

**TRANSACTIONS OF SOCIETY OF ACTUARIES  
1958 VOL. 10 NO. 27**

**MORTALITY OF RAILROAD ANNUITANTS, 1953-56**

A. M. NIESSEN

A SERIES of mortality studies recently completed by the Railroad Retirement Board brought out some very interesting information on the mortality of railroad retirement beneficiaries in the past several years. These studies also led to the construction of a mortality table for disability annuitants designated as the 1956 RRB Disability Annuitants Mortality Table. This paper will discuss the mortality experience of retired railroad employees during the policy years 1953-56 and present the new mortality table for disability annuitants.

**BENEFIT PROVISIONS**

For a better understanding of the mortality experience discussed in this paper, it may be helpful to have in mind a general outline of the railroad retirement plan insofar as it relates to employee retirement benefits. The pertinent provisions of the Railroad Retirement Act follow:

1. A minimum of 10 years of railroad service is required for any benefit under the act. Individuals with less service have their railroad wage credits transferred to the Social Security System (hereafter referred to as OASDI).
2. The normal retirement age is 65 but retirement is not compulsory at any age. The act permits nondisability retirement at age 60 provided the employee has 30 years of service. In cases of such prenormal retirement, the annuity is reduced for men but not for women.
3. Totally and permanently disabled employees may retire at any age, subject only to the general 10-year service requirement. The qualifying service need not have been recent or continuous.
4. Employees disabled for their regular occupation may retire at any age if they have 20 years of service and a current connection with the railroad industry or at age 60 with 10 years of service and a current connection.
5. There is no waiting period for a disability annuity and no presumption of permanency after a specified duration of disability.
6. The annuity is withheld for any month the retired employee works for a railroad or for his last employer even if not a railroad. In addition, disability annuities are withheld for any month the annuitant earns more than \$100 in employment for hire or self-employment.
7. Annuities are paid to spouses of retired employees provided both husband and wife are age 65 or over.
8. The present (January 1958) maximum annuity payable to a retired employee is about \$185 a month. In addition, a spouse's annuity of up to

\$54.30 a month may be available. The present benefit formulas will permit considerably higher employee annuities in the future. Disability annuities are computed under the same formulas as nondisability annuities. It might be added that railroad retirement annuities are, in general, directly proportional to the number of years of creditable service and are strongly related to career average earnings—although with a weighted benefit formula.

9. The family benefit cannot be below the additional amount which would have been available under OASDI on the basis of the employee's railroad service.
10. Retirement annuities are not reduced for concurrent OASDI benefits. Spouses' and wives' annuities are reduced for concurrent old-age benefits under the Social Security Act, but not for the wife's benefit based on her husband's separate social security benefit.

#### MORTALITY OF RAILROAD AGE ANNUITANTS

The mortality of normal age retirements was studied on a policy year basis by number of lives. The exposure for the 3-year period 1953-56 amounted to about 639,000 life years and the actual number of deaths was in excess of 45,000. A summary of this study is presented in Table 1.

The ratio of actual to expected deaths derived by means of the mortality standard previously in use was fairly steady for each of the 3 policy years studied—running in the neighborhood of 103 percent. This was appreciably below the ratio of 105.8 percent which was arrived at in an earlier study covering the policy years 1950-53.

The question, therefore, arose whether the new data indicate a genuine improvement in the mortality of railroad age annuitants over the preceding 3-year period or merely a change in the composition of the group studied. To answer this question, an analysis was made of the experience by duration since retirement, considering durations 0 and 1 on a select basis and durations 2 and over grouped together. A summary of this analysis is presented in Table 2.

An examination of the data for duration 0 reveals that beginning with 1952 a seemingly new trend toward lower mortality has set in. This was accompanied by increased numbers of retirements. Similar trends manifest themselves at duration 1, beginning with policy year 1953-54. A further examination of the figures in Table 2 shows that the ultimate mortality for durations 2 and over during the years 1953-56 was not much different from that during the preceding 3-year period 1950-53. All these facts considered in conjunction would seem to justify the following conclusions:

1. Beginning with 1952, proportionately more healthy railroad workers have been retiring at ages 65 and over as compared with the experience

of previous years. The greater proportion of healthy lives in the group has brought about lower mortality at the early durations since retirement and this in turn has lowered the recent over-all mortality ratios.

2. The seemingly lower mortality of railroad age annuitants during 1953-56 is due in the main to the effect of a change in the composition of the groups who had retired since 1952 and does not indicate a genuine improvement in mortality at the older ages.

TABLE 1  
MORTALITY OF NORMAL\* AGE RETIREMENTS DURING  
BENEFIT YEARS† 1953-56, BY NUMBER OF LIVES

Period Covered†	Attained Age‡	Exposed	Actual Deaths	Expected Deaths§	Ratio Act./Exp.
1953-54. . . .	65-69	61,425	2,644	2,596	101.8%
	70-74	70,902	4,194	4,084	102.7
	75-79	41,076	3,509	3,447	101.8
	80-84	21,559	2,747	2,565	107.1
	85-89	5,402	940	875	107.4
	90+	543	134	130	103.1
	All Ages	200,907	14,168	13,697	103.4%
1954-55. . . .	65-69	63,805	2,653	2,685	98.8%
	70-74	76,275	4,419	4,401	100.4
	75-79	43,129	3,741	3,615	103.5
	80-84	22,494	2,914	2,684	108.6
	85-89	6,518	1,136	1,063	106.9
	90+	666	173	160	108.1
	All Ages	212,887	15,036	14,608	102.9%
1955-56. . . .	65-69	66,472	2,648	2,784	95.1%
	70-74	80,033	4,560	4,610	98.9
	75-79	46,929	4,015	3,913	102.6
	80-84	23,189	2,976	2,775	107.2
	85-89	7,446	1,437	1,224	117.4
	90+	849	216	204	105.9
	All Ages	224,918	15,852	15,510	102.2%
1953-56. . . . (total)	65-69	191,702	7,945	8,065	98.5%
	70-74	227,210	13,173	13,095	100.6
	75-79	131,134	11,265	10,975	102.6
	80-84	67,242	8,637	8,024	107.6
	85-89	19,366	3,513	3,162	111.1
	90+	2,058	523	494	105.9
	All Ages	638,712	45,056	43,815	102.8%

\* Retirements at ages 65 and over.

† Period between retirement anniversaries in calendar years indicated.

‡ Age last birthday at beginning of year of exposure.

§ Table A-4 of the third valuation report with a 1-year rateback in age which was the standard used in the sixth valuation. This table appears also on page 16 of TSA II.

