THE UP-1984 – A "UNISEX" MORTALITY TABLE FOR NON-INSURED PENSION PLANS

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In the United States the mortality tables employed in the actuarial valuation of private non-insured pension plans have usually been based on simple modifications of tables developed by the insurance industry for use in connection with insured group pension plans. The UP-1984 Mortality Table has recently been constructed specifically for non-insured pension plans. The Committee on Self-Administered Retirement Plans of the Society of Actuaries maintains the mortality experience among pensioners for 12 large pension plans. The over 65 rates in the UP-1984 Table are based on that experience over the years 1965-1970 which included 2,182,436 life years of exposure and 118,942 deaths at attained age 65 or over. In combining the separate mortality results of the large groups, the composite experience mortality rates were consolidated without regard to sex so that the resulting crude mortality rates reflect the fact that about 20% of the exposure is on female employees.

Mortality experience at younger ages under non-insured pension plans is not readily available due to the absence of an accurate exposure base. The limited information that has been available for several large groups, however, suggests that the actual mortality before retirement has been significantly higher than that expected by the usual pension mortality tables. The most extensive mortality experience available covering active employees is the ongoing study of Group Life Insurance Mortality conducted by the Society of Actuaries. This experience has an exposure base of about 4½ million employees currently and about 70% of these employees are estimated to be in groups with non-insured pension plans. The mortality experience used in the construction of the UP-1984 Table at younger ages was the group life insurance mortality experience for calendar years 1965-1969, all industries and all disability clauses combined.

Allowance for Future Mortality Improvement

The mortality improvement among pensioners under self-administered retirement plans for the 10-year period 1957-1967 amounted to approximately 6% for both male and female pensioners. This rate of mortality improvement was then assumed to apply from the mid-point of the pensioner experience in 1967 until calendar year 1984, i.e., 10 years from the date of construction of the table, and the crude mortality rates at ages over 65 were adjusted accordingly. The mortality experience under group life insurance programs over the same 10-year period 1957-1967 indicated a rate of mortality improvement averaging only .05% annually. Accordingly, the crude mortality rates up to age 65 from the group life experience were used without adjustment. The adjusted pensioner mortality rates and unadjusted group life mortality rates fit together very smoothly at age 65 to form a consistent mortality pattern. Individual age rates were then developed by logarithmic interpolation and graphic graduation.

Gompertz Approximation for Last Survivor Calculations

The basic experience data for pensioner mortality contained limited information at the very oldest ages. Only 15,523 life years of exposure were included above age 90. However, the ratio of the crude mortality rate at each central quinquennial age was found to be approximately 1.5 times the rate for the prior central age (1.49 at 72, 1.55 at 77, 1.53 at 82, 1.48 at 87 and 1.50 at 92). Accordingly, the mortality rates for central ages 97, 102 and 107 were obtained from the central age 92 composite rate by extension, using the 1.50 factor. Since the central quinquennial rates increase geometrically, the underlying force of mortality can be approximated by a Gompertz curve and a uniform seniority table can be developed for use in calculating joint life functions under the UP-1984 Table as shown below.

UP-1984 Uniform Seniority Table

Difference in Ages	Addition to Older Age	Difference in Ages	Addition to Older Age	Difference in Ages	Addition to Older Age
0	8.6	10	4.5	20	2.2
1	8.1	11	4.2	21	2.1
2	7.6	12	4.0	22	1.9
3	7.1	13	3.7	23	1.8
4	6.7	14	3.4	24	1.6
5	6.3	15	3.2	25	1.5
6	5.9	16	3.0	26	1.4
7	5.5	17	2.8	27	1.3
8	5.2	18	2.6	28	1.2
9	4.9	19	2.4	29	1.1

The underlying mortality rates in the UP-1984 Mortality Table cannot be exactly reproduced by a Gompertz curve, and yet the basic Gompertz relationship is of such practical value in last survivor calculations that its use on practical grounds in a mortality standard for pension plans is highly desirable. Here, however, instead of forcing mortality rates into a strict Gompertz curve, an approximating set of uniform seniority values was developed to provide a consistent approach to approximating joint life annuity values for the UP-1984 Mortality Table.

