP-94 tables, the RPEC noted that 1986-1990 Group Annuity Mortality (GAM) and CSRS<sup>1</sup> experience were similar. Because of the similar experience, the RPEC combined GAM and CSRS data to prepare the GAR-94 and UP-94 tables. The GAM experience was used for ages 66 and greater, while a blend of CSRS retiree and active data was used for ages 65 or less. This data was graduated and projected to 1994 as described in the Transactions of Society of Actuaries (TSA) to produce the UP-94 table. The GAR-94 table is the same table as the UP-94 table with a seven percent reserve margin for insurance purposes.

This analysis compares the 1986-1990 data used to prepare the UP-94 and GAR-94 tables with the non-military data gathered from 1998-2002. The 1986-1990 based rates can be found in Tables 3 and 6 in the TSA Report previously mentioned. While the UP-94 and GAR-94 tables used GAM data to develop rates for ages 66 or greater, the RPEC also noted then that the GAM and CSRS experience were comparable. Thus a comparison of the 1998-2002 data to the underlying data supporting the UP-94 and GAR-94 tables can be used to monitor mortality improvement over the 1986-2002 time period (approximately 12 years because the prior data is centered in 1988 and the current data is centered in 2000).

Tables 2 and 3 on pages 20 and 21 respectively of this analysis compare the 1986-1990 experience to the 1998-2002 experience for males and females. For each age between age 50 and age 95, the experience is compared. To

**Table 1**  
**SOA-RPEC**  
**Summary of 1998-2002 Retiree Exposure**

	# Plans	Exposure (Life Years)
Other Retirement Plans	65	512,046
Civil Service Retirement System	1	9,175,835
Military	1	3,354,183
<b>Total</b>	<b>67</b>	<b>13,042,064</b>

give the reader an indication of the credibility of the current data, for each age and gender, the number of deaths in the 1998-2002 data is provided. Both tables are income based; that is they are based on the annuity amounts rather than the number of lives. For example, if there are two lives age 90, with annuities of \$9,900 and \$100, and the person with an annuity of \$100 died, the  $q$  shown is .01 rather than .50. The column labeled "Ratio" is an indication of the total improvement over the 1986-2002 period; the column labeled "Average Annual Decrease" is equal to the "Ratio" raised to the 1/12th power. Because these amounts fluctuate, averages for five-year age groups are shown. Charts 1 and 2 on pages 22 and 23, respectively, compare the average annual decrease for ages 66 and over in five-year age groups to the Scale AA improvement trends that were developed for the UP-94 and GAR-94 tables.

### Observations

Male mortality has improved considerably more than female mortality. Male mortality improvement is roughly 2 percent per year for ages 60 to 75, then gradually decreasing with virtually no measurable improvement for ages greater than age 90. The improvements for males are generally greater than the Scale AA trends. While there seems to be some female mortality improvement for ages 65 to 85, it is considerably slower than the male mortality improvement and is less than .5 percent per year (and less than the Scale AA trends).

The comparison of 1986-1990 experience to 1998-2002 experience seems to indicate that mortality rates *increased* for males less than 60 and for females

less than age 65. We believe that the differing experience at younger ages may be due to the use of active lives in the 1986-1990 data as documented in the TSA report. The RP-2000 report found that retiree mortality rates are 50 percent to 100 percent higher than the same aged active employee mortality rates. As noted above, the 1998-2002 data studied consists entirely of retired lives. Thus, different populations were used for ages less than age 65.

Note that some of the trends indicated by this analysis are consistent with other research on mortality improvement. For example, in a paper presented at the 2005 Living to 100 and Beyond seminar, Ulrich Padika and Jurgen Wolff used the Berkeley Mortality Database (<http://www.mortality.org>) to show a comparison of mortality improvement trends for ten developed countries for ages 60 to 89 over rolling 20-year periods from 1960 to 1999. The paper can be viewed at [http://ce.soa.org/living-to-100/4b\\_papers.pdf](http://ce.soa.org/living-to-100/4b_papers.pdf).<sup>2</sup> Of the countries illustrated, all but two show female mortality improvement rates leveling off or decreasing. Three of the countries show leveling off and/or decrease in mortality improvement for males as well.

