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ACTUARIAL NOTE: A NEW MORTALITY BASIS FOR GROUP ANNUITIES

HENRY E. BLAGDEN

FOR some time now it has been questionable whether the 1937 Standard Annuity Table is a satisfactory mortality basis for group annuity reserves. The Prudential's mortality experience in recent years, measured by this table, shows that we have lost the mortality margin we once had on active lives and that the margin on retired lives is getting quite thin. For the calendar years 1947, 1948, and 1949 combined, the ratio of actual to expected reserve released for active lives was 90% even when poor health terminations are taken into account. The ratio for retired lives was 106%, including early retirements. These figures include all the experience under the group annuity contracts which we administer for employers other than ourselves.

Because of such figures as these and the recent results of intercompany mortality investigations, considerable thought has been given to the desirability of changing our mortality assumptions, particularly below age 65, in order to re-establish a satisfactory mortality margin in our reserves. At first we considered using the 1937 Standard Annuity Table rated back two years below age 65 and unrated above age 65. There were various practical objections to this, however, so that we felt a strong need for a completely new table. When the "Annuity Table for 1949" was published last fall, we immediately began to consider it as a possible new basis for group annuity reserves.

At the present time the use of projection factors as recommended by Jenkins and Lew seems too complicated to be practical in group annuity work. On the other hand, some definite provision should be made for future improvement in mortality. In a noncontributory group annuity plan, the employer pays all of the cost or, in a contributory plan, the greater part of it. If the individual annuitant contributes, the amount he pays in the usual fixed-benefit plan is merely a percentage of his salary and does not depend on the rate basis. We are not, therefore, concerned greatly with the problem of individual equity. We are concerned with making each employer's contract self-supporting. We believe this can be done by keeping close watch on the experience of each contract and periodically adjusting the basis of rates and reserves to maintain a margin of safety.

Test calculations on the 1949 Table without projection showed reserves that we considered adequate at the present time for lives below age 65, which is the retirement age in most of our contracts. At the higher ages among the retired lives, however, the 1949 Table without projection produces annuity values as much as 15% below those produced by the

Standard Annuity Table. If projection factors are not used, such a reserve basis for new business is questionable. Such a reserve basis would also introduce practical complications if in the future we should want to strengthen reserves for business now on our books from 1937 Standard Annuity to the new basis. Therefore, we felt we should have a table that would produce annuity values which, beginning somewhere between ages 70 and 75, would follow roughly those of the Standard Annuity Table, with some added margin.

The 1949 Table above age 65 was based on the experience under individual annuity contracts, where there is a large degree of self-selection by the annuitant. In group annuities, the element of individual selection is not so important. Therefore it was felt reasonable to assume slightly higher mortality rates than those of the 1949 Table in the age range around 65 to 75, where the effects of selection on individual annuities are most important.

Based on the foregoing considerations, we have produced a modification of the 1949 Table, which has been called the "Prudential 1950 Group Annuity Valuation Table." This new table has the mortality rates of the "Annuity Table for 1949—Males—Ultimate—without Projection" at ages 60 and below. The mortality rates for ages 61 to 76, inclusive, are slightly higher than the 1949 Table. From about age 71 on, the new table runs roughly parallel to the 1937 Standard Annuity Table, with slightly lower mortality rates. A graphical comparison between the new table, the 1949 Table, and the 1937 Standard Annuity Table for ages 55 to 95 is included as Exhibit I of this Note. The new table reproduces approximately the immediate life annuity values of the 1949 Table without projection at age 65 and below and has higher values above age 65. At age 70, the immediate life annuity value at $2\frac{1}{4}\%$ interest on the 1950 Table is 1.4% above the 1949 Table and 4.1% above the 1937 Standard Annuity Table. At age 80, the corresponding figures are 9.4% and 4.2%.