This type of approximation is not only quite common in current actuarial consulting practice in the U.S. but also fully in accord with actuarial precedent. Thomas Simpson, in a paper "Doctrine of Annuities and Reversions" published in 1752, set forth a rule for the approximation of a three-life joint life annuity by a two-life joint life annuity with appropriately adjusted ages. George King devoted an entire chapter in the Institute of Actuaries 1887 Textbook on Life Contingencies to various methods for approximating multiple life annuity values. Clearly, such a simplifying approximation is warranted for joint and survivor values since the application of the basic table to beneficiary lives is not an exact reproduction of their mortality anyway and since antiselection in option election further distorts the actual values.

Mortality Rates at Advanced Ages

The mortality rates at the extreme old ages are relatively unimportant in the determination of the cost of a pension plan because of the small number of retired lives at those ages that would be included in any actuarial valuation and the very heavy interest discounts from those ages that would be used in developing costs for the younger retired lives and the active workforce. The extension of the central mortality rates by the 1.50 proforma compounding factor was simply taken as the most practical means of extending the experience results to the end of the table and results in a terminal age of 111 years. The mortality rates at very old ages have been developed under the U.S Social Security Program, the U.S. Railroad Retirement System and for the Union Civil War Veterans. The mortality rates for males under the UP-1984 Table are slightly below those in the other three studies up until the mid-90s. At ages over 100 the UP-1984 mortality rates are considerably higher. Of course, considerable variations can occur in the mortality of the elderly as gerontologists have observed in the cases of the Vilcabambans of Ecuador, the Abkhazians of the Georgian Socialist Republic, and the Hunzukuts of Kashmir.

Mortality Variations by Sex

In the analysis of the mortality rates for non-insured pensioners by sex, it was found that the older the age group, the narrower the differential between male and female mortality rates. Between the ages of 60 and 75, the female mortality rate was about one-half the male rate. However, this ratio increases with advancing age until for ages 90 and over it approaches 90%.

A five- or six-year setback in male mortality rates appears to offer a good approximation for female mortality rates over the full range of retirement ages. The male mortality rates are very close to the composite rates in the UP-1984 Table set forward two years. Thus, where separate male and female mortality rates are required, the basic UP-1984 Mortality Table can be set forward two years in age to develop appropriate male mortality rates (possibly set forward only one year for a group in nonhazardous employment). Similarly, the table can be set back four years in age to approximate female mortality rates. The appearance of impartiality in starting with a composite table which requires adjustment for both male and female mortality rates helps to avoid the charges of male chauvinism that arise when mortality tables are developed for male lives with the female rates produced by a setback in age in a secondary determination.

In the United States the differential in rates of mortality of males and females at all ages has been widening. At age 20 mortality rates for females have improved from about 86% of the male rate in the 1910 census to 33% of the male rate by 1970. At age 50 the improvement has been from 81% of the male rate to 52%, and at age 80 from 93% to 68%. The variations found in male and female mortality experience in the past are not considered to be due to environmental factors that are likely to have lesser effect in the future by reason of any imminent socio-economic changes. While actuaries in the 1950s could reason that variations in mortality due to race would tend to diminish with improved work opportunities and higher income, the underlying causes for the variations in mortality by sex appear to be basic biolgoical differences. Indeed, recent medical research has isolated some of the possible causative factors in mortality variations in the prostaglandins which affect cardiac output and contractility, tension in blood vessels, aggregation of blood platelets, plasma flow, creation of steroids, etc. Known as PG, these compounds are found throughout the tissues of the body. A man produces from 109 to 226 micrograms in 24 hours, a woman from 23 to 48 micrograms. These compounds affect so many bodily functions that they clearly have a general bearing on mortality, and the specific functions they affect in the greatest degree are the very functions associated with causes of death that account for most of the variation in mortality by sex.