The RPEC is in the midst of collecting recent experience data for an updated mortality table. Those interested in contributing data can contact either Gavin Benjamin, current chair of RPEC, or Jack Luff, Experience Studies Actuary in the SOA office for further details. It is anticipated that in addition to the creation of a new table, further mortality improvement analysis will be possible with this new data. ♦



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<sup>1</sup> *SOA Transactions*, Volume 47, Pages 865-919.

<sup>2</sup> Ulrich Pasdika & Jurgen Wolff, "Coping with Longevity- The New German Annuity Valuation Table DAV 2004 R."

## Comparisons of 1986-1990 GAM and Non-Military 1998-2002 Experience • Table 2 - Male

Age	1986-1990 <sup>1</sup>	1998-2002 Non-Military	Ratio	Average Annual Decrease	Five Year Average Decrease	Five Year Average Scale AA	1998-2002 Non-Military Deaths
50	0.003070	0.012486	406.71%	-12.40%			551
51	0.003447	0.010426	302.47%	-9.66%			593
52	0.003698	0.010447	282.50%	-9.04%			704
53	0.004081	0.008934	218.92%	-6.75%	-6.57%	1.96%	718
54	0.004963	0.007907	159.32%	-3.96%			799
55	0.004763	0.007144	149.99%	-3.44%			936
56	0.005751	0.007067	122.8%	-1.73%			1,080
57	0.007180	0.007301	101.69%	-0.14%			1,213
58	0.007569	0.007713	101.90%	-0.16%	-0.15% <sup>2</sup>	1.66%	1,367
59	0.008356	0.007828	93.68%	0.54%			1,449
60	0.009165	0.008373	91.36%	0.75%			1,635
61	0.010456	0.008848	84.62%	1.38%			1,889
62	0.011893	0.009534	80.16%	1.83%			2,270
63	0.013728	0.010518	76.62%	2.19%	1.99% <sup>2</sup>	1.44%	2,630
64	0.015347	0.011620	75.72%	2.29%			3,044
65	0.017188	0.013102	76.23%	2.24%			3,531
66	0.019269	0.014835	76.99%	2.16%			4,177
67	0.020827	0.016005	76.85%	2.17%			4,647
68	0.021989	0.017936	81.57%	1.68%	1.96%	1.38%	5,144
69	0.025223	0.020141	79.85%	1.86%			5,740
70	0.027970	0.022103	79.02%	1.94%			6,236
71	0.030305	0.024250	80.02%	1.84%			6,797
72	0.034400	0.026702	77.62%	2.09%			7,441
73	0.037566	0.032996	81.12%	1.73%	1.84%	1.48%	8,565
74	0.041715	0.032996	79.10%	1.93%			9,248
75	0.045670	0.037498	82.11%	1.63%			10,352
76	0.049899	0.040824	81.81%	1.66%			11,195
77	0.055961	0.044859	80.16%	1.83%			12,042
78	0.060834	0.049383	81.18%	1.72%	1.71%	1.20%	12,323
79	0.066465	0.054157	81.48%	1.69%			12,715
80	0.072808	0.059766	82.09%	1.63%			12,652
81	0.083702	0.065279	77.99%	2.05%			12,233
82	0.087230	0.073909	84.73%	1.37%			11,894
83	0.100734	0.082199	81.60%	1.68%	1.48%	1.48%	11,464
84	0.108259	0.090591	83.68%	1.47%			10,709
85	0.109440	0.099252	90.69%	0.81%			9,651
86	0.118562	0.113071	95.37%	0.39%			8,952
87	0.137411	0.120946	88.02%	1.06%			7,811
88	0.151901	0.136404	89.80%	0.89%	0.53%	0.78%	6,983
89	0.15654	0.149855	95.78%	0.36%			6,061
90	0.161550	0.162286	100.46%	-0.04%			5,157
91	0.199729	0.189106	94.68%	0.45%			4,382
92	0.1947780	0.202534	103.98%	-0.33%			3,494
93	0.234746	0.221054	94.17%	0.50%	0.12%	0.30%	2,723
94	0.232451	0.242746	104.43%	-0.36%			2,057
95	0.267373	0.257150	96.18%	0.32%			1,511

<sup>1</sup> Blended CSRS from Age 50-65; GAM from Age 66 to 95.<sup>2</sup> As noted, the 1986-1990 data is likely not comparable to the 1998-2002 data for ages less than 65 because the 1986-1990 data used active lives.

