TRANSACTIONS OF SOCIETY OF ACTUARIES
1956 VOL. 8 NO. 22

A NEW ANNUITY MORTALITY TABLE AND A GRADED RATE SYSTEM FOR THE LIFE INCOME SETTLEMENT OPTIONS

WILLIAM C. McCARTER

SEE PAGE 127 OF THIS VOLUME

WILMER A. JENKINS:

This paper is a most welcome one. It has many merits. I should like to discuss only the new mortality table which Mr. McCarter presents and the projection scale he uses. He says that these are not an essential part of the paper, but discussing them should, nevertheless, be in order because a considerable part of the paper is devoted to them and they can have important effects on some of Mr. McCarter's conclusions.

In its general relationships to previous mortality tables, the proposed 1955 American Annuity Table is portrayed clearly in Mr. McCarter's Charts 1 and 2. There we see that, except for females under age 30, the new tabular death rates are almost uniformly a little below those of the 1937 Standard Annuity Table or of the Annuity Table for 1949, whichever is the lower. Since the q_x curves of these two tables cross near age 80, Mr. McCarter's tabular death rates roughly parallel the 1949 table below age 80 and the 1937 table above that age. Obviously, the resulting 1955 table is another step in the direction of conservatism.

Discussion will probably center on the degree of conservatism that is necessary or desirable at the oldest ages—say, over age 85; and opinions may differ, depending partly on the particular data on which the opinion is based. On the basis of the 1948–53 intercompany experience under individual annuities, as shown in Mr. McCarter's Table 8, the new table for males seems to embody a reasonable and proper amount of conservatism, though some actuaries may conclude that there is too much. (Females at advanced ages present a different question which I shall discuss later.) On the other hand, the 1941–46 intercompany data, upon which the Annuity Table for 1949 was based, show a steeper slope in the male q_x curve at the advanced ages than the newer experience does. If the flatter 1948–53 curve is here to stay, we had better recognize it, but we all know that mortality changes develop irregularly, with frequent reversals of trend. Both of these experiences covered only 5-year periods and are entitled to limited credence on this account. However, 1948–53 experience is new and, as Mr. McCarter brings out, is of substantial size; also, it points in the direction

of conservatism. These, I assume, were the main reasons that led Mr. McCarter to base his table entirely on the 1948–53 experience. At the same time, I know that he appreciates that this experience may have been an exceptional one and that in the end he may find that he has used a larger degree of conservatism than necessary at the highest ages.

My own opinion is that it would be foolish to shut our eyes to the 1948–53 data, and that our premiums and reserves should be calculated with some recognition of the possibility of relatively low death rates over age 85 or so, but I probably would not move as far in that direction as Mr. McCarter has. That, of course, is a matter of opinion.

Especially, it seems to me that use of a 5-year age differential between the sexes is unfortunate in that it clearly and seriously underestimates the female mortality rates at advanced ages. It is true that only a few annuities are begun at these ages, but there are some. (I had occasion to buy two in recent years and was not at all happy over what I thought were serious overcharges.) Moreover, the death rates in question increase premium rates at younger ages also, and tend to overstate all reserves to varying degree. The latter, moreover, acts to distort the incidence of surplus earnings. None of these consequences is particularly desirable. Even though two mortality tables—one for each sex—involve additional detailed work, I personally would have preferred them instead of Mr. McCarter's 5-year differential. The importance of this question is brought out by the very high mortality ratios for females at the advanced ages, as shown in Mr. McCarter's Tables 8 and 9.

Mr. McCarter's projection formula of a year setback in age for each eight or ten calendar years elapsed has considerable historical prestige, since it was originally advanced about 30 years ago in Great Britain. It also has considerable backing in the 1948–53 intercompany study in comparison with the previous one. The trends developed from these two studies were discussed at our meeting in California in the Spring of 1955. This discussion brought out that the long-term trends Mr. Lew and I had observed in many places over long periods of time and had incorporated in our Scale B apparently had not shown up in the latest intercompany study. This study had indicated a scale flat or even increasing with age. But here again we have a new trend showing up in the most recent data, and the big question is: is it a new, long-term trend or simply a short-term fluctuation. Here again also, the current data are new, based on substantial exposure, and have conservative indications. Presumably, for these reasons, Mr. McCarter adopted the projection scale he did with full realization that the mortality improvement he assumes at the advanced ages may be only temporary, and in the long run may prove too conservative.

As in the matter of old age death rates, my personal opinion on this matter is similar to, but a little different from, Mr. McCarter's. The statement I made ten years ago, which Mr. McCarter quotes in the paper, still seems like good advice: within broad limits it doesn't make too much difference what kind of projection scale we use so long as we use a scale of some kind and don't shut our eyes to the repeatedly demonstrated fact that in general the long-term trend of death rates is down.

HARRY WALKER:

In his paper Mr. McCarter has derived a table of mortality and a system for adjusting for future mortality improvement, to be used for life income settlement option guarantees. As he states, the "twin objectives of the proposed graded rate system are understandability and equity."