The mortality experience of recent normal age retirements is limited to just a few years and does not as yet provide sufficient data for an answer to the question as to the manner in which the allowance for the observed lighter mortality in the early durations after retirement should be made. The solution may lie in the construction of a select and ultimate table or in the adoption of an aggregate table with appropriate margins built in by means of a mortality projection or otherwise. This will be decided at some later date after more experience bearing

TABLE 2

MORTALITY OF NORMAL† AGE RETIREMENTS DURING BENEFIT YEARS‡  
1947-56, BY NUMBER OF LIVES; SELECTED DATA FOR IMMEDIATE§ RE-  
TIREMENTS BY DURATION|| SINCE RETIREMENT AND ATTAINED AGE#

DURATION	PERIOD COVERED‡	ACT./EXP.** RATIOS FOR ATTAINED AGES#					VOLUME OF EXPERIENCE FOR ALL AGES	
		65-69††	70-74	75-79	80+	All Ages	Exposed	Actual Deaths
0 . . . . .	1947-48	120.0%	102.2%	108.2%	*	114.6%	17,760	860
	1948-49	132.7	112.7	97.6	*	125.1	15,292	806
	1949-50	114.8	104.8	76.1	*	110.2	18,125	839
	1950-51	122.0	106.9	74.7	*	115.0	17,519	847
	1951-52	128.7	99.6	104.8	*	119.5	17,558	897
	1952-53	102.0	90.3	76.1	*	96.9	20,309	858
	1953-54	97.4	85.6	83.3	*	92.6	21,155	850
	1954-55	96.0	78.0	65.2	77.3%	88.8	23,327	906
1955-56	96.4	64.0	59.7	86.6	85.6	24,153	893	
1 . . . . .	1947-48	111.0%	91.9%	89.9%	*	102.3%	17,140	819
	1948-49	108.6	87.6	92.9	*	100.4	16,900	785
	1949-50	117.0	116.6	97.4	79.4%	114.7	14,486	767
	1950-51	108.3	94.5	84.6	119.0	104.0	17,286	828
	1951-52	109.3	97.8	91.4	*	105.1	16,672	807
	1952-53	121.2	97.3	93.5	*	113.8	16,661	885
	1953-54	104.8	91.6	100.3	*	100.5	19,313	930
	1954-55	96.2	86.8	87.8	73.3	93.0	20,305	894
1955-56	91.8	88.9	83.5	*	89.8	22,421	962	
2 and over	1950-53	99.7%	105.4%	105.3%	109.8%	105.8%	381,216	29,421
	1953-56	99.1	102.3	102.9	108.4	104.1	441,407	35,199

\* Less than 10 actual deaths.

† Retirements at ages 65 and over.

‡ Period between retirement anniversaries in calendar years indicated.

§ Year last worked in railroad industry same as year of retirement or the calendar year immediately preceding.

|| Completed years since beginning date of annuity.

# Age last birthday at beginning of year of exposure.

\*\* According to sixth valuation standards, i.e., Table A-4 of the third valuation report with a 1-year rateback in age.

†† Ages 65-69 for duration 0; 66-69 for duration 1; and 67-69 for durations 2 and over.

on this problem is accumulated. In the meantime, the Board will continue to use for normal age retirements the sixth valuation mortality standards which were as follows:

- a) For annuitants on the rolls and employees with prior service (service before 1937), the 1944 Railway Annuitants Mortality Table<sup>1</sup> with a one-year rateback in age.
- b) For present employees with subsequent service only (years of entry 1937 and later) and for future entrants, the same table as above but with a two-year rateback in age.

#### *Comparison with Other Experiences*

It was desired to compare the Railroad Retirement Board experience with that of the intercompany group annuity studies. The period chosen for the comparison was the calendar year 1955 and the data are shown in Table 3.

For the first age groups, *i.e.*, 65-69 for the railroad study and 66-70 for the intercompany study, the respective mortality ratios are not strictly comparable because of the inclusion of nonretired employees in the intercompany experience and their exclusion from the RRB experience. However, for the succeeding age groups, this particular difference should be practically nonexistent. Nevertheless, the railroad annuitants had a considerably heavier mortality as evidenced by a comparison of the mortality ratios calculated according to the 1937 Standard Annuity and Ga-51 (without projection) tables, respectively.

By comparison with general U.S. mortality, the mortality of railroad age annuitants was about the same as for white males in the general population. It would seem reasonable to assume that current mortality of pensioners covered by large industrial pension plans is closer to the railroad retirement than to the group annuity experience.

#### MORTALITY OF DISABILITY ANNUITANTS

Mortality has been almost the sole cause of termination of disability annuities payable under the Railroad Retirement Act. Other terminations have been so relatively infrequent as to be practically negligible. Because of this, railroad disability annuities have been valued according to a mortality, not a total termination table.

Before data on mortality of railroad disability annuitants are presented, it should be pointed out that the Board's classification of disability annuities has been along lines of administrative convenience rather

<sup>1</sup> Actuarial Aspects of the Railroad Retirement System, by Joseph Musher, *TSA II*, 16.

than lines of medical evaluation of the degree of disability. Adjudication is simpler under the "occupational" disability provisions of the act and that is why most awards have been listed as occupational. The situation is expected to change in the very near future as a result of the necessity of considering the effects of the "disability freeze" provisions of the Social Security Act which were enacted in 1954.<sup>2</sup> It will be recalled

TABLE 3

COMPARISON BETWEEN 1955 MORTALITY OF RAILROAD ANNUITANTS AND INDIVIDUALS INCLUDED IN THE INTERCOMPANY GROUP ANNUITY STUDY, BY NUMBER OF LIVES RETIREMENTS ON OR AFTER NORMAL RETIREMENT DATE

ATTAINED AGES†	EXPOSED	ACTUAL DEATHS	RATIO ACT./EXP. ACCORDING TO			
			44-RRB‡	37-SA	GA-51§	55-U.S. W.M.¶
Railroad Retirement Board Study						
65-69.....	50,841	1,971	99%	115%	128%	95%
70-74.....	80,433	4,441	101	118	122	100
75-79.....	50,901	4,018	103	119	112	98
80-84.....	25,912	3,189	110	129	111	102
85-89.....	9,444	1,675	115	132	113	112
90 and over.....	1,255	296	106	124	110	108
Total.....	218,786	15,590	104%	121%	116%	101%
Intercompany Group Annuity Study, Men#						
66-70.....	64,539	2,265	*	99%	108%	*
71-75.....	31,981	1,781	*	109	110	*
76-80.....	10,956	906	*	113	104	*
81-85.....	3,120	389	*	120	102	*
86-90.....	669	121	*	122	105	*
91 and over.....	100	27	*	129	117	*
Total.....	111,365	5,489	*	106%	108%	*

\* Not available.

† For Railroad Retirement Board Study, age on birthday in 1955; for Intercompany Study, age nearest birthday on January 1, 1955.

‡ See footnote on page 209.

§ Without projection.

¶ Unpublished data prepared by the Metropolitan Life Insurance Company.

# Data for retirements on or after normal retirement date. TSA 1956 Reports, 158. See text for remarks on comparability.

<sup>2</sup> 1954 Amendments to the Social Security Act, by Robert J. Myers, TSA VII, 69-88.

that the provisions of the Social Security Act may have a bearing on railroad retirement benefit amounts because of the social security minimum guaranty and, besides, they are the legal basis for arriving at settlements under the financial coordination provisions.<sup>3</sup>

An analysis of the mortality of disability annuitants during policy years 1953-56 by number of lives revealed that the 1944 mortality table<sup>4</sup> could no longer be considered an adequate valuation standard. The insufficiency was particularly evident in the ultimate rates which, as can be seen from Table 4, produced an over-all mortality ratio of 91.6

TABLE 4  
ULTIMATE MORTALITY OF DISABILITY  
RETIREMENTS DURING BENEFIT YEARS 1953-56  
BY NUMBER OF LIVES  
(Deferred\* disability retirements with accrual  
years after 1946 not included)

Attained Age†	Exposed	Actual Deaths	Expected‡ Deaths	Ratio Act./Exp.
Under 50.....	966	25	26	96.2%
50-54.....	3,636	149	138	108.0
55-59.....	10,660	432	599	72.1
60-64.....	20,081	1,114	1,334	83.5
65-69.....	39,689	2,896	3,169	91.4
70-74.....	28,357	2,566	2,675	95.9
75 and over....	16,803	1,933	2,014	96.0
All ages.....	120,192	9,115	9,955	91.6%

\* Year last worked in the railroad industry earlier than the calendar year immediately preceding the year of accrual of the annuity.

† Age last birthday at beginning of year of exposure.