The basic male functions of the Prudential 1950 Group Annuity Valuation Table with a column of D_x and N_x at $2\frac{1}{4}\%$ interest are appended as Exhibit II. While the reasons which prompted Jenkins and Lew to discard the device of obtaining a female table by rating down the male table a fixed number of years are recognized as very important when individual annuities are involved, it is questionable if the same is true for group annuities. The proportion of female lives covered under most group annuity contracts is small, so the financial effect is not great. Again, there is little need to worry about individual equities and the use of the basic male factors with the age rated down for females has great practical advantages. Accordingly, for female employees we have in mind retaining the five-year rate-down principle used with the 1937 Standard Annuity Table.

EXHIBIT I

COMPARISON OF MORTALITY RATES - AGES 55 TO 75

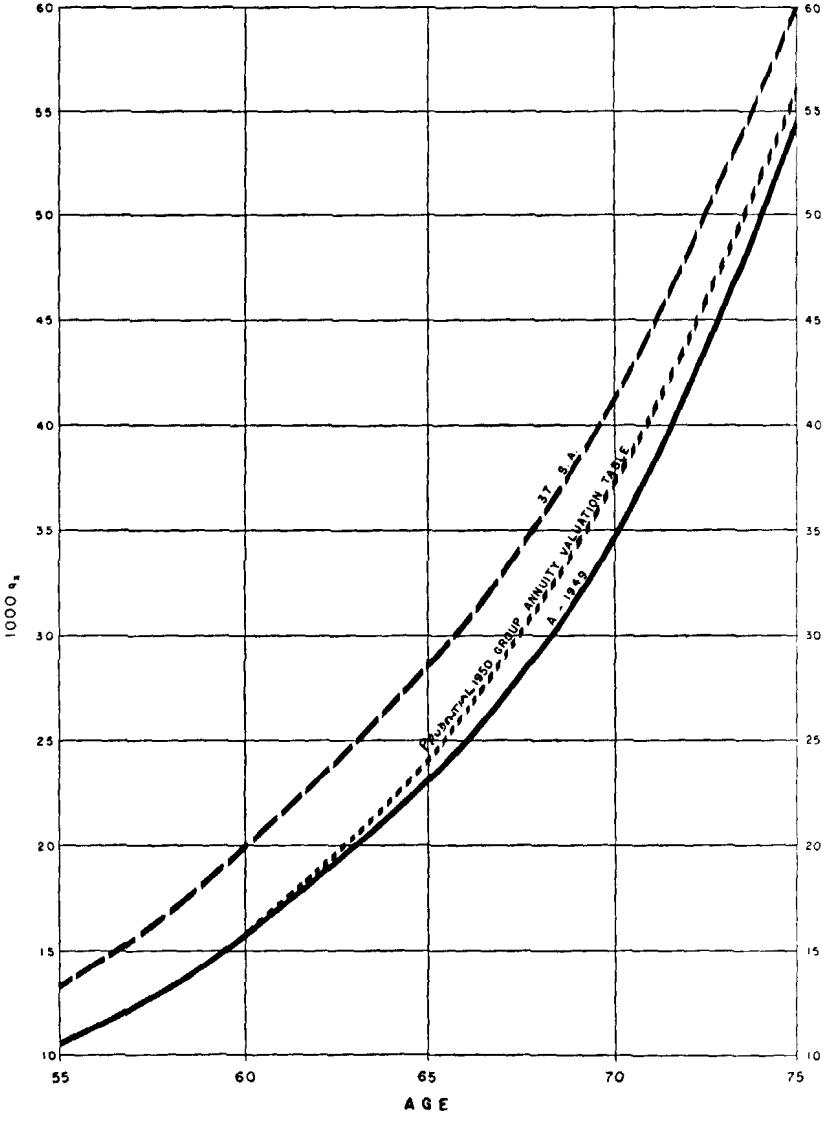

EXHIBIT I—*Continued*

COMPARISON OF MORTALITY RATES - AGES 75 TO 95

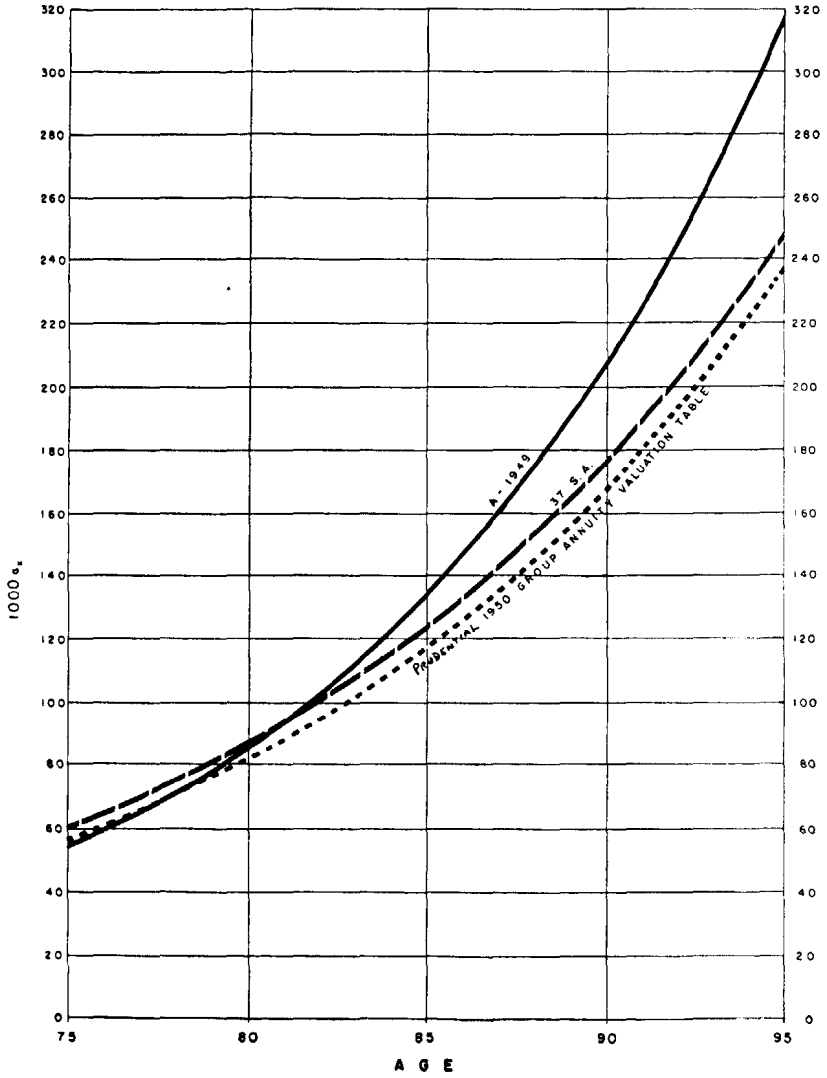

EXHIBIT II

PRUDENTIAL 1950 GROUP ANNUITY VALUATION TABLE $i = .0225$

x	l_x	d_x	$1000q_x$	D_x	N_x