All of us who have worked with the problem of deriving a satisfactory basis for life income settlement option guarantees, which would recognize the latest mortality experience under such options and make provision for future improvement in mortality, have realized that some compromise with theory is necessary if we are to have a manageable structure. In order to avoid too cumbersome a structure Mr. McCarter has suggested a system based on a table of mortality applicable in 1955 to male lives, to be used for female lives by setting the age back 5 years, and involving a fixed setback in age (*e.g.*, 1/10 of a year of age) for each calendar year elapsed from 1955 to the calendar year in which the settlement becomes effective. As Mr. McCarter has referred in his paper to the approach used in the development of the "ELAS" Life Income Mortality Table (*TSA* VI, 85) I thought it might be well to discuss briefly the differences between the two methods, both of which represent a practical approach to the development of a table of mortality which includes provision for future improvement.

Mr. McCarter's proposed system gives explicit recognition to the fact that the cost of a life income settlement at a given age will depend upon the calendar year of settlement, while the "ELAS" Life Income Mortality Table was designed as a basis for life income settlement option guarantees in current issues, that would be independent of the calendar year of settlement. The latter involves an averaging of the net single premiums required for life income settlements that would become effective in different calendar years. The use of a single entry table independent of the calendar year of settlement made it feasible to recognize explicitly the difference between male and female mortality in the "ELAS" Life Income Table approach. On the other hand, under Mr. McCarter's system female mortality is taken to correspond with male mortality with the age set back 5 years.

To arrive at some measure of the significance of the approximation involved in assuming that the net single premium for a female life is the same as for a male life 5 years younger, I referred to Table 7 of Mr. McCarter's paper and to the table appearing on pages 150 and 151. For a female age 65 the 10 years certain life annuity value shown in Table 7 (15.927) on the proposed 1955 American Annuity Table exceeds by .366 the corresponding value under the "Female Experience Table" in the next column. This difference of .366 per unit of annual income, or approximately $44 per $10 of monthly income has the same effect as a 9 year overstatement in the assumed calendar year of settlement. (See page 151 —*i.e.*, 44 = approximately 9 × 4.95.) Similarly for a female age 75 the overstatement in the annuity value resulting from the 5 year age setback assumption corresponds to a 19 year overstatement in the assumed calendar year of settlement.

As is pointed out in the paper, the retirement income type of policy raises a problem in a system in which life option rates vary by year of settlement. Mr. McCarter has mentioned the variations in maturity value by age at issue and the necessity for changing premiums and nonforfeiture values, if not every year, at least periodically, say every 4 or 5 years. There is a further complication not mentioned in the paper. Most retirement income policies provide for optional forms of income—*e.g.*, life annuity, 20 years certain life income, refund certain life income, etc. While the varying maturity values for the different issue ages will all correspond to $10 per month of 10 years certain life income, the equivalent in the form of an optional income settlement will not be a fixed amount that is independent of the issue age.

Considering the complications involved in the retirement income form of policy and the departures from theory which, as a practical matter, are inherent in either system, I seriously question whether on balance it is worth while making explicit provision for a variation in the life income net single premium with the calendar year of settlement, as compared with the broader averaging implied in a single entry table for each sex. The departures from theory that I have in mind are: (1) disregarding the substantial difference in the mortality experienced among various classes of life income settlements—*i.e.*, death claim settlements involving payee elections, death claim settlements involving nonpayee elections, settlements of cash values or endowment maturity values, and deferred annuity settlements; (2) disregarding the difference between the mortality experienced under the various types of life income settlements and the mortality under nonrefund immediate annuities underlying the construction of the basic table; (3) disregarding the elements of uncertainty in any forecasting of future mortality improvement.

There is one additional point that I think is worthy of mention. Inasmuch as most life income settlements arising out of life insurance proceeds involve female lives, would it not be more appropriate to derive a basic table with reference to female experience, and then apply an age adjustment to that table for male lives, if the technique of age adjustment for sex is to be used?

EDWARD A. LEW:

Mr. McCarter has presented a valuable paper proposing a practical graded rate system for life insurance settlement options that is based on a new annuity mortality table which makes provision for future improvements in mortality. It will be possible to form a better judgment of Mr. McCarter's assumptions and extrapolations when the report of the Committee on Mortality under Ordinary Insurances and Annuities on the subject of mortality under settlement options between 1950 and 1955 anniversaries is in hand sometime early next year.

I take issue nevertheless with Mr. McCarter on one important point—namely, the probable course of mortality at the advanced ages. Mr. McCarter's Table 13 shows that since 1949 there has been virtually no improvement in mortality in the general population of the United States for males at ages 55–64, 65–74, and 75–84, while for females at these ages there has been only a slight improvement during the same period. The population mortality statistics cited for ages 85 and over, to the extent that they have not been adjusted for age distribution, are not meaningful. (The average age for the group 85 and over has decreased.) It should also be kept in mind that the death rates extrapolated for the very advanced ages (past 90) depend largely on the base and the methods of extrapolation used rather than on actual statistics. In the preparation of the 1949–51 U.S. Life Tables, the National Office of Vital Statistics explicitly stated that ". . . population and mortality statistics at the oldest ages were least trustworthy. Special methods were devised to determine the proportions dying at ages over 87 for non-white and for ages over 92 for whites. Therefore, the life tables at the oldest ages are more likely to contain errors than those at the younger ages. In fact, they may not necessarily represent actual conditions."