‡ According to sixth valuation standards, *i.e.*, ultimate rates of Table 7a, TSA II, 18.

percent. It was, therefore, decided to construct a new mortality table which will be used temporarily until the Board accumulates sufficient experience on properly classified disability retirements. It appears as Table 5 of this paper. The methods used in its construction are described in the Appendix.

The new table will be used for all disability annuities regardless of their classification. The select period has been shortened to 5 years as compared with 8 years in the 1944 table.

<sup>3</sup> Railroad Retirement Amendments of 1951, by Robert J. Myers, *Social Security Bulletin*, March 1952; also Measure of Actuarial Soundness in a Pension Plan of the Railroad Retirement Type, by A. M. Niessen, TSA VI, 34-42.

<sup>4</sup> Joseph Musher, *op. cit.*, Table 7a.

TABLE 5  
 1956 RRB DISABILITY ANNUITANTS MORTALITY TABLE  
 NUMBER OF DEATHS PER 1,000 INDIVIDUALS—1,000  $q_{[x]+a}^{\Delta}$

Age at Entry* [x]	SELECT SECTION					ULTIMATE SECTION			
	1,000 $q_{[x]}^{\Delta}$	1,000 $q_{[x]+1}^{\Delta}$	1,000 $q_{[x]+2}^{\Delta}$	1,000 $q_{[x]+3}^{\Delta}$	1,000 $q_{[x]+4}^{\Delta}$	Age† x	1,000 $q_x^{\Delta}$	Age† x	1,000 $q_x^{\Delta}$
30....	83.31	65.51	50.27	47.00	31.69	35....	24.46	70....	76.36
31....	83.29	65.53	50.30	47.03	32.15	36....	25.03	71....	79.93
32....	83.27	65.55	50.35	47.07	32.63	37....	25.59	72....	83.64
33....	83.25	65.57	50.39	47.11	33.09	38....	26.14	73....	87.62
34....	83.23	65.59	50.43	47.15	33.59	39....	26.67	74....	91.82
35....	83.21	65.61	50.49	47.18	34.05	40....	27.20	75....	96.38
36....	83.19	65.63	50.55	47.22	34.55	41....	27.76	76....	101.37
37....	83.17	65.67	50.67	47.28	35.01	42....	28.34	77....	106.76
38....	83.15	65.69	50.81	47.34	35.51	43....	28.99	78....	112.76
39....	83.13	65.71	50.93	47.40	35.99	44....	29.66	79....	119.51
40....	83.11	65.74	51.05	47.48	36.49	45....	30.37	80....	127.38
41....	83.08	65.76	51.17	47.58	36.99	46....	31.12	81....	136.65
42....	83.06	65.78	51.30	47.70	37.57	47....	31.86	82....	147.48
43....	83.03	65.86	51.43	47.81	38.16	48....	32.63	83....	159.98
44....	83.01	65.94	51.57	47.92	38.83	49....	33.39	84....	173.85
45....	82.98	66.00	51.69	48.03	39.23	50....	34.16	85....	189.09
46....	82.94	66.10	51.91	48.17	39.91	51....	34.99	86....	205.27
47....	82.86	66.22	52.13	48.31	40.55	52....	35.80	87....	222.59
48....	82.71	66.34	52.41	48.58	41.13	53....	36.65	88....	241.12
49....	82.42	66.51	52.79	48.88	41.97	54....	37.55	89....	260.85
50....	81.98	66.68	53.23	49.20	42.79	55....	38.57	90....	280.99
51....	81.33	66.85	53.87	49.48	43.69	56....	39.77	91....	301.73
52....	80.38	67.01	54.51	49.96	44.89	57....	41.14	92....	323.64
53....	79.08	67.29	55.25	50.52	45.95	58....	42.77	93....	346.66
54....	77.35	67.59	56.05	51.40	47.51	59....	44.62	94....	371.00
55....	75.22	67.90	56.95	52.14	49.01	60....	46.72	95....	396.21
56....	73.28	68.18	58.53	53.42	51.07	61....	49.04	96....	447.19
57....	71.93	68.53	59.57	54.48	52.35	62....	51.54	97....	548.26
58....	71.35	69.15	61.73	56.68	55.17	63....	54.26	98....	724.67
59....	71.20	69.55	63.47	58.32	57.61	64....	57.12	99....	1,000.00
60....	71.40	70.49	65.96	61.32	60.80	65....	60.13		
61....	71.93	71.37	68.07	64.12	63.83	66....	63.25		
62....	73.08	73.03	72.03	69.40	68.54	67....	66.41		
63....	76.06	75.71	75.09	73.52	72.95	68....	69.65		
64....	82.04	80.39	79.75	79.16	78.25	69....	72.94		

\* Age nearest birthday on date of accrual of disability annuity.  
 † Age nearest birthday.



TABLE 5a  
1956 RRB DISABILITY ANNUITANTS MORTALITY TABLE  
 $l_{[x]+w}^h$  COLUMNS

Age at Entry* [x]	SELECT SECTION					ULTIMATE SECTION			
	$l_{[x]}^h$	$l_{[x]+1}^h$	$l_{[x]+2}^h$	$l_{[x]+3}^h$	$l_{[x]+4}^h$	Age† x	$l_x$	Age† x	$l_x$
30...	133,198	122,101	114,102	108,366	103,273	35...	100,000	70...	23,718
31...	130,009	119,181	111,371	105,769	100,795	36...	97,554	71...	21,907
32...	126,829	116,268	108,647	103,177	98,320	37...	95,112	72...	20,156
33...	123,654	113,360	105,927	100,589	95,850	38...	92,678	73...	18,470
34...	120,492	110,463	103,218	98,013	93,392	39...	90,255	74...	16,852
35...	117,345	107,581	100,523	95,448	90,945	40...	87,848	75...	15,305
36...	114,225	104,723	97,850	92,904	88,517	41...	85,459	76...	13,830
37...	111,132	101,889	95,198	90,374	86,101	42...	83,087	77...	12,428
38...	108,059	99,074	92,566	87,863	83,704	43...	80,732	78...	11,101
39...	105,001	96,272	89,946	85,365	81,319	44...	78,392	79...	9,849
40...	101,962	93,488	87,342	82,883	78,948	45...	76,067	80...	8,672
41...	98,939	90,719	84,753	80,416	76,590	46...	73,757	81...	7,567
42...	95,943	87,974	82,187	77,971	74,252	47...	71,462	82...	6,533
43...	92,973	85,253	79,638	75,542	71,930	48...	69,185	83...	5,570
44...	90,030	82,557	77,113	73,136	69,631	49...	66,927	84...	4,679
45...	87,081	79,855	74,585	70,730	67,333	50...	64,692	85...	3,866
46...	84,202	77,218	72,114	68,371	65,078	51...	62,481	86...	3,135
47...	81,346	74,606	69,666	66,034	62,844	52...	60,296	87...	2,491
48...	78,526	72,031	67,252	63,727	60,631	53...	58,137	88...	1,937
49...	75,757	69,513	64,890	61,464	58,460	54...	56,006	89...	1,470
50...	73,011	67,026	62,557	59,227	56,313	55...	53,903	90...	1,087
51...	70,293	64,576	60,259	57,013	54,192	56...	51,824	91...	782
52...	67,604	62,170	58,004	54,842	52,102	57...	49,763	92...	546
53...	64,910	59,777	55,755	52,675	50,014	58...	47,716	93...	369
54...	62,250	57,435	53,553	50,551	47,953	59...	45,675	94...	241
55...	59,551	55,072	51,333	48,410	45,886	60...	43,637	95...	152
56...	56,963	52,789	49,190	46,311	43,837	61...	41,598	96...	92
57...	54,304	50,398	46,944	44,148	41,743	62...	39,558	97...	51
58...	51,902	48,199	44,866	42,096	39,710	63...	37,519	98...	23
59...	49,402	45,885	42,694	39,984	37,652	64...	35,483	99...	6
60...	47,071	43,710	40,629	37,949	35,622	65...	33,456		
61...	44,684	41,470	38,510	35,889	33,588	66...	31,444		
62...	42,617	39,503	36,618	33,980	31,622	67...	29,455		
63...	40,534	37,451	34,616	32,017	29,663	68...	27,499		
64...	38,800	35,617	32,754	30,142	27,756	69...	25,584		

\* Age nearest birthday on date of accrual of disability annuity.  
† Age nearest birthday.