10.....	1000.0000	.4830	.483	800.5101	27193.3842
11.....	999.5170	.4918	.492	782.5169	26392.8741
12.....	999.0252	.5015	.502	764.9211	25610.3572
13.....	998.5237	.5112	.512	747.7136	24845.4361
14.....	998.0125	.5230	.524	730.8858	24097.7225
15.....	997.4895	.5357	.537	714.4282	23366.8367
16.....	996.9538	.5493	.551	698.3320	22652.4085
17.....	996.4045	.5650	.567	682.5890	21954.0765
18.....	995.8395	.5816	.584	667.1902	21271.4875
19.....	995.2579	.6001	.603	652.1277	20604.2973
20.....	994.6578	.6207	.624	637.3931	19952.1696
21.....	994.0371	.6441	.648	622.9783	19314.7765
22.....	993.3930	.6695	.674	608.8750	18691.7982
23.....	992.7235	.6969	.702	595.0754	18082.9232
24.....	992.0266	.7272	.733	581.5723	17487.8478
25.....	991.2994	.7613	.768	568.3579	16906.2755
26.....	990.5381	.7984	.806	555.4244	16337.9176
27.....	989.7397	.8403	.849	542.7645	15782.4932
28.....	988.8994	.8861	.896	530.3704	15239.7287
29.....	988.0133	.9356	.947	518.2348	14709.3583
30.....	987.0777	.9910	1.004	506.3512	14191.1235
31.....	986.0867	1.0522	1.067	494.7118	13684.7723
32.....	985.0345	1.1190	1.136	483.3095	13190.0605
33.....	983.9155	1.1935	1.213	472.1373	12706.7510
34.....	982.7220	1.2746	1.297	461.1879	12234.6137
35.....	981.4474	1.3652	1.391	450.4545	11773.4258