This is not to deny that there had been some real improvement in mortality at ages over 85 between 1940 and 1952, mainly as a result of the introduction of antibiotics, better surgery for the aged, etc. The point, however, is that the effect of these measures has been pretty well exhausted by now and that there is little reason at present to project the reductions effected from 1940 to 1952 into the future. Over 80 percent of the mortality at the advanced ages is accounted for by the cardiovascular-renal

diseases and cancer and in the last five years these causes of death have shown no significant decrease at these ages. Death rates from cardiovascular-renal diseases have remained almost unchanged. Cancer death rates have even increased slightly, especially for males. So long as no real dent is made in curbing mortality from the cardiovascular-renal diseases and cancer, there can be no sizable improvement in total mortality at the advanced ages. I do not know of any current developments that suggest any such accomplishment in the near future.

The last report of the Committee on Mortality under Ordinary Insurances and Annuities showed for durations 6 and over a mortality ratio of only 92% of the *a*–1949 Table under male nonrefund annuities at ages 80 and over (as compared with 99% under female nonrefund annuities). The 92% mortality ratio is misleading, however, because it reflected partly the prolonged effects of temporary selection among males purchasing nonrefund annuities in their seventies and early eighties. The corresponding mortality ratios for attained ages 70–79 (representing the ultimate mortality among those who purchased nonrefund annuities in their sixties) were 113% of the *a*–1949 Table by number and 127% by amount of income. The indications are that when the full tide of survivors of the males to whom nonrefund annuities were issued at about 65 reach their eighties, the mortality in this age range will be materially increased.

Such other meaningful experience data as are available do not show any mortality improvement at the advanced ages between the late 1940's and the early 1950's. For instance, the group annuity mortality experience on matured lives for the years 1951–54 shows higher death rates for males at ages 86 and over than for the years 1946–50. The population mortality rates (based on population estimates) at ages 85 and over in England and Wales for the years 1951–54 show distinctly higher mortality rates than for the years 1946–50. The Ordinary insurance experience on standard issues at ages 85 and over during the 16th and subsequent policy years as reported to the Committee on Mortality under Ordinary Insurances and Annuities has shown no clear-cut trend since 1949.

I am, therefore, led to the conclusion that at the advanced ages we must reckon with the cumulative effect of seriously impaired lives which modern medicine is keeping alive to such ages. For instance, the growing number of diabetics who reach advanced ages will undoubtedly tend to increase the mortality at these ages; persons with other serious impairments who survive to these ages will likewise have the same effect. Unless the human life span is increased appreciably—and for this there is currently no evidence—a time must come when the growing body of impaired lives surviving to the older ages will tend to offset any further re-

ductions in mortality among healthy lives at the older ages with the possible net effect of higher death rates at the advanced ages. Of course, the outlook could be changed by any major discoveries leading to reductions in mortality from the cardiovascular-renal diseases and cancer. On the whole, however, I cannot go along with the optimistic projections of mortality rates for the advanced ages envisaged by Mr. McCarter in his table.

RICHARD A. LEGGETT:

Mr. McCarter has contributed several ideas to help solve the problem of mortality improvement on annuities. His new annuity table is quite conservative for direct use. He has lowered the mortality rates on males to a level far below that on recent nonrefund annuity experience, and below both the *a*-1949 and 1937 Standard tables at all important ages, and then introduced the further conservatism of using male mortality with an age setback of 5 years to represent female mortality. I suspect that he may have been influenced by the mortality ratios in his Table 2 which indicate lower mortality for life income options than for immediate annuities. These results in Table 2 depend, however, on the use of the 1937 Standard Table for the expected deaths. We have worked approximate ratios comparable to a part of his Table 2 but using the *a*-1949 Table as a standard, and these ratios indicate that settlement option mortality may not be significantly lower than that on immediate nonrefund annuities.

Our method of transforming the 1946–48 experience ratios to the *a*-1949 Table was tested on other data where ratios on both standards were available, and it is suitably accurate. It consists of determining a central age to nearest tenth for each age group by dividing expected deaths on the 1937 Standard Table by the exposure and comparing this with mortality rates on the 1937 Standard Table. This central age is then used to determine an average mortality rate and the expected deaths on the *a*-1949 Table.

As for the results, it may be that the *a*-1949 Table is not an ideal standard either. Also, if a common age distribution were used, the ratios for all ages combined would be reduced relatively by a small amount on the life options. In view of the results, however, I think that the mortality on settlement options is not significantly lower than on immediate nonrefund annuities. The proposed 1955 American Annuity Table is therefore quite conservative for all classes of annuities or life incomes.

If it is desirable to use the same table for males and females for practical reasons, we can also use the *a*-1949 Table with a 5 year setback for females, although Messrs. Jenkins and Lew may consider this a perversion of their efforts. This results in female mortality ratios well in excess of

100% for ages 70 and higher, even for recent nonrefund annuity experience. Where mortality of the *a*-1949 Table is a little high on immediate nonrefund annuities at high ages for males, it is more than balanced by the low rates for females. If the *a*-1949 Table is used for annuity premiums, some allowance should certainly be made on nonrefund annuities at the high ages for the antiselection shown in the experience. This would not be so necessary in using the proposed 1955 American Annuity Table.