TABLE 5b  
1956 RRB DISABILITY ANNUITANTS MORTALITY TABLE  
 $D_{(x)+n}^A$  FUNCTIONS AT 3%

SELECT SECTION						ULTIMATE SECTION			
Age at Entry* [x]	$D_{(x)}^A$	$D_{(x)+1}^A$	$D_{(x)+2}^A$	$D_{(x)+3}^A$	$D_{(x)+4}^A$	Age† x	$D_x^A$	Age† x	$D_x^A$
30	54,875.8	48,838.8	44,310.0	40,856.8	37,802.6	35	35,538.3	70	2,995.5
31	52,001.9	46,282.4	41,989.8	38,716.2	35,820.8	36	33,659.3	71	2,686.2
32	49,252.4	43,836.1	39,769.7	36,667.4	33,923.5	37	31,860.9	72	2,399.5
33	46,620.8	41,494.9	37,644.7	34,706.4	32,108.1	38	30,141.8	73	2,134.8
34	44,105.5	39,256.7	35,613.5	32,832.7	30,373.5	39	28,498.4	74	1,891.0
35	41,702.4	37,118.9	33,673.5	31,042.2	28,716.2	40	26,930.4	75	1,667.4
36	39,411.3	35,080.4	31,823.4	29,334.8	27,135.5	41	25,435.0	76	1,462.8
37	37,227.3	33,137.0	30,059.1	27,704.8	25,626.1	42	24,008.7	77	1,276.2
38	35,143.6	31,283.0	28,376.8	26,150.5	24,187.0	43	22,648.8	78	1,106.8
39	33,154.5	29,512.9	26,770.4	24,667.0	22,813.5	44	21,351.8	79	953.3
40	31,257.2	27,824.6	25,238.3	23,252.2	21,503.2	45	20,115.1	80	815.0
41	29,447.0	26,214.1	23,776.9	21,903.1	20,253.4	46	18,936.2	81	690.4
42	27,723.6	24,680.5	22,385.4	20,618.6	19,063.2	47	17,812.5	82	578.7
43	26,082.9	23,220.5	21,059.4	19,394.4	17,929.2	48	16,742.7	83	479.0
44	24,521.7	21,831.3	19,797.8	18,229.8	16,850.6	49	15,724.5	84	390.7
45	23,027.6	20,501.7	18,591.0	17,116.6	15,819.9	50	14,756.7	85	313.4
46	21,617.8	19,247.3	17,451.5	16,063.8	14,844.7	51	13,837.5	86	246.7
47	20,276.2	18,054.6	16,368.0	15,062.8	13,917.6	52	12,964.4	87	190.3
48	19,003.2	16,923.7	15,340.7	14,113.2	13,036.5	53	12,136.1	88	143.7
49	17,799.1	15,856.4	14,370.7	13,215.6	12,203.5	54	11,350.7	89	105.9
50	16,654.3	14,843.8	13,450.6	12,363.6	11,413.0	55	10,606.3	90	76.0
51	15,567.3	13,884.7	12,579.1	11,554.8	10,663.2	56	9,900.2	91	53.1
52	14,535.7	12,978.0	11,755.7	10,791.1	9,953.4	57	9,229.6	92	36.0
53	13,550.0	12,115.0	10,970.7	10,062.8	9,276.2	58	8,592.2	93	23.6
54	12,616.2	11,301.3	10,230.6	9,375.8	8,634.9	59	7,985.1	94	15.0
55	11,717.7	10,520.7	9,520.8	8,717.2	8,022.0	60	7,406.6	95	9.2
56	10,882.0	9,790.9	8,857.6	8,096.3	7,440.6	61	6,854.9	96	5.4
57	10,071.9	9,075.2	8,207.0	7,493.4	6,878.8	62	6,328.9	97	2.9
58	9,346.0	8,426.4	7,615.2	6,937.0	6,353.2	63	5,827.8	98	1.3
59	8,636.7	7,788.2	7,035.5	6,397.0	5,848.5	64	5,351.0	99	.3
60	7,989.5	7,202.9	6,500.2	5,894.6	5,372.0	65	4,898.4		
61	7,363.4	6,634.8	5,981.8	5,412.3	4,917.7	66	4,469.7		
62	6,818.3	6,136.0	5,522.2	4,975.1	4,495.0	67	4,065.1		
63	6,296.1	5,647.8	5,068.2	4,551.2	4,093.8	68	3,684.6		
64	5,851.3	5,214.8	4,655.9	4,159.9	3,719.0	69	3,328.1		

\* Age nearest birthday on date of accrual of disability annuity.

† Age nearest birthday.