Equal Benefits by Sex

In the United States the Equal Employment Opportunity Commission has recently ruled that the provision under a pension plan of different benefits for males and females, stemming solely from the use of separate actuarial tables for males and females, may be illegal. A paragraph from "Decision No. 72-1919" of the Commission dated June 6, 1972 reads as follows:

> "The pension plan, incorporated in the bargaining agreement, provided a smaller reduction of the pension benefits for females who retired early than males who retired early. This followed from the use of separate actuarial tables for males and females in computing the early retirement benefits. Since there was no conceivable non-discriminatory justification for the use of sex-segregated actuarial tables to determine the reduction of an employee's pension upon early retirement, the pension plan discriminated

against its male employees with respect to terms and conditions of their employment within the meaning of the Civil Rights Act."

The Equal Employment Opportunity Commission is not questioning the fact that differences in mortality rates for males and females have been observed in the past, nor that such differences must be considered in estimating costs for the future. Their basic concern is that when actuarial tables are sex-segregated this frequently results in the payment of different periodic pension benefits to males and females under the guise of "actuarial equivalence" Any such difference in benefits would, in their judgment, constitute a violation of the Civil Rights Act of 1964, which prohibits any discrimination in hiring practices, pay, work rules, fringe benefits, etc., that is based on sex, race, age (to 65 only) or religion. Thus, the Commission requires that the periodic pension benefits paid to male and female employees in equivalent circumstances must be equal in amount. They have no quarrel with the actuary who insists upon his right to develop plan costs by whatever group characteristics seem to have a substantive bearing on his results. The actuarial profession in the U S., however, now has the obligation of seeing that the application of actuarial factors will not result in differentials in benefits between the sexes.

Actuarial factors in the past have developed different benefits for males and females in two primary areas: (1) the actuarial equivalence reductions used for early retirement benefits, and (2) the actuarial equivalence reductions for joint and survivor options. As to the early retirement reductions, the basic trend in benefit design in the U.S is towards the use of simple fractional reductions regardless of sex, such as 4% or 5% per year short of normal retirement age. The use of a basic mortality table that has been developed on a composite basis for determining actuarially equivalent early retirement benefits offers another simple solution to this problem. In fact, many actuaries have deplored the use of separate male and female factors for early retirement benefits on the grounds that the end results are unreasonable. After all, the fact that a given annual pension costs 15% more for a female employee retiring at 65 than for a male employee, under a plan providing both with the same benefit regardless of sex, does not appear to be sufficient grounds to justify giving the female employee a benefit at age 60 that is 3% or 4% greater than the benefit for a male employee retiring at that age simply to preserve the 15% cost differential in the benefits.

"Unisex" Joint and Survivor Option Factors

The actuarial reduction factors for survivor options that are developed from sex-segregated actuarial tables charge a male employee electing survivorship rights on behalf of a female spouse considerably more than the charge made when a female employee elects on behalf of a male spouse. However, these survivorship options have been elected by a very small proportion, usually 5% or 10%, of the retiring population under typical non-insured pension plans. This percentage will undoubtedly increase in the future because the 1974 Pension Reform Act requires that a 50% option be the standard form of retirement benefit for retiring employees making no other positive election, i.e., the employee who wishes to receive only a life annuity must sign an election form for that benefit specifically waiving rights to the survivorship annuity form. Even with a larger percentage electing survivorship options, however, a significant degree of anti-selection seems likely, since those employees in ill health will choose the maximum survivorship option available while those employees whose spouses are in ill health will choose the life annuity basis. This suggests that if actuarial cost equivalence is really desired, there must be some loading on the pure actuarial factors in order to compensate for the anti-selection. One practical approach is to set forward the electing employee's age several years and set back the beneficiary's age.