COMPARISON OF EXPERIENCE BY NUMBER OF CONTRACTS—
a-1949 TABLE MORTALITY RATIOS
NONREFUND IMMEDIATE ANNUITIES VS. PAYEE-ELECTED
LIFE INCOME SETTLEMENTS

ATTAINED AGES	MALES			FEMALES		
	Imm. Ann. 1946–48	Life Opt. 1945–50	Imm. Ann. 1948–53	Imm. Ann. 1946–48	Life Opt. 1945–50	Imm. Ann. 1948–53
	Durations 1–5					
Under 60....	45%	87%	89%	135%	119%	98%
60–69.....	125	102	92	89	101	83
70–79.....	98	85	88	91	91	75
80 and over..	65	100	64	80	81	61
All.....	92%	96%	80%	89%	101%	73%
	All Durations					
Under 60....	132%	93%	99%	165%	129%	114%
60–69.....	125	102	90	109	105	102
70–79.....	110	105	108	108	105	104
80 and over..	103	94	89	109	106	97
All.....	109%	102%	96%	109%	108%	100%

However, for rate-making purposes, probably any table should be adjusted to reflect mortality variations by type of income, year of settlement, and effect of antiselection. The *a*-1949 Table is still an appropriate starting point for many classes of life incomes.

I do not like to appear to be in a position of discouraging any move toward more conservative income options, for I feel rather strongly that it is an area where more caution is necessary. However, we need not so much a more conservative table for current settlements as to assume more rapid mortality improvement with whatever table we start.

My company has in recent years worked theoretical premiums by using the *a*–1949 Table with Projection B, modified to continue the improvement rate of .75% per year at all ages above 75. However, this is probably not enough allowance for improvement. Perhaps, because of the erratic pattern which mortality improvement has taken in recent years, a constant 1% per year improvement for all ages is as reasonable as any other estimate. In this connection Mr. McCarter's method of providing for mortality improvement by use of age setbacks can be applied to the *a*–1949 Table just as well as to his table. A setback of 1/8 year of age per calendar year in the *a*–1949 Table corresponds to improvement over the next 40 years very close to 1% per year. The exact rates are .93% at 40, 1.47% at 50, .98% at 60, 1.04% at 70, 1.12% at 80, 1.10% at 90, and .95% at 100.

In the accompanying Tables 1 and 2 are shown values on two bases similar to those in Mr. McCarter's Tables 16–19.

Mr. McCarter states that the practical problem to which his paper is directed is the development of a system of life income values which are graded by year of settlement as well as by sex and age. Although his use of a single table with yearly adjustments is a practical method, it is convenient to have tables giving income in terms of units of proceeds. In a table of income per $1,000 of proceeds the yearly adjustments are too small. However, it may be suitable to show income per $10,000 of proceeds, with yearly adjustments to the nearest cent. Using the data of his illustration we might then have:

Age of Beneficiary		Instalment Refund	
Male	Female	Income	Yearly Adjustment
10	15	$25.73	.01
20	25	27.51	.02
30	35	30.05	.03
40	45	33.81	.04
.	.	.	.
.	.	.	.
.	.	.	.
70	75	61.96	.16

I realize that by the end of 50 years this can result in inaccuracy to the extent of $.25 per month on the income from $10,000 proceeds, but we shall probably be well pleased if income options guaranteed today are that close to par 50 years from now.

TABLE 1

Male Age	(1) a-1949 Table Projection B	(2) Proposed 1955 American Annuity Table with Projection*	(2)/(1) %	(3) a-1949 Table with Projection B Modified (.75% per year above 75)	(3)/(1) %	(4) a-1949 Table with Projection† Females Set Back 5 Years in Male Table	(4)/(1) %
	Immediate Nonrefund Annuities—1955 Year of Issue (Table 16)						
35.....	25.140	25.835	102.8	25.367	100.9	25.473	101.3
55.....	16.550	17.384	105.0	16.765	101.3	16.983	102.6
75.....	7.491	8.146	108.7	7.706	102.9	8.027	107.2
85.....	3.947	4.704	119.2	4.137	104.8	4.379	110.9
	Life Income Settlement Options with 10 Year Certain Period—1955 Year of Settlement (Table 17)						
35.....	26.229	26.895	102.5	26.427	100.8	26.535	101.2
55.....	18.020	18.732	104.0	18.212	101.1	18.438	102.3
75.....	10.631	11.176	105.1	10.834	101.9	11.059	104.0
85.....	9.177	9.452	103.0	9.248	100.8	9.319	101.5
	Immediate Nonrefund Annuities—1980 Year of Issue (Table 18)						
35.....	26.193	26.693	101.9	26.322	100.5	26.455	101.0
55.....	17.684	18.583	105.1	17.995	101.8	18.228	103.1
75.....	7.978	9.165	114.9	8.586	107.6	9.205	115.4
85.....	4.041	5.462	135.2	4.811	119.1	5.281	130.7
	Life Income Settlement Options with 10 Year Certain Period—1980 Year of Settlement (Table 19)						
35.....	26.983	27.742	102.8	27.365	101.4	27.507	101.9
55.....	18.887	19.854	105.1	19.327	102.3	19.592	103.7
75.....	10.852	11.858	109.3	11.404	105.1	11.855	109.2
85.....	9.186	9.736	106.0	9.449	102.9	9.622	104.7

* One-tenth year age setback per calendar year.

† One-eighth year age setback per calendar year.