36.....	980.0822	1.4642	1.494	439.9295	11322.9713
37.....	978.6180	1.5726	1.607	429.6061	10883.0418
38.....	977.0454	1.6932	1.733	419.4775	10453.4357
39.....	975.3522	1.8259	1.872	409.5360	10033.9582
40.....	973.5263	1.9714	2.025	399.7744	9624.4222
41.....	971.5549	2.1569	2.220	390.1857	9224.6478
42.....	969.3980	2.4051	2.481	380.7525	8834.4621
43.....	966.9929	2.7114	2.804	371.4503	8453.7096
44.....	964.2815	3.0732	3.187	362.2579	8082.2593
45.....	961.2083	3.4844	3.625	353.1574	7720.0014
46.....	957.7239	3.9420	4.116	344.1341	7366.8440
47.....	953.7819	4.4418	4.657	335.1762	7022.7099
48.....	949.3401	4.9802	5.246	326.2741	6687.5337
49.....	944.3599	5.5528	5.880	317.4205	6361.2596
50.....	938.8071	6.1558	6.557	308.6104	6043.8391
51.....	932.6513	6.7869	7.277	299.8404	5735.2287
52.....	925.8644	7.4421	8.038	291.1085	5435.3883
53.....	918.4223	8.1189	8.840	282.4143	5144.2798
54.....	910.3034	8.8136	9.682	273.7582	4861.8655
55.....	901.4898	9.5242	10.565	265.1419	4588.1073
56.....	891.9656	10.2496	11.491	256.5679	4322.9654
57.....	881.7160	10.9862	12.460	248.0388	4066.3975
58.....	870.7298	11.7340	13.476	239.5582	3818.3587
59.....	858.9958	12.4915	14.542	231.1295	3578.8005