Actuarial Valuations on a "Unisex" Table

The UP-1984 Table has been developed as a composite mortality table which is appropriate for use with groups having a 10%-30% female content. The table can be set forward one year in age for use with groups with less than 10% female content, set backward one year in age for groups having a 30% to 50% female content, and so on. The use of a composite table for the actuarial valuation of pension benefits should not be considered less accurate or less scientific than the use of sex-segregated mortality tables, because statistically significant data are generally not available relative to the differentials by sex in pay increase factors, early retirement rates, disability retirement rates or rates of withdrawal from service, even for the largest plans. The cost of an employee's pension must thus be based on so many actuarial assumptions that are not subject to accurate delineation by sex that the use of sex-segregated mortality rates would appear to be an unwarranted refinement in most cases. While the use of sex-segregated tables does add an element of spurious accuracy that may have made the actuary's work appear more scientific in the past, the continued use of sex-segregated tables in areas where benefit differentials are a necessary consequence may make the actuary's work appear anti-social in the present milieu. Indeed, in Henderson v Oregon, a U.S. District Court in December, 1975 held illegal the state's use of separate life expectancy tables for men and women and in June, 1976, the Equal Employment Opportunity Coordinating Council recommended to President Ford a bill requiring use of unisex tables to equalize pension benefits for men and women.

Examples of Use of Unisex Mortality Table

Taking the case with 20% female content as an example, the UP-1984 Table is an appropriate mortality standard for actuarial valuation without adjustment in age. Early retirement actuarially equivalent reduction factors that are developed directly from the commutation functions will produce benefits which are identical for male and female employees. For option costs, since the employee group is 20% female, it can be assumed that the beneficiary group will be 80% female so that the UP-1984 Table, together with the uniform seniority factors, can be used to develop joint life functions after setting back the age of each beneficiary by three years. Similarly, if a group were 40% female, the beneficiary group would be assumed to be 60% female, and the basic table would be set back one year in age for use in the actuarial valuation and beneficiaries'

ages would be set back one additional year in age to reflect the different sex content of the beneficiary group. An additional modification is necessary if the expected added cost of anti-selection in option elections is to be taken into account and this can be done by rating forward the electing employee's age by, say, three to five years and by rating backward the beneficiary's age by three to five years.

Composite mortality tables employed in the suggested manner, with actuarial factors independent of sex, are referred to in U.S. actuarial literature as "Unisex Tables" or 'Unisex Factors'. Such tables have been employed for some years in the actuarial valuations of some of the largest non-insured pension plans. "Unisex Option Factors" developed on the basis of age setback for the beneficiary to reflect the different sex content of the beneficiary class have also been used for some large plans. These "Unisex" actuarial methods have been found satisfactory in practice and they are in full compliance with both the letter and the spirit of the 1964 Civil Rights Act.

Summary and Conclusion

The UP-1984 Table is a mortality table constructed from the pensioner mortality experience under non-insured private pension plans in the United States. The basic table is a composite table appropriate for use in standard industries where the employee group has approximately a 20% female composition. When the ages are advanced one year, the rates are appropriate for use with an all male population and, when ages are set back four years, the rates are appropriate for use with an all female population. It is expected that the underlying mortality rates will be appropriate for use in actuarial valuations throughout the next decade. A booklet setting forth all of the details of construction of the table, comparisons of annuity values with those of other well-known tables, and commutation functions at 3½, 4, 5, 6, 7 and 8% is available from the authors on request.