TABLE 2

Female Age	(1) a-1949 Table Projection B	(2) Proposed 1955 American Annuity Table with Projection*	(2)/(1) %	(3) a-1949 Table with Projection B Modified (.75% per year above 75)	(3)/(1) %	(4) a-1949 Table with Projection† Females Set Back 5 Years in Male Table	(4)/(1) %
	Immediate Nonrefund Annuities—1955 Year of Issue (Table 16)						
35.....	26.794	27.506	102.7	27.098	101.1	27.016	100.8
55.....	18.798	19.746	105.0	19.098	101.6	18.974	100.9
75.....	8.798	10.240	116.4	9.063	103.0	9.935	112.9
85.....	4.583	6.290	137.2	4.794	104.6	5.866	128.0
	Life Income Settlement Options with 10 Year Certain Period—1955 Year of Settlement (Table 17)						
35.....	27.870	28.546	102.4	28.138	101.0	28.062	100.7
55.....	20.030	20.961	104.6	20.309	101.4	20.288	101.3
75.....	11.372	12.638	111.1	11.619	102.2	12.389	108.9
85.....	9.293	10.114	108.8	9.388	101.0	9.868	106.2
	Immediate Nonrefund Annuities—1980 Year of Issue (Table 18)						
35.....	27.560	28.273	102.6	27.818	100.9	27.903	101.2
55.....	19.636	20.867	106.3	20.078	102.3	20.210	102.9
75.....	9.230	11.362	123.1	9.931	107.6	11.179	121.1
85.....	4.669	7.186	153.9	5.488	117.5	6.910	148.0
	Life Income Settlement Options with 10 Year Certain Period—1980 Year of Settlement (Table 19)						
35.....	28.356	29.307	103.4	28.848	101.7	21.941	102.1
55.....	20.653	22.041	106.7	21.234	102.8	21.449	103.9
75.....	11.575	13.504	116.7	12.249	105.8	13.354	115.4
85.....	9.302	10.594	113.9	9.638	103.6	10.393	111.7

* One-tenth year age setback per calendar year.

† One-eighth year age setback per calendar year.

WALTER G. BOWERMAN:

The author has followed Messrs. Fassel and Noback in using a constant age setback for female lives. This is at variance with my comment (*TSA* II, June, 93), "I would agree with Jenkins and Lew that the 5 year setback in age is not close enough to realities, and must (reluctantly) be discarded for future tables of annuity mortality." The use of modern, electronic machines will make the constant age setback less desirable than formerly.

The 1955 table extends down to only age 5 male and age 10 female. Extension to zero would seem necessary and that is where the age setback system becomes most at variance with biological realities. The other place is at the extreme upper ages. A woman of 100 or more usually does not differ much from a man of the same age, either psychologically or as to mortality. Yet here are the relative death rates per 1,000 in the 1955 table:

DEATH RATES PER 1,000

	Age 80	Age 90	Age 100	Age 110	Age 112	Age 114
Male.....	77	169	342	625	734	1,000
Female.....	50	115	244	467	524	588
Ratio (M/F).	1.52	1.47	1.40	1.34	1.40	1.70

In the inevitable conflict between the rigidity of mathematics and the verities of biology, I note that the former has triumphed in this table.

In the last six years there have been many papers published showing strong probability of lowered future general death rates at ages over 50. One, by William L. Laurence, promised a coming "break-through" in medicine, which would create havoc in the degenerative diseases, much as the last 100 years have done in the infectious disorders. All of these papers have thrown doubt on the future adequacy of annuity rates. Thus the present paper is timely and merits a keen discussion. I would agree with the author's conclusion: "It would be unsound to assume for projection purposes that the future rate of decrease at ages 80 and over would be much less than the rates assumed for ages under 80."

It seems strange that the mortality by number of contracts was generally lower than by amounts.

At middle of page 135 the text might better read ". . . increased 5 years to age 115 *for men and 120 for women.* These are the values of omega."

At the bottom of page 138 ". . . to the rate of unity at age 114" reveals another unfortunate aspect of the 1955 table. I had pointed out in *TASA* XL and in *TSA* II that it is better not to attain unity at any age. If in

doubt as to the limit of life, don't show any! A number of modern tables are on this basis.

ARTHUR C. CRAGOE:

I should like to discuss one point of Mr. McCarter's excellent paper. On page 153 he offers a solution to the problem of using a graded settlement return depending on the year of settlement as well as the attained age of the payee, together with using the traditional retirement income policy without changing maturity values and consequently premium rates and nonforfeiture values for this policy each year. His solution is to grade the maturity values of the retirement income plan by age at issue and to change such values every 4 or 5 years.

To achieve complete correlation between the settlement options of non-retirement income policies and the maturity values of such policies issued in the years subsequent to the year of change in maturity values, he would deduct the "small deficiency in life option net single premium from the final year's dividend." For a company which may not wish to change maturity values as often as every 4 or 5 years or whose gross premium scale, and consequently dividend margins, are somewhat less than the Northwestern Mutual's, a supplement to this program would be to withhold that portion of the annual dividend return, over the scale in effect at issuance of the policy, due to improvement in *mortality* occurring during the premium paying period. Such a procedure would be somewhat inequitable between those who take the maturity value in cash and those who take income and also among those retirement income policyholders with differing years of issue in the interval between changes in maturity value. Also, the calculation of the value of the undistributed mortality improvement, if any, occurring during the premium paying period and valued at the date of income commencement would probably be somewhat arbitrary. However, the effect would be to reduce the deduction from the final year's dividend and to prevent increased dividends to premium paying retirement income policyholders due to improvements in mortality occurring during the premium paying period when such improvements will turn to losses as soon as income commences.