EXHIBIT II—*Continued*

x	l_x	d_x	$1000q_x$	D_x	N_x
60.....	846.5043	13.2580	15.662	222.7564	3347.6710
61.....	833.2463	14.0977	16.919	214.4426	3124.9146
62.....	819.1486	15.0297	18.348	206.1755	2910.4720
63.....	804.1189	16.0711	19.986	197.9390	2704.2965
64.....	788.0478	17.2330	21.868	189.7144	2506.3575
65.....	770.8148	18.5088	24.012	181.4824	2316.6431
66.....	752.3060	19.8699	26.412	173.2270	2135.1607
67.....	732.4361	21.2736	29.045	164.9406	1961.9337
68.....	711.1625	22.6626	31.867	156.6258	1796.9931
69.....	688.4999	23.9846	34.836	148.2979	1640.3673
70.....	664.5153	25.1958	37.916	139.9822	1492.0694
71.....	639.3195	26.2767	41.101	131.7111	1352.0872
72.....	613.0428	27.2314	44.420	123.5185	1220.3761
73.....	585.8114	28.1113	47.987	115.4345	1096.8576
74.....	557.7001	28.9011	51.822	107.4769	981.4231
75.....	528.7990	29.5842	55.946	99.6648	873.9462
76.....	499.2148	30.1431	60.381	92.0186	774.2814
77.....	469.0717	30.5553	65.140	84.5598	682.2628
78.....	438.5164	30.8071	70.253	77.3120	597.7030
79.....	407.7093	30.8803	75.741	70.2989	520.3910
80.....	376.8290	30.7594	81.627	63.5446	450.0921
81.....	346.0696	30.4323	87.937	57.0735	386.5475
82.....	315.6373	29.8909	94.700	50.9092	329.4740
83.....	285.7464	29.1301	101.944	45.0739	278.5648
84.....	256.6163	28.1493	109.694	39.5882	233.4909
85.....	228.4670	26.9561	117.987	34.4700	193.9027
86.....	201.5109	25.5602	126.843	29.7340	159.4327
87.....	175.9507	23.9833	136.307	25.3912	129.6987
88.....	151.9674	22.2476	146.397	21.4476	104.3075
89.....	129.7198	20.3859	157.153	17.9049	82.8599
90.....	109.3339	18.4341	168.604	14.7590	64.9550
91.....	90.89980	16.43314	180.783	12.0005	50.1960
92.....	74.46666	14.42598	193.724	9.6147	38.1955
93.....	60.04068	12.45520	207.446	7.5815	28.5808
94.....	47.58548	10.56217	221.962	5.8766	20.9993
95.....	37.02331	8.78622	237.316	4.4716	15.1227
96.....	28.23709	7.15774	253.487	3.3354	10.6511
97.....	21.07935	5.72450	271.569	2.4351	7.3157
98.....	15.35485	4.50109	293.138	1.7348	4.8806
99.....	10.85376	3.45621	318.434	1.1993	3.1458
100.....	7.397550	2.573408	347.873	.7994	1.9465
101.....	4.824142	1.844916	382.434	.5098	1.1471
102.....	2.979226	1.259647	422.810	.3079	.6373
103.....	1.719579	.808455	470.147	.1738	.3294
104.....	.9111240	.4774654	524.040	.0901	.1556
105.....	.4336586	.2563425	591.116	.0419	.0655
106.....	.17731610	.11886527	670.358	.0168	.0236
107.....	.05845083	.04533008	775.525	.0054	.0068
108.....	.01312075	.01093395	833.333	.0012	.0014
109.....	.00218680	.00218680	1000.000	.0002	.0002

DISCUSSION OF PRECEDING PAPER

RAY M. PETERSON:

Mr. Blagden has presented in his actuarial note a modification of the Jenkins and Lew Annuity Table for 1949. This was done because of the opinion that the 1937 Standard Annuity Table is no longer a satisfactory mortality basis for group annuity reserves. We agree that the 1937 Standard Annuity Table is unsatisfactory. In our company we have been using the 1937 Table with ages set back one year and with $2\frac{1}{4}\%$ interest for group annuity reserves for business issued since 1947.

We have done some experimental work for group annuity purposes with the Jenkins and Lew Annuity Table for 1949. So far, we have been hoping to incorporate projection factors on an approximate basis for group annuities. We may, however, find that we will have to resort to a static table as Mr. Blagden has done. In our experimental work we have used Projection B factors with $2\frac{1}{2}\%$ interest and with a modification of the Jenkins and Lew Annuity Table for 1949 to increase the mortality rates in the age range 60 to 90 up to a maximum of 115% at age 75. This modification was designed to produce mortality rates more suitable for group annuity experience. Our increase of the mortality rates from ages 60 to 70 was quite close to the increase used by Mr. Blagden.

Mr. Blagden modified the mortality rates after age 80 downward to mortality rates under those of the 1949 Annuity Table and paralleled the rates of the 1937 Standard Annuity Table. Because we were hoping to use projection factors we did not decrease the mortality rates at the higher ages comparable to the mortality rates of the 1937 Standard Annuity Mortality Table. One of the reasons stated by Mr. Blagden for this modification at the higher ages was to produce reserves at all ages greater than the reserves of the 1937 Standard Annuity Table. It is probably a minor point, but we are inclined to feel that it would not cause much trouble if reserves at the high ages were less than Standard Annuity reserves. If the Annuity Table for 1949 had been followed more closely at ages over 80, it is likely that for most group annuity contracts the aggregate reserve would be greater than the Standard Annuity reserve. It would, therefore, still seem to be possible to strengthen reserves on business now being valued on the 1937 Standard Annuity Table. One incidental advantage for Mr. Blagden's modification at the high ages is that it may give the effect of some mortality improvement in a fairly correct way. For current annuity purchases, it will be some years before the lives

concerned reach the advanced ages over 80 where Mr. Blagden's table shows decreased mortality rates.