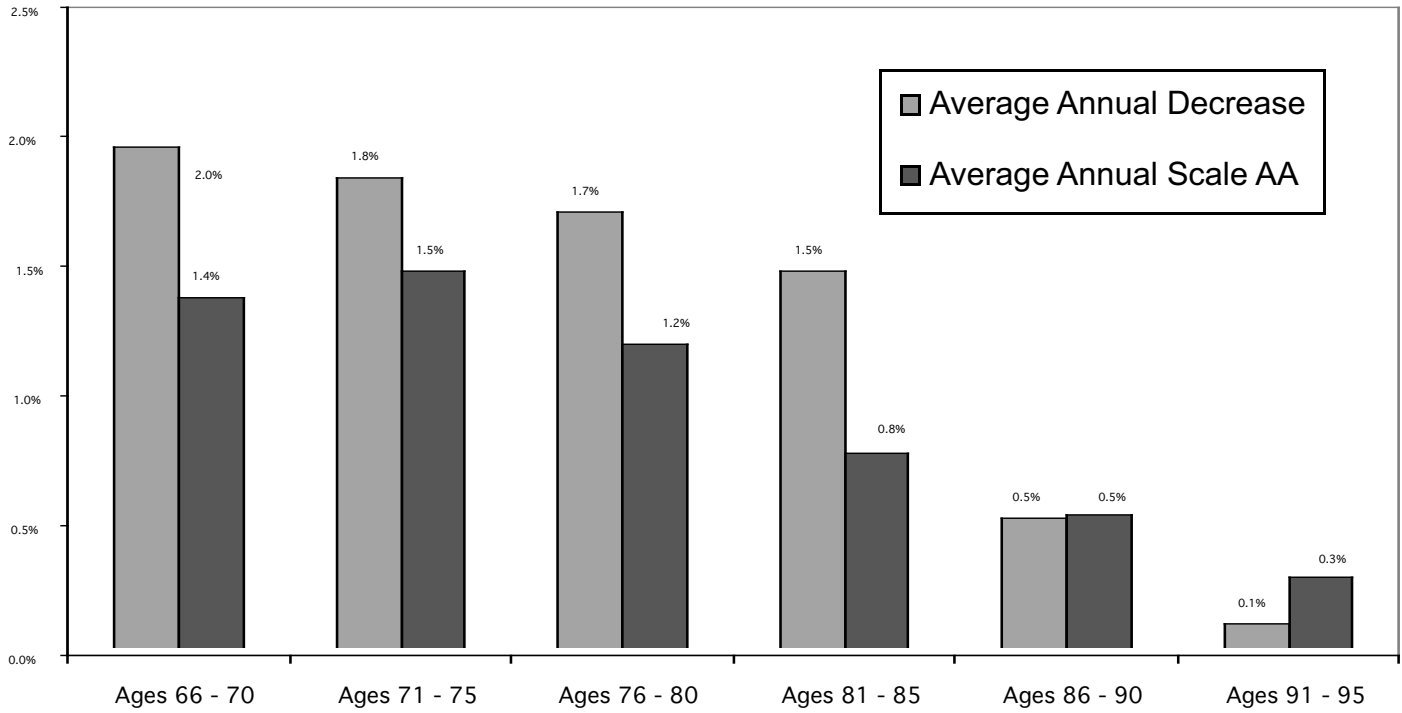
Comparisons of 1986-1990 GAM and Non-Military 1998-2002 Experience • Table 3 – Female