One company, which uses a two factor dividend formula, has adopted a scheme of returning the improvements in mortality represented by the difference of the former company experience table q'_x and a new company experience table q''_x for premium paying policies. The theory is to add a factor of the form $(q'_{x+t-1} - q''_{x+t-1}) \times$ (amount at risk) to the present two factor formula. This has the effect of paying out mortality improvements more or less as they occur at the attained ages where there is improvement

without recomputing company experience net premiums which assumes that the new mortality rates have been experienced since the date of issue. This latter point has been especially important in the older American Experience policies. For retirement income policies the additional mortality factor would not be added, since the dividend scale at issue assumes a certain table of company experience mortality and any improvements during the premium paying period should go toward offsetting the mortality losses such improvements will engender after income commences. Of course, if improvements occur only at ages before income would commence, the withholding of improvements is not warranted. However, our studies have shown improvements at all ages and especially at the ages after normal retirement. The theory of withholding mortality improvements from retirement income policies is as appropriate for a company using a three factor dividend formula and the method is straightforward.

Although we have not seen fit to withhold mortality improvements from our current series of retirement income policies where we are not sure of the understatement of our present maturity values, we have adopted the idea for our older retirement income policies where we know that the maturity values are too low.

Of course, an ideal theoretical solution would be to have participating incomes after maturity where dividends could be cut in the event of mortality improvement. However, if we must have 100% guaranteed incomes, the next best thing may be to try to recoup the cost of mortality improvements from dividends during the premum paying period instead of entirely from the final dividend. The problem still remains for a nonparticipating company with no dividends to adjust.

(AUTHOR'S REVIEW OF DISCUSSION)

WILLIAM C. McCARTER:

My thanks to those who discussed the paper—and my reply will be in the same order of subject as the paper, *i.e.*, the mortality table, graded rate system, and mortality projection basis.

MORTALITY TABLE

Mr. Jenkins and Mr. Lew both question whether the lower mortality at ages 80 and over shown by the 1948–53 intercompany experience should be reflected to the extent it has been in the derived mortality table. Mr. Jenkins apparently feels that in spite of the substantial size of the experience at ages 80 and over in this investigation, the reduction in mortality rates for this particular age group may be a temporary or cyclical change rather than indicative of a trend.

While it must be agreed, as Mr. Jenkins says, that mortality changes develop irregularly, and the extent of improvement in any one age range may vary considerably from the over-all rate of decrease or from period to period, the trend of annuitant mortality has been persistently downward in every age group. Cyclical fluctuations in the rate of decrease have been numerous, but not "frequent reversals of trends." In describing this experience at the higher ages as "new" and "exceptional," Mr. Jenkins apparently overlooked the fact that the 1946–48 intercompany experience showed pronouncedly lower mortality at ages 80 and over than in the 1941–46 experience. As may be seen in the following comparison of mortality ratios for male lives from the three experiences, particularly those by amounts, the accelerated rate of decrease has continued fairly consistently over the entire period. With advance in medical science and geriatrics making further such decreases possible, if not probable, I would not think it safe to assume that the proposed 1955 American Annuity Table embodies a larger degree of conservatism than warranted at the higher ages.

IMMEDIATE ANNUITY EXPERIENCES—MALE
ATTAINED AGES 80 AND OVER
MORTALITY RATIOS ON 1937 STANDARD ANNUITY TABLE

CONTRACT YEARS	BY NUMBER OF CONTRACTS			BY AMOUNTS OF ANNUAL INCOME		
	1941–46	1946–48	1948–53	1941–46	1946–48	1948–53
	NONREFUND ANNUITIES					
1–5	110%	68%	67%	96%	65%	80%
6 and over	113	116	99	131	116	99
All	113	109	95	124	108	97
	REFUND ANNUITIES					
1–5	107%	124%	100%	108%	103%	114%
6 and over	122	110	104	137	118	108
All	118	112	104	130	116	109
	NONREFUND AND REFUND ANNUITIES COMBINED					
1–5	108%	103%	86%	103%	85%	95%
6 and over	118	112	102	134	117	104
All	116	111	101	127	112	103

Mr. Lew on the other hand feels that the low mortality at ages 80 and over shown in the 1948–53 experience for nonrefund annuities at duration 6 and over is due in large part to the prolonged effects of selection among annuitants entering in their seventies and early eighties, and he predicts that mortality in this age group will be materially increased in future as survivors of those to whom nonrefund annuities were issued around 65 reach their eighties.

Unfortunately in the data furnished by the Committee on Mortality all durations of more than five years were combined, so that it is not possible to demonstrate from the ratios for durations 6–10 and 11 and over to what extent, if any, mortality at the high ages has been affected by prolonged selection. General reasoning would indicate, however, that those taking annuities in their seventies and early eighties who were able to exercise such an unusual degree of selection would concentrate their purchases in nonrefund annuities, and hence that true ultimate mortality should be experienced under refund annuities. If then the Annuity Table for 1949 does correctly reflect the incidence of ultimate mortality by attained age, and ratios on that table for nonrefund annuities at ages 80 and over have in fact been distorted by prolonged selection, the corresponding ratios for refund annuities should show little if any variation between age groups.