TABLE 5c  
1956 RRB DISABILITY ANNUITANTS MORTALITY TABLE  
 $N_{[x]+n}^A$  FUNCTIONS AT 3%

Age at Entry* [x]	SELECT SECTION					ULTIMATE SECTION			
	$N_{[x]}^A$	$N_{[x]+1}^A$	$N_{[x]+2}^A$	$N_{[x]+3}^A$	$N_{[x]+4}^A$	Age† x	$N_x^A$	Age† x	$N_x^A$
30.....	782,411.0	727,536.1	678,697.3	634,387.3	593,530.5	35.....	555,727.9	70.....	22,750.1
31.....	735,000.7	682,998.8	636,716.4	594,726.6	556,010.4	36.....	520,189.6	71.....	19,754.6
32.....	689,979.4	640,727.0	596,890.9	557,121.2	520,453.8	37.....	486,530.3	72.....	17,068.4
33.....	647,244.3	600,623.5	559,128.6	521,483.9	486,777.5	38.....	454,669.4	73.....	14,668.9
34.....	606,710.0	562,604.5	523,347.8	487,734.3	454,901.6	39.....	424,528.1	74.....	12,534.1
35.....	568,282.9	526,580.5	489,461.6	455,788.1	424,745.9	40.....	396,029.7	75.....	10,643.1
36.....	531,884.7	492,473.4	457,393.0	425,569.6	396,234.8	41.....	369,099.3	76.....	8,975.7
37.....	497,418.6	460,191.3	427,054.3	396,995.2	369,290.4	42.....	343,664.3	77.....	7,512.9
38.....	464,796.5	429,652.9	398,369.9	369,993.1	343,842.6	43.....	319,655.6	78.....	6,236.7
39.....	433,925.1	400,770.6	371,257.7	344,487.3	319,820.3	44.....	297,006.8	79.....	5,129.9
40.....	404,730.5	373,473.3	345,648.7	320,410.4	297,158.2	45.....	275,655.0	80.....	4,176.6
41.....	377,134.4	347,687.4	321,473.3	297,696.4	275,793.3	46.....	255,539.9	81.....	3,361.6
42.....	351,075.0	323,351.4	298,670.9	276,285.5	255,666.9	47.....	236,603.7	82.....	2,671.2
43.....	326,477.6	300,394.7	277,174.2	256,114.8	236,720.4	48.....	218,791.2	83.....	2,092.5
44.....	303,279.7	278,758.0	256,926.7	237,128.9	218,899.1	49.....	202,048.5	84.....	1,613.5
45.....	281,380.8	258,353.2	237,851.5	219,260.5	202,143.9	50.....	186,324.0	85.....	1,222.8
46.....	260,792.4	239,174.6	219,927.3	202,475.8	186,412.0	51.....	171,567.3	86.....	909.4
47.....	241,409.0	221,132.8	203,078.2	186,710.2	171,647.4	52.....	157,729.8	87.....	662.7
48.....	223,182.7	204,179.5	187,255.8	171,915.1	157,801.9	53.....	144,765.4	88.....	472.4
49.....	206,074.6	188,275.5	172,419.1	158,048.4	144,832.8	54.....	132,629.3	89.....	328.7
50.....	190,003.9	173,349.6	158,505.8	145,055.2	132,691.6	55.....	121,278.6	90.....	222.8
51.....	174,921.4	159,354.1	145,469.4	132,890.3	121,335.5	56.....	110,672.3	91.....	146.8
52.....	160,786.0	146,250.3	133,272.3	121,516.6	110,725.5	57.....	100,772.1	92.....	93.7
53.....	147,517.2	133,967.2	121,852.2	110,881.5	100,818.7	58.....	91,542.5	93.....	57.7
54.....	135,109.1	122,492.9	111,191.6	100,961.0	91,585.2	59.....	82,950.3	94.....	34.1
55.....	123,463.6	111,745.9	101,225.2	91,704.4	82,987.2	60.....	74,965.2	95.....	19.1
56.....	112,626.0	101,744.0	91,953.1	83,095.5	74,999.2	61.....	67,558.6	96.....	9.9
57.....	102,430.0	92,358.1	83,282.9	75,075.9	67,582.5	62.....	60,703.7	97.....	4.5
58.....	93,052.6	83,706.6	75,280.2	67,665.0	60,728.0	63.....	54,374.8	98.....	1.6
59.....	84,252.9	75,616.2	67,828.0	60,792.5	54,395.5	64.....	48,547.0	99.....	.3
60.....	76,155.2	68,165.7	60,962.8	54,462.6	48,568.0	65.....	43,196.0		
61.....	68,607.6	61,244.2	54,609.4	48,627.6	43,215.3	66.....	38,297.6		
62.....	61,774.5	54,956.2	48,820.2	43,298.0	38,322.9	67.....	33,827.9		
63.....	55,419.9	49,123.8	43,476.0	38,407.8	33,856.6	68.....	29,762.8		
64.....	49,679.1	43,827.8	38,613.0	33,957.1	29,797.2	69.....	26,078.2		

\* Age nearest birthday on date of accrual of disability annuity.

† Age nearest birthday.

The goodness of fit of the new mortality table is analyzed in Table 6. It was not considered desirable to force the fit any further since that would have produced more irregularities in the mortality curves (see charts in Appendix).

The over-all mortality ratio produced by the new table is 104.1 percent. The 1944 table as used in the sixth valuation would have produced a ratio of only 93.7 percent. The margin of 4 percent which the new table gives is, of course, not substantial but is well in line with the mortality margins which have been used hitherto in the Board's actuarial valuations.

TABLE 5d  
1956 RRB DISABILITY ANNUITANTS MORTALITY TABLE  
ANNUITY VALUES  $a_{[x]+n}^{A(12)}$  AT 3%

Age at Entry* [x]	SELECT SECTION					ULTIMATE SECTION			
	$a_{[x]}^{A(12)}$	$a_{[x]+1}^{A(12)}$	$a_{[x]+2}^{A(12)}$	$a_{[x]+3}^{A(12)}$	$a_{[x]+4}^{A(12)}$	Age† x	$a_x^{A(12)}$	Age† x	$a_x^{A(12)}$
30.....	13.7162	14.3550	14.7753	14.9854	15.1591	35.....	15.0957	70.....	7.0531
31.....	13.5924	14.2155	14.6210	14.8195	14.9803	36.....	14.9129	71.....	6.8124
32.....	13.4674	14.0747	14.4670	14.6522	14.8003	37.....	14.7288	72.....	6.5716
33.....	13.3415	13.9329	14.3111	14.4839	14.6189	38.....	14.5429	73.....	6.3296
34.....	13.2142	13.7897	14.1535	14.3134	14.4352	39.....	14.3549	74.....	6.0866
35.....	13.0854	13.6446	13.9938	14.1412	14.2495	40.....	14.1640	75.....	5.8414
36.....	12.9540	13.4967	13.8312	13.9656	14.0604	41.....	13.9698	76.....	5.5943
37.....	12.8200	13.3458	13.6655	13.7878	13.8690	42.....	13.7725	77.....	5.3452
38.....	12.6839	13.1927	13.4969	13.6069	13.6743	43.....	13.5719	78.....	5.0932
39.....	12.5463	13.0378	13.3265	13.4238	13.4772	44.....	13.3685	79.....	4.8395
40.....	12.4067	12.8807	13.1537	13.2381	13.2776	45.....	13.1622	80.....	4.5830
41.....	12.2655	12.7217	12.9787	13.0498	13.0754	46.....	12.9531	81.....	4.3274
42.....	12.1217	12.5598	12.8005	12.8581	12.8698	47.....	12.7413	82.....	4.0742
43.....	11.9752	12.3949	12.6198	12.6639	12.6614	48.....	12.5262	83.....	3.8268
44.....	11.8261	12.2270	12.4358	12.4661	12.4489	49.....	12.3076	84.....	3.5881
45.....	11.6776	12.0599	12.2522	12.2681	12.2361	50.....	12.0847	85.....	3.3600
46.....	11.5221	11.8847	12.0605	12.0628	12.0158	51.....	11.8570	86.....	3.1446
47.....	11.3643	11.7063	11.8633	11.8538	11.7914	52.....	11.6247	87.....	2.9407
48.....	11.2028	11.5230	11.6648	11.6395	11.5629	53.....	11.3868	88.....	2.7457
49.....	11.0361	11.3321	11.4563	11.4175	11.3264	54.....	11.1430	89.....	2.5622
50.....	10.8670	11.1365	11.2426	11.1907	11.0847	55.....	10.8929	90.....	2.3899
51.....	10.6948	10.9353	11.0227	10.9592	10.8372	56.....	10.6371	91.....	2.2229
52.....	10.5198	10.7274	10.7951	10.7191	10.5827	57.....	10.3767	92.....	2.0611
53.....	10.3452	10.5163	10.5654	10.4773	10.3268	58.....	10.1124	93.....	1.9032
54.....	10.1675	10.2971	10.3268	10.2266	10.0647	59.....	9.8464	94.....	1.7316
55.....	9.9948	10.0798	10.0903	9.9782	9.8033	60.....	9.5797	95.....	1.5344
56.....	9.8081	9.8500	9.8396	9.7217	9.5380	61.....	9.3138	96.....	1.2916
57.....	9.6282	9.6353	9.6061	9.4772	9.2831	62.....	9.0498	97.....	1.0100
58.....	9.4147	9.3922	9.3438	9.2125	9.0169	63.....	8.7885	98.....	.6891
59.....	9.2135	9.1674	9.0991	8.9616	8.7591	64.....	8.5308		
60.....	8.9902	8.9219	8.8369	8.6977	8.4993	65.....	8.2767		
61.....	8.7757	8.6891	8.5876	8.4429	8.2460	66.....	8.0266		
62.....	8.5184	8.4147	8.2990	8.1612	7.9840	67.....	7.7798		
63.....	8.2606	8.1362	8.0365	7.8973	7.7285	68.....	7.5359		
64.....	7.9486	7.8628	7.7516	7.6213	7.4705	69.....	7.2941		

\* Age nearest birthday on date of accrual of disability annuity.