It appears that Mr. Blagden is resting on a margin in the interest rate to take care of mortality improvement. We have made some calculations (shown in Table 1) which compare reserves for a no death benefit life

TABLE 1

COMPARISON OF RESERVES FOR NO DEATH BENEFIT LIFE ANNUITY

Reserves for Annuity of $1 per Month
Ages 35–55, Deferred Annuity Beginning at Age 65
Ages 65–85, Immediate Annuity

Age	Prudential 1950 Group Annuity Valuation Table		Equitable Experimental 2¼% Reserve		
			Calendar Period		
	2¼%	2½%	1950–1959	1960–1969	1970–1979
35	$ 59.50	$ 54.12	$ 62.89	.....	.....
45	75.89	70.74	78.30	$ 81.96	.....
55	101.08	96.55	101.56	105.98	$110.20
65	147.68	144.55	145.01	149.26	153.34
75	99.73	98.22	.....	94.69	97.06
85	62.00	61.39	.....	.....	54.06

annuity on our experimental basis with reserves on the Prudential 1950 Group Annuity Valuation Table using both 2¼% and 2½% interest. Our experimental reserves are shown for three decades in the future. Reserves for a particular annuity purchased in the present decade can be followed in subsequent years by moving down a diagonal.

Three conclusions can be drawn from this table using our experimental values as an estimate of appropriate reserves.

1. The Prudential 1950 Group Annuity Valuation Table using 2½% interest shows unsatisfactory reserves at the outset. Using 2¼% interest the reserves are satisfactory at the present time.

2. The reserves on the Prudential table using 2¼% interest prove unsatisfactory in the second and third decades.

3. The influence of the lower mortality rates at the high ages is demonstrated by the fact that the reserves at ages 75 and 85 prove higher than our experimental reserves even in the second and third decades.

The ¼% interest margin to take care of mortality improvement does better justice on no death benefit annuities than on annuities with death benefit. Therefore, it does produce some inequity between different types of pension plans. The table above suggests the force of Mr. Blagden's remark that the Prudential must periodically adjust the basis of rates and reserves. It appears that an adjustment will be necessary as soon as ten years if the Projection B factors prove to be realistic. This touches on another important problem in surplus distribution. If a static mortality table is used with an interest margin to cover mortality improvement, this fact must be kept in mind in the surplus distribution. In other words, it suggests that one should recognize excess interest for surplus distribution as the interest in excess of 2½% rather than interest in excess of 2¼%. Another approach is one of continuing to provide for margins for future reserve strengthening so that when the reserve strengthening occurs it will not produce an abrupt effect on surplus distribution.

HORACE R. BASSFORD:

There have been several suggestions for using a lower interest rate as a margin against possible decreases in the mortality rate under annuity contracts. I think we actuaries are prone to take the easiest way of arriving at a general result without thinking of the possible consequences. Group Annuities offered at an extremely low interest rate are not attractive to many employers. It seems more advisable to use a mortality table which will provide such margins. Moreover, the use of the low interest rate will make it seem as if there were a larger interest margin than is really the case. For many practical reasons, we should not use a margin in one factor for application to any other factor.

(AUTHOR'S REVIEW OF DISCUSSION)

HENRY E. BLAGDEN:

In reply to the discussion I can only repeat what I said when presenting this paper, namely, that ultimately for group annuity purposes we should adopt forecast tables along the lines of those presented by Mr. Fassel or something similar. The use of the 1950 Group Annuity Valuation table is to some extent a stop-gap measure. It was not, however, our deliberate intention to rely heavily upon an artificially low interest rate, although I suppose with a 2¼% interest assumption there is some tendency to feel that if the mortality assumptions have not been conservative the margin from interest and loading will take care of it. I agree entirely with Mr. Bassford as to the desirability of establishing a mortality margin. This, I repeat, can only be done by the use of forecast tables.