1948–53 INTERCOMPANY EXPERIENCE UNDER
INDIVIDUAL IMMEDIATE ANNUITIES
CONTRACT YEARS 6 AND OVER
MORTALITY RATIOS ON ANNUITY TABLE FOR 1949

ATTAINED AGES	NONREFUND		REFUND	
	By Number	By Amount	By Number	By Amount
	MALE			
70–79	113	127	122	128
80–89	92	86	101	106
90 and over	93	111	80	76
	FEMALE			
70–79	108	110	114	120
80–89	100	103	108	109
90 and over	95	84	100	94

Actually, however, the refund annuity ratios on the Annuity Table for 1949 given in Table 8 decrease sharply with increase in age, following much the same pattern as for nonrefund annuities. It is at least doubtful, therefore, whether the nonrefund annuity experience at the high ages for durations 6 and over can be ascribed to other than basic improvement in mortality.

Mr. Leggett considers the proposed 1955 American Annuity Table to be quite conservative for all classes of annuities or life incomes. He states that mortality rates on males have been lowered "to a level far below that on recent nonrefund annuity experience," and gives mortality ratios on the Annuity Table for 1949 comparing recent annuity and life option experience to demonstrate that the mortality under life options is not significantly lower than that under nonrefund annuities.

Whether the mortality ratios on the 1955 Table for all contract years combined of 109% by number and 115% by amount, as shown in Table 8 for male nonrefund annuities, indicates that the table's male mortality rates are "far below" those in recent experience is perhaps a matter of opinion as to what constitutes a proper safety margin. In view of the Northwestern Mutual's 1950–55 life option experience given in Table 9, however, with mortality ratios for payee and nonpayee elections combined of 103% by number and 92% by amount for males, and 115% by number and 118% by amount for females, it is difficult to accept his view that the proposed 1955 American Annuity Table is ultraconservative.

As Mr. Bowerman points out, the assumption of a constant age setback for females results in an overstatement of mortality rates for this sex at the younger ages and an understatement at the upper ages. In terms of premium values as shown in Tables 6 and 7, for issue ages above 15 the overstatement of mortality at the younger ages is more than offset by the understatement of mortality at the upper ages. This added safety margin in premium value for female lives, ranging from approximately 1% to 4% over the critical area of issue ages 50 to 70, does not appear to be an unreasonable precaution against proportionately greater decrease in future female annuitant mortality, as may be presaged by the recent higher rates of improvement in the U.S. white female population shown in Table 13.

Thus, while I would agree with Mr. Jenkins that the practical advantages of a dual reference table should not be the sole consideration in its adoption, I do not feel that its use will result in overstatement of reserves or distortion of the incidence of surplus to an extent that would justify using a separate table for females.

GRADED RATE SYSTEM

The traditional approach of showing payment rates per unit of policy proceeds can, as Mr. Leggett suggests, be used under the graded rate system. If shown on a $10,000 unit basis the errors are not significant, although the resulting crudity in grading of the yearly adjustment factors will produce anomalies at the young ages between the different options, and at the points where the 10, 15 and 20 year certain period option rates cross those for the refund option. These might, of course, be minimized by using a $100,000 unit, but, as is the case with a $10,000 unit, it seems somewhat inconsistent to use a different amount unit here than is used elsewhere in the policy contract for nonforfeiture and loan values. Otherwise there is little difference between the two bases, in either understandability or space requirements.

It appears from Mr. Walker's comments that he is under the misapprehension that separate mortality tables for each sex cannot be used under the graded rate system. As noted in the paper, the mortality table and projection basis given therein are not an essential part of the system. The effect of using separate mortality tables would be only that a second table of rates similar to that on pages 150–51 would have to be included in the policy contract for females.

Mr. Walker's characterizing as "departures from theory" the disregarding of mortality differences between payee and nonpayee elected settlements of death claims, settlements of cash values and endowment maturity values, etc., would seem to imply that there is unanimity of opinion as to the soundness of making such adjustments. Judging from the Northwestern Mutual's most recent life option experience, it is doubtful whether the heavier mortality previously experienced under endowment maturity settlements can be anticipated in future. Also, under death claim settlements where intercompany experience has shown consistently higher mortality under nonpayee elected settlements, it is not at all clear that the theoretically correct solution would be to make a corresponding adjustment in rates and thereby encourage this type of election which, as the mortality experience shows, is often not in the best interests of the beneficiary. In any case, such adjustments can as readily be made under the graded rate system as under a flat rate scale.

The question raised by Mr. Walker as to how alternate forms of settlement would be handled at maturity of retirement income policies under the graded rate system indicates the need for a more detailed illustration of this phase of the system. The following figures are based on the male Retirement Income at 65 plan, age at issue 45, and the graded life option rates given on pages 150–51 of the paper.