† Age nearest birthday.

TABLE 6

TEST OF APPROPRIATENESS OF THE 1956 RRB DISABILITY ANNUITANTS  
MORTALITY TABLE

SELECT AND ULTIMATE 1953-56 MORTALITY OF IMMEDIATE DISABILITY  
RETIREMENTS, BY NUMBER OF LIVES

Attained Age†	Exposed	Actual Deaths	Expected Deaths	Ratio Act./Exp.	Exposed	Actual Deaths	Expected Deaths	Ratio Act./Exp.
	Duration 0				Duration 1			
Under 45..	620	43	52	82.7%	461	23	30	76.7%
45-49.....	1,244	94	103	91.3	966	72	64	112.5
50-54.....	3,211	271	253	107.1	2,617	181	175	103.4
55-59.....	6,720	472	484	97.5	5,559	389	381	102.1
60-64.....	10,455	814	795	102.4	9,329	716	684	104.7
65-69.....	.....	.....	.....	.....	1,461	145	123	117.9
All Ages...	22,250	1,694	1,687	100.4%	20,393	1,526	1,457	104.7%
	Duration 2				Duration 3			
Under 45..	368	8	19	*	262	9	12	*
45-49.....	688	33	36	91.7%	546	23	26	88.5%
50-54.....	2,075	102	112	91.1	1,779	88	88	100.0
55-59.....	4,674	292	272	107.4	4,124	224	215	104.2
60-64.....	8,284	579	563	102.8	7,464	499	455	109.7
65-69.....	3,120	278	249	111.6	4,939	372	374	99.5
All Ages...	19,209	1,292	1,251	103.3%	19,114	1,215	1,170	103.8%
	Duration 4				Durations 5 and Over‡			
Under 45..	192	4	7	*	291	11	8	137.5%
45-49.....	560	7	22	*	1,408	34	46	73.9
50-54.....	1,444	67	61	109.8%	4,502	182	165	110.3
55-59.....	3,867	180	182	98.9	11,824	508	505	100.6
60-64.....	6,842	425	393	108.1	21,582	1,210	1,158	104.5
65-69.....	6,846	525	498	105.4	40,372	2,939	2,774	105.9
70-74.....	.....	.....	.....	.....	28,430	2,567	2,400	107.0
75-79.....	.....	.....	.....	.....	14,581	1,625	1,582	102.7
80 and over	.....	.....	.....	.....	2,222	308	306	100.7
All Ages...	19,751	1,208	1,163	103.9%	125,212	9,384	8,944	104.9%

\* No actual to expected ratios shown for groups with less than 10 actual deaths.

† Age last birthday at beginning of year of exposure.

‡ Includes deferred disability retirements prior to 1947.

NOTE.—For the total experience, the ratio of actual to expected deaths is 104.1%.

## MORTALITY AT THE VERY ADVANCED AGES

The mortality study summarized in Table 1 includes 88,666 years of exposure at attained ages 80 and over with 12,673 actual deaths. The data are considered very reliable since proof of age was obtained for practically all cases as contrasted with general population mortality data which are not backed by evidence of correct ages.

Crude death rates by single age are shown in Table 7. In addition, Table 7 contains graduated rates derived from the Board's experience and 1955 death rates for white males in the general U.S. population.

TABLE 7  
MORTALITY OF RAILROAD ANNUITANTS AT AGES 80  
AND OVER IN 1953-56 BY NUMBER OF LIVES

ATTAINED AGE†	EXPOSED	ACTUAL DEATHS	DEATH RATES PER 1,000		
			Crude Rates	RRB Graduated‡	1955 U.S. Male§
80.....	17,830	1,956	109.70	110.79	112.74
81.....	15,994	1,916	119.79	120.54	122.27
82.....	13,678	1,842	134.67	130.87	133.11
83.....	11,061	1,610	145.56	141.75	145.80
84.....	8,679	1,313	151.28	153.12	152.86
85.....	6,634	1,128	170.03	164.94	154.50
86.....	5,107	880	172.31	177.20	159.50
87.....	3,697	717	193.94	189.85	166.50
88.....	2,497	497	199.04	202.84	175.00
89.....	1,431	291	203.35	216.16	190.00
90.....	843	202	239.62	229.76	210.00
91.....	494	117	236.84	243.67	230.00
92.....	304	80	263.16	258.49	250.00
93.....	181	58	320.44	275.48	270.00
94.....	86	19	220.93	295.89	292.76
95.....	66	20	303.03	320.97	313.90
96.....	34	13	382.35	351.99	330.69
97.....	22	6	*	390.19	347.64
98.....	11	3	*	436.83	364.87
99.....	7	2	*	493.16	382.34
100.....	7	1	*	560.44	399.89

\* Data considered insufficient for calculation of crude rate.

† Age last birthday at beginning of year of exposure.

‡ Rates for ages 90 and over are not strictly comparable with the U.S. rates because of different assumptions regarding the terminal age and the terminal rate. The RRB table has a rate of 1,000 per 1,000 for age 105 while the U.S. table has a rate of 528.10 per 1,000 at age 108 with the one survivor to that age dying within the year.

§ Linear interpolation of graduated rates developed by the Metropolitan Life Insurance Company from Census data.

## APPENDIX

## THE 1956 RRB DISABILITY ANNUITANTS MORTALITY TABLE

*Underlying Experience*

The data were generally limited to "immediate" retirements, *i.e.*, annuitants who last worked in the railroad industry not earlier than in the calendar year preceding the year in which the disability annuity began. The only exception was the group of accruals in 1936-46, all of which was included in the ultimate experience.

The experience used was for policy years 1953-56 and was derived from tabulations in the December 31, 1956 position. However, corrections were made for deaths in policy year 1955-56 which were reported to the Board in the first four months of 1957. It can therefore be assumed that the actual deaths are reasonably complete.

Since the Railroad Retirement Act allows retirement also on account of occupational disability, the level of mortality among railroad disability annuitants is in all likelihood lower than for disability pensioners in general.

*Graduation*

The period of selection was limited to 5 years so that completed durations 5 and over constituted the ultimate experience.

Crude death rates were calculated for quinquennial age groups by age last birthday for the ultimate experience and by attained age at retirement for the several durations 0 to 4 of the select experience.