Age	1986-1990 <sup>1</sup>	1998-2002 Non-Military	Ratio	Average Annual Decrease	Five Year Average Decrease	Five Year Average Scale AA	1998-2002 Non-Military Deaths
50	0.001540	0.011366	738.05%	-18.12%			266
51	0.001766	0.010933	619.08%	-16.41%			331
52	0.002068	0.009700	469.05%	-13.75%			315
53	0.002153	0.009284	431.21%	-12.95%	-12.42% <sup>2</sup>	1.20%	343
54	0.002313	0.007319	316.43%	-10.08%			336
55	0.002522	0.007018	278.27%	-8.90%			389
56	0.002669	0.007431	278.42%	-8.91%			478
57	0.003222	0.007462	231.60%	-7.25%			484
58	0.003703	0.007514	202.92%	-6.07%	-6.16 <sup>2</sup>		532
59	0.004186	0.007216	172.38%	-4.64%			558
60	0.004759	0.007561	158.88%	-3.93%			608
61	0.004990	0.007911	158.54%	-3.91%			670
62	0.005865	0.008702	148.37%	-3.34%			824
63	0.007110	0.008989	126.43%	-1.97%	-2.15 <sup>2</sup>	0.50%	871
64	0.008633	0.009705	112.42%	-0.98%			947
65	0.009975	0.010664	106.91%	-0.56%			1,071
66	0.011659	0.010781	92.47%	0.65%			1,172
67	0.011558	0.011535	99.80%	0.02%			1,242
68	0.012648	0.013057	103.23%	-0.27%	0.20%	0.50%	1,389
69	0.014816	0.014256	96.22%	0.32%			1,492
70	0.016470	0.015968	96.95%	0.26%			1,732
71	0.018468	0.018263	98.89%	0.09%			2,003
72	0.019646	0.018900	96.20%	0.32%			2,193
73	0.022562	0.021638	95.90%	0.35%	0.23%	0.68%	2,502
74	0.022690	0.023571	103.88%	-0.32%			2,758
75	0.026181	0.024035	91.80%	0.71%			2,877
76	0.031442	0.031934	90.10%	0.86%			3,363
77	0.033878	0.031934	94.26%	0.49%			3,534
78	0.035267	0.034266	97.16%	0.24%	0.49%	0.72%	3,648
79	0.040115	0.038361	95.63%	0.37%			3,721
80	0.045878	0.043140	94.03%	0.51%			3,850
81	0.050633	0.047094	93.01%	0.60%			3,864
82	0.053618	0.053192	99.21%	0.07%			3,948
83	0.062886	0.060423	96.08%	0.33%	0.23%	0.68%	4,057
84	0.067163	0.068632	102.19%	-0.18%			4,063
85	0.079880	0.076621	95.92%	0.35%			4,061
86	0.083499	0.082021	98.23%	0.15%			3,948
87	0.093969	0.094976	101.07%	-0.09%			3,898
88	0.106342	0.106439	100.09%	-0.01%	-0.12%	0.38%	3,743
89	0.112547	0.115825	102.91%	-0.24%			3,459
90	0.127477	0.133534	104.75%	-0.39%			3,329
91	0.14480	0.149869	103.73%	-0.31%			3,033
92	0.161609	0.164484	101.78%	-0.15%			2,653
93	0.193206	0.188557	97.59%	0.20%	-0.43%	0.24%	2,378
94	0.178502	0.204159	114.37%	-1.13%			2,021
95	0.199738	0.218872	109.58%	-0.77%			1,559

<sup>1</sup> Blended CSRS from Age 50-65; GAM from Age 66 to 95.

<sup>2</sup> As noted, the 1986-1990 data is likely not comparable to the 1998-2002 data for ages less than 65 because the 1986-1990 data used active lives.

Comparison of 1986-1990 GAM and  
Non-Military 1998-2002 Mortality Experience (Males)  
Chart 1



**Comparison of 1986-1990 GAM and  
Non-Military 1998-2002 Mortality Experience (Females)**  
Chart 2