For a policy issued in 1955 and hence maturing in 1975, the maturity value would be the net single premium for $10 monthly life income, 10 years certain, for settlement in 1975: $1,678 + $4.60(1975 − 1965) = $1,724. The corresponding net single premium for the refund life option would be $1,844 + $4.65(1975 − 1965) = $1,890.50. If then at maturity the refund option is taken in lieu of the 10 year certain option, the amount of monthly income payable per $1,000 face amount of policy would be simply

$$\frac{\$10 \times 1{,}724}{1{,}890.50}, \text{ or } \$9.12 .$$

The same policy issued in 1958 and maturing in 1978 for $1,724 would be deficient in maturity value by 3 times the $4.60 yearly adjustment for age 65, or $13.80, which would have to be made up out of dividends. But the fact of there being this difference between maturity value and the net single premium for the $10 monthly retirement income as determined from the life option rate table would not complicate determination of benefits under an alternate form of settlement. If, for example, the refund option is taken in lieu of the 10 year certain option, the income to be allowed under the former would be found by dividing the net single premium for the 10 year certain annuity by the net single premium for the refund annuity:

$$\frac{\$10 \times 1{,}737.80}{1{,}904.45} = \$9.12 .$$

The approach suggested by Mr. Cragoe of withholding future increase in insurance mortality gains to cover the deficiency in retirement income plan maturity values does not seem practical. Considering how small the mortality gains are in total under this plan, and their concentration in the first half of the premium paying period, it would be fortuitous if the amount netted by this system over and above the administrative expense involved would remotely approximate the maturity value deficiency.

A solution of this problem for nonparticipating policies through increase in expense loading, discussion of which was inadvertently omitted from the paper, can also be used for participating policies where, as in Mr. Cragoe's case, it is desired to spread the deduction out over the premium paying period. Assuming the initial year's maturity values are to be continued unchanged for a period of x years, the maximum deficiency would be $(x - 1)$ times the yearly adjustment in life option net single premium for the age at maturity, and the average deficiency under all of the policies issued in that period would be one-half of this maximum deficiency. It should be noted that the obvious solution of increasing maturity values

by the amount of this average deficiency will not work, because the resulting overcharge for the retirement income under policies issued in the first half of the period would be avoided by taking settlement under the life option provisions in the policy, leaving nothing to offset the undercharge under policies issued in the last half of the period. And since net premiums must necessarily be based on guaranteed maturity values, the only remaining source of funds to cover the deficiency is the premium loading.

The small "extra" loading needed can be easily determined, using the average amount of deficiency in maturity value for the particular retirement income plan (the deficiency varies by sex and age at maturity, but not by age at issue); allowance should, of course, be made for the fact that not all of the policies will persist to maturity or elect to take the retirement income at that time.

PROJECTION BASIS

I would agree with Mr. Leggett that a setback of one-eighth year in age per calendar year, which is roughly equivalent to a rate of decrease of 1% at all ages, including ages 80 and over, would be a sounder projection assumption for life option mortality than some lesser rate.

Mr. Lew thinks on the contrary that further decrease at the advanced ages cannot be anticipated in future. He sees no current evidence of any appreciable increase in the human life span, and little prospect of future reduction in the death rates from cardiovascular-renal disease or cancer.

I cannot subscribe to Mr. Lew's reasoning that there has been no increase in annuitant longevity, or that a wave of delayed deaths is about to descend on the 80 and over age group from "seriously impaired lives which modern medicine is keeping alive to such ages." We are not concerned here with mortality among the population of England and Wales, or the ultimate mortality among insured lives or group annuitants, but with the mortality among annuitants receiving income under life option settlements and individual immediate annuity contracts. As the experience shows, the latter are select lives at time of issue, of average age 60 for females and 65 for males. The rate of incidence of serious impairment should accordingly be comparatively light in the age group 60–69, and would increase with increase in age along a curve similar to that of the death rates for the corresponding causes of death.

It should follow then that if modern medicine is succeeding in keeping such seriously impaired lives alive for a longer period than was formerly the case—and I would not question that that is true—the larger improvement in annuitant mortality would develop at the advanced ages where

the rate of incidence of impairment is greatest. The net result must necessarily be to increase the life span. Both the 1946–48 and 1948–53 intercompany immediate annuity experiences confirm this hypothesis.

These recent experiences give concrete evidence of the broad frontal attack of medical science on the ailments of the aged. It is a continuing attack that will inevitably produce further decrease in annuitant mortality, particularly at the advanced ages. How soon the benefits from this extensive medical research will be fully realized is a matter of conjecture, but until that point is reached and the attention of the medical profession is turned elsewhere, there can be no sound basis for assuming that the future rates of decrease at ages 80 and over will be much less than the rates assumed for ages under 80.

There remains the question of what over-all rate of decrease in mortality should be assumed under the life options guaranteed in currently issued policies, to be settled on an average of 25 years hence. I would agree with Mr. Lew that the rate of improvement will depend largely on decrease in the death rates from cardiovascular-renal disease and cancer. However, I would disagree with his statement that there are no "current developments that suggest accomplishment" of substantial future reductions in mortality from these two causes; not only is it at variance with medical opinion quoted in the recent paper co-authored by Mr. Lew, but also with the quite numerous reports being published currently of progress in cancer and heart research. For example, Dr. C. P. Rhoads, scientific director of the Sloan Kettering Institute, says: "We now know more about the cancer cell than was known about bacteria in 1936, just before the great antibiotic discoveries. It is no longer a question *if* cancer will be controlled but *how soon*."