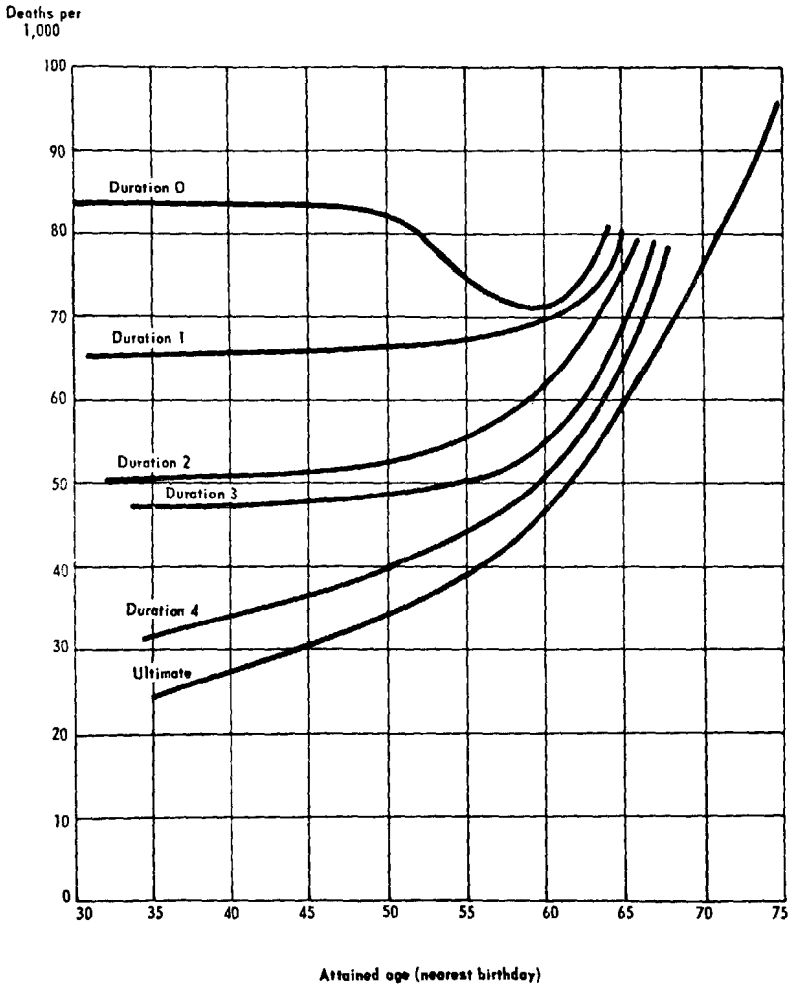
The age specific rates for the ultimate experience were first adjusted to an exact age basis by using the ratios  $q_x^h \div q_{x+1/2}^h$  from the 1944 RRB table ( $x$  being the central age) and then reduced by  $.0062 \cdot \frac{h}{x}$ . The factor  $.0062$  was calculated so as to produce an over-all ratio of actual to expected deaths of about 105 percent. The life expectancy  $\frac{h}{x}$  for the central age  $x$  was also taken from the Board's 1944 table.

The adjusted ultimate age specific rates were then interpolated by Jenkins fifth difference modified formula and merged into the 1941 CSO rates at age 90. It might be mentioned that the 1944 RRB disability mortality table was merged into the American Experience table at age 80.

The graduated rates for duration 0 were derived also from age specific rates but by graphic graduation. The flow of these rates as shown in Charts 1 and 2 was such that graduation by mathematical formula did not appear feasible. The rates read off the graph were in spots adjusted by inspection to improve the flow of first differences.

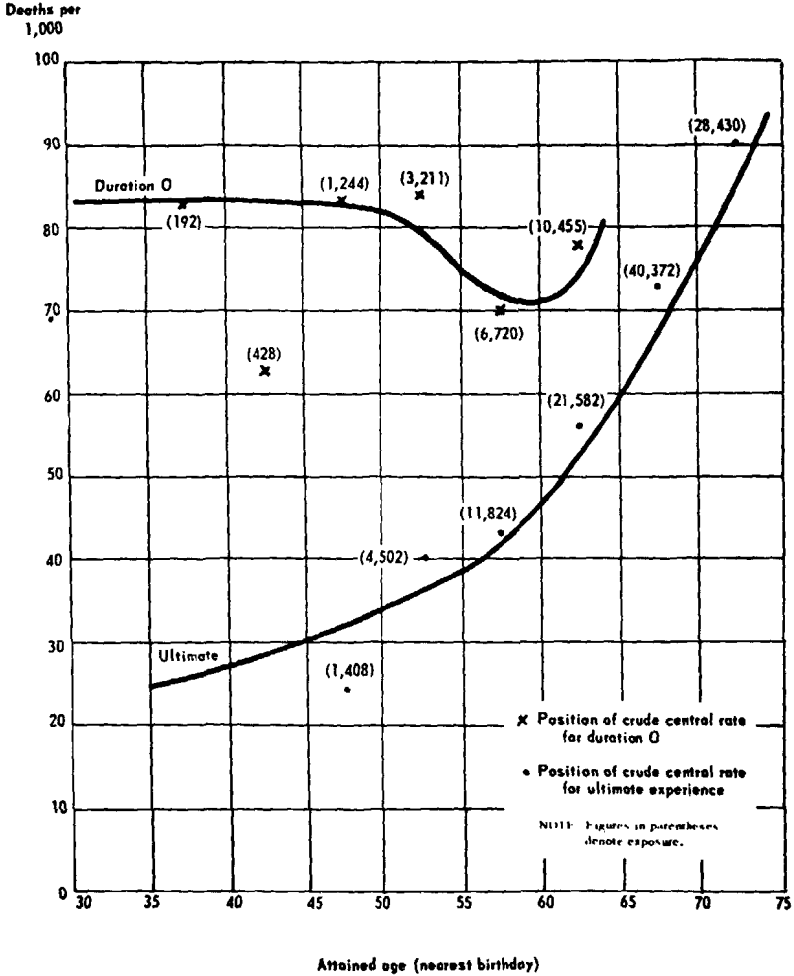
The graduated rates for durations 1 to 4 were also obtained by graphic

CHART 1  
 1956 RRB DISABILITY ANNUITANTS MORTALITY TABLE  
 (Graduated Mortality Rates)





**CHART 2**  
**1956 RRB DISABILITY ANNUITANTS MORTALITY TABLE**  
 (Fit of Graduated Mortality Rates for Duration 0  
 and Ultimate Section)



methods. In some instances, use was made of ratios of the crude central rates at these durations to corresponding rates for either duration 0 or the ultimate experience.

Even though emphasis was on fit rather than smoothness, no effort has been made to eliminate all irregularities in the ratios of actual to expected deaths. To do so would have required the introduction of still more bends and twists in the curves.

### *Graphic Presentation*

The mortality curves representing the graduated rates are shown in Chart 1. The rates are by exact age and completed duration since disability retirement.

Chart 2 gives an indication of the fit for duration 0 and the ultimate rates. Besides showing the graduated curves, the chart shows also the crude group rates to which the curves are related. The magnitude of the exposures at the central points is shown beside the points in parentheses. It will be recalled that the graduated ultimate rates contain a reduction factor graded by age (decreasing as the age increases) and that is why the ultimate curves are consistently below the actual experience points.

DISCUSSION OF PRECEDING PAPER

ROBERT J. MYERS:

The Railroad Retirement Board has conducted many valuable mortality studies that are presented from time to time in their triennial valuations and in papers such as Mr. Niessen has given. Unfortunately, we in the Social Security Administration have not been able to make such thorough and continuous investigations—in part, perhaps, because our operations are on a very broad group basis, whereas the Railroad Retirement system is operated to a certain extent as a staff pension system. We do hope, however, to make more extensive studies in the future than those in the past. These latter suggest that our mortality experience has not been very different from that of the general population.

In discussing Tables 1 and 2, Mr. Niessen indicates that the figures show an improvement in the mortality of age annuitants in 1953–56 as compared with 1950–53. He questions whether this is genuine, or whether it merely results from a change in the composition of the group studied. His analysis by cohorts, based on year of retirement, seems to indicate that the improvement might not be real but rather may be due to the fact that the larger number of retirements, beginning in 1952, resulted in a greater proportion of healthy lives. In this connection, it would have been of value to have had the data for durations 2 and over broken down in more detail—both by duration and by period covered—since even here the experience during the second 3-year period seemed slightly lower than that in the first 3-year period.

In Table 7, Mr. Niessen has given some interesting mortality experience for railroad annuitants at the oldest ages. After graduating the crude data, Mr. Niessen compared the mortality rates with the U.S. male population mortality rates for 1955 as developed by the Metropolitan Life Insurance Company from census data (with simple adjustment in such rates so as to have them on an attained age basis rather than on an exact age basis). The graduated RRB rates are quite close to the population rates for ages 80–84 and 92–95, being generally within a 2% range. However, for ages 85–91 there are sizable differences, with the RRB rates being as much as 15% higher. Correspondingly, for ages 96 and over, the RRB rates are increasingly higher than the population rates. The latter tendency is explained by the fact that the RRB rates have a terminal age of 105, with a mortality rate of 1,000 per thousand assumed

at that point, whereas the population table, in essence, has no terminal age but rather only gradually rising mortality rates that are at all times well below 1,000 per thousand. It would seem better to have gradually rising mortality rates and let the terminal age fall where it may, rather than to assume at a given age a mortality rate of 1,000 per thousand.