August 26, 1976

Table 10

UP-1984 Table

Age x	q_x	l_x	d_x	$\overset{\circ}{e}_x$	Age x	q_x	l_x	d_x	$\overset{\circ}{e}_x$
15	.001453	77,177,281	112,139	59.30	60	.014162	66,004,046	934,749	18.88
16	.001437	77,065,142	110,742	58.38	61	.015509	65,069,297	1,009,160	18.14
17	.001414	76,954,400	108,814	57.47	62	.017010	64,060,137	1,089,663	17.42
18	.001385	76,845,586	106,431	56.55	63	.018685	62,970,474	1,176,603	16.71
19	.001351	76,739,155	103,675	55.62	64	.020517	61,793,871	1,267,825	16.02
20	.001311	76,635,480	100,469	54.70	65	.022562	60,526,046	1,365,588	15.35
21	.001267	76,535,011	96,969	53.77	66	.024847	59,160,458	1,469,960	14.69
22	.001219	76,438,042	93,178	52.84	67	.027232	57,690,498	1,571,028	14.05
23	.001167	76,344,864	89,095	51.90	68	.029634	56,119,470	1,663,044	13.43
24	.001149	76,255,769	87,618	50.96	69	.032073	54,456,426	1,746,581	12.82
25	.001129	76,168,151	85,994	50.02	70	.034743	52,709,845	1,831,298	12.23
26	.001107	76,082,157	84,223	49.08	71	.037667	50,878,547	1,916,443	11.65
27	.001083	75,997,934	82,305	48.13	72	.040871	48,962,104	2,001,130	11.09
28	.001058	75,915,629	80,319	47.18	73	.044504	46,960,974	2,089,951	10.54
29	.001083	75,835,310	82,130	46.23	74	.048504	44,871,023	2,176,424	10.01
30	.001111	75,753,180	84,162	45.28	75	.052913	42,694,599	2,259,099	9.49
31	.001141	75,669,018	86,338	44.33	76	.057775	40,435,500	2,336,161	9.00
32	.001173	75,582,680	88,658	43.38	77	.063142	38,099,339	2,405,669	8.52
33	.001208	75,494,022	91,197	42.43	78	.068628	35,693,670	2,449,585	8.06
34	.001297	75,402,825	97,798	41.48	79	.074648	33,244,085	2,481,604	7.62
35	.001398	75,305,027	105,276	40.53	80	.081256	30,762,481	2,499,637	7.19
36	.001513	75,199,751	113,777	39.59	81	.088518	28,262,844	2,501,770	6.78
37	.001643	75,085,974	123,366	38.65	82	.096218	25,761,074	2,478,679	6.39
38	.001792	74,962,608	134,333	37.71	83	.104310	23,282,395	2,428,587	6.02
39	.001948	74,828,275	145,766	36.78	84	.112816	20,853,808	2,352,643	5.66
40	.002125	74,682,509	158,700	35.85	85	.122079	18,501,165	2,258,604	5.32
41	.002327	74,523,809	173,417	34.92	86	.132174	16,242,561	2,146,844	4.99
42	.002556	74,350,392	190,040	34.00	87	.143179	14,095,717	2,018,211	4.67
43	.002818	74,160,352	208,984	33.09	88	.155147	12,077,506	1,873,789	4.37
44	.003095	73,951,368	228,879	32.18	89	.168208	10,203,717	1,716,346	4.08
45	.003410	73,722,489	251,394	31.28	90	.182461	8,487,371	1,548,615	3.80
46	.003769	73,471,095	276,912	30.39	91	.198030	6,938,756	1,374,081	3.54
47	.004180	73,194,183	305,952	29.50	92	.215035	5,564,675	1,196,600	3.29
48	.004635	72,888,231	337,837	28.62	93	.232983	4,368,075	1,017,687	3.05
49	.005103	72,550,394	370,225	27.75	94	.252545	3,350,388	846,124	2.83
50	.005616	72,180,169	405,364	26.89	95	.273878	2,504,264	685,863	2.62
51	.006196	71,774,805	444,716	26.04	96	.297152	1,818,401	540,341	2.42
52	.006853	71,330,089	488,825	25.20	97	.322553	1,278,060	412,242	2.23
53	.007543	70,841,264	534,356	24.37	98	.349505	865,818	302,608	2.05
54	.008275	70,306,908	582,001	23.55	99	.378865	563,210	213,381	1.88
55	.009033	69,724,907	629,825	22.74	100	.410875	349,829	143,736	1.72
56	.009875	69,095,082	682,314	21.95	101	.445768	206,093	91,870	1.57
57	.010814	68,412,768	739,815	21.16	102	.483830	114,223	55,264	1.43
58	.011863	67,672,953	802,804	20.39	103	.524301	58,959	30,912	1.29
59	.012952	66,870,149	866,103	19.63	104	.568365	28,047	15,941	1.17
					105	.616382	12,106	7,462	1.05
					106	.668696	4,644	3,105	.94
					107	.725745	1,539	1,117	.84
					108	.786495	422	332	.75
					109	.852659	90	77	.66
					110	.924666	13	12	.58