Next, considering the rather unusual trend between ages 85 and 91, I note that the population mortality rates move in a rather unusual fashion, which I understand is true of the basic rates developed by the Metropolitan Life Insurance Company (and modified by Mr. Niessen only by averaging). Thus, the first differences in these rates are as follows: about 10 at ages 80 through 82, then 7 at age 83, 2 at age 84, 5 at age 85, and increasing to about 20 at ages 89 and over. This led me to believe that the peculiarity noticed in comparing the RRB rates at ages 85-91 with the population rates arose from the graduation of the population table. Accordingly, I have compared the RRB rates with those for the U.S. total males in the official 1949-51 table; the mortality rates at the oldest ages in this table are based on both census data and the relatively accurate data for Civil War veterans (see *TSA* VII, 63-68). Most interestingly, the ratio of these two sets of rates was between 98% and 100% for every single age from 80 through 94 (the excess of the RRB rates over the population rates at ages 95 and over has been explained previously). Accordingly, it may be reasonably concluded that the mortality experience of RRB annuitants at ages 80 and over closely parallels general population mortality.

HARWOOD ROSSER:

Mr. Niessen concludes that, in recent years, proportionately more healthy railroad workers have gone on age retirement than previously. From his Table 4, I would also conclude that more healthy workers than before have gone on disability retirement. The ratios of actual to expected deaths are noticeably low for age groups where early retirement is not permitted. This experience is not recent enough to have been affected by the new Social Security disability feature, much less by the current recession. However, one wonders how many early retirements, for instance, are masquerading as disability cases.

ALAN A. GROTH:

In his paper Mr. Niessen has raised the challenging question whether the improvement in the mortality of annuitants, as indicated by the data, truly reflects a genuine improvement of mortality. Mr. Niessen has described two possible reasons why the indicated results may show

better mortality without necessarily indicating a genuine improvement. This raises a question in my mind whether the spectacular improvement in mortality shown by the intercompany group annuity mortality studies could not be, at least partially, due to the same factors.

It would, of course, be of great importance to separate somehow the true improvement of mortality from the apparent improvement indicated by the studies. In his paper Mr. Niessen suggests one approach, the derivation of a select and ultimate annuity table. I think that such a table would eliminate the effect of only one of the two factors, that is, the effect of the change in the composition of the retired. However, we have to find some other method to determine whether there were any changes in the retirement practices of employees and how such changes, if any, have affected the experience results.

We know that in the past, mainly because of the inadequacy of pensions, employees have worked as long as they were able to work. Today the increased Social Security and private pension benefits allow employees to retire at an earlier age while still in good health.

Mr. Niessen has told me that under the Railroad Retirement Act most retirements in the past were preceded by a sick leave period. He knows also that the percentage of employees now retiring, who were previously on a sick leave, is much lower. Perhaps Mr. Niessen could analyze his data to determine the differences in mortality of employees retiring after a period of sick leave and of those who have retired without an intervening period of sick leave.

#### E. FORREST ESTES:

I am not presenting a prepared discussion of Mr. Niessen's paper, but it occurs to me that what has happened in the case of two annuitants under the Railroad Retirement Act may be suggestive. I refer to my parents.

My father retired in 1931 at the age of 70; for a number of years prior to retirement his physical condition grew progressively worse, largely because of overwork. After retirement he rapidly improved; he passed on shortly before his 90th birthday. His improved physical condition was not due to medical care, for he was not under the care of a doctor. I have often used him to illustrate how life seems to be lengthened when worries are eliminated—how a life annuity seems to promote longevity.

The other annuitant is my mother. Fifteen years ago, when she was 80, she was critically ill—we did not expect her to live. Modern medicine pulled her through and now, at 95, it is keeping her reasonably

active; and she regularly cashes her monthly check (as a surviving widow) from the Railroad Retirement Board.

I mention this as a reminder (at least to those of us who issue annuities commercially) that the statistics shown in Mr. Niessen's paper may be a bit optimistic.

HOWARD H. HENNINGTON:

It seems proper, because of the remarks that have just been made by Dr. Groth, to make one or two statements about the group annuity intercompany mortality study.

One of the points that is being discussed here has to do with whether the matter of changing incentives to retire is having an effect on the intercompany group annuity mortality studies. This, I think, might well be true if one looked only at the ages prior to 65, namely the usual early retirement ages, but I do not think it applies to ages over 65. The bulk of the data in connection with the intercompany study comes from deferred annuities and these lives get into the retired life experience at ages over 65 whether or not these employees are in fact actually retired.

In connection with Deposit Administration contracts, the results could be affected because under many contracts lives are included in the experience only if they have retired. On those Deposit Administration contracts where the annuity is not necessarily purchased until the actual retirement date these lives are coded with a distinguishing code. When the volume of data for these employees becomes sufficiently large so that it could significantly affect the results, it is the intent of the committee to remove these lives from the experience and analyze them separately.

(AUTHOR'S REVIEW OF DISCUSSION)

A. M. NIESSEN:

I was very much gratified to note that the gentlemen who participated in the discussion of my paper seemed to agree that the problem of the changes in mortality levels at the older ages is far from clear. This is an area where great caution should be exercised not to draw conclusions from over-all mortality ratios without going through as thorough an analysis of the underlying data as possible.

Mr. Myers would have liked to see a further breakdown of the railroad retirement experience by duration and period covered. This is a very valid point and we shall try to make an analysis of this kind in our future mortality studies. Another valid point made by Mr. Myers relates to the comparability of the railroad retirement rates for the advanced ages with those for the general population. The difficulty

here is that our rates were derived by assigning a rate of 100 percent at age 105, whereas the 1955 population table ends with a rate of only 52.8 percent at age 108. Actually, I intended to have the comparisons run only up to age 92 or so—that is, up to the point where we had sufficient experience to calculate crude rates. Comparisons for the older ages would, in any event, be more theoretical than realistic because the rates would have been derived from certain predetermined mathematical formulas.

Dr. Groth suggested that the spectacular improvements in mortality at the older ages shown in the intercompany group mortality studies may be due to changes in the characteristics of the groups studied rather than to a true improvement in the levels of mortality at the ages in question. In this connection, Mr. Hennington pointed out that the group annuity experience relates to all covered individuals age 65 and over, regardless of whether they have or have not retired. While I appreciate (as undoubtedly does Dr. Groth) the significance of the fact pointed out by Mr. Hennington, I still feel that one should not rule out the possibility that significant changes have been taking place in the composition of the employee groups covered under group annuity contracts and this is the main reason for the apparent great improvements in mortality shown in the intercompany studies.

Mr. Rosser has drawn on his own experience to emphasize the fact that the composition and characteristics of groups considered in post-retirement mortality investigations are a very important factor. I was pleased to learn from his remarks that at least one serious student of mortality trends shares my concern about the problem of true mortality levels after retirement.

Mr. Estes told a very interesting story as to how his parents have been benefited by the railroad retirement system, citing this as an example that the availability of a fairly decent retirement income tends to improve the longevity of the pensioner. We, at the Railroad Retirement Board, have been convinced all along that our program has been of great help to railroad workers and their families. It was extremely gratifying to have Mr. Estes corroborate our conviction.