# HOW INSURANCE PREMIUM RATE IS MADE

## "Mysteries" of the Mortality Table Explained-Rate is Conservative

How the premium paid on an insurance policy is made up, was the theme of an instructive address by Mr. E. E. Reid, assistant manager of the London Life. He explained, in a way interesting both to those who buy and sell life insurance, what are often erroneously considered the mysteries of the mortality table. He presented a hypothetical mortality table, in which the deaths occur at only four periods, thus necessitating a minimum of calculation, and yet giving such results as approximated sufficiently near, for illustration purposes, to the exact figures.

"Consider a mortality table, starting with the usual assumption that at age 20 there are 100,000 lives under observation," said Mr. Reid. "Suppose that these all live to age 35, when 15,000 die upon attaining that age; that the remaining 85,000 lives live to age 50, when 25,000 die. The remaining 60,000 lives may be supposed to live to age 65, when 30,000 die, and these 30,000 we may suppose all to die at age 75. Such a table is all that would be necessary for our purpose were it not for the interest factor, which enters into all financial considerations extending over a period of years. While the tool represented by the mortality table is an absolute essential to the calculation of a premium, no tool is absolutely essential in reference to the interest factor. Nevertheless, tools in the shape of interest tables greatly facilitate the work, just as in any other piece of construction, the more efficient the tools the more rapid and perfect the execution.

Ages.	No. living.	No. dying.
20	 100,000	
35	 85,000	15,000
50	 60,000	25,000
60	 30,000	30,000
75	 	30,000

#### When Individual Will Die

"Now, suppose we are asked to calculate the premium that a person age 20 should pay throughout life to insure \$1,000 payable at death, assuming the deaths to occur according to this hypothetical table. We cannot take any individual, for we do not know when the individual will die. If, however, we take 100,000 individuals our table tells us how many live the periods indicated, so we will first deal with the whole group. To obtain the value of the payments to be made by the insuring company, i.e., the present value of the claims, we have four calculations to make: 15,000 claims of \$1,000 each are due at the end of 15 years, 25,000 claims are due at the end of 55 years.

and 30,000 at the end of 55 years. "According to government requirements we must adopt a rate of interest of 3½ per cent. From the interest tables in the manuals of almost every company are found the figures which will make this calculation an exceedingly easy one. Set out in full it is as follows:---

1	Discour	nt term.	Amount of claims.	Discounted value of \$1.		Value of benefits.
15	years		\$15,000,000	× .590891		8,953,305
30	vears		25,000,000	× .356278	=	8,900,950
45	vears		30,000,000	× .212659	=	6,379,770
55	years		30,000,000	× -150758	=	4,522,740
	1.1				1	828,762,825

"It is thus seen that on the above abbreviated mortality table the value at age 20 of \$1,000, payable at the death of each of the 100,000 lives, is \$28,762,825, or an average value for each life—usually designated single premium—of \$287.63.

## Finding the Value.

"We can in a like manner find the value of one dollar a year paid during the life of each of the 100,000 persons. Thus we have 15,000 pay a dollar a year for 15 years only, 25,000 pay each year for 30 years, 30,000 for 45 years, and the remaining 30,000 for 55 years. Taking from our interest tables the value of an annuity of one dollar a year for the various terms above indicated, this calculation set out in full is as follows:-

Term of premium payments.	Number Value of living. \$1 per an.		Value of payments.	
E VEATS	15,000	X \$11.9205	= \$ 178,808	
o veare	25,000	X 19.0358	= 475,895	
years	30,000	× 23.2828	= 698,484	
years	30,000	X 25.1133	= 753,399	
5 years	30,000	1		

\$2,106,586

"If \$2,106,586 is the present value of \$1 per annum paid at the beginning of each year during the lifetime of the 100,000 individuals living at age 20, then \$21.07 is, on the average, the value of \$1 per annum payable during the lifetime of an individual age 20. Now, at the outset, the value of the benefit guaranteed under an insurance contract must be exactly balanced by the value of the premiums to be received. In our illustration we found the value of the benefit, or the single premium, to be \$287.63 and the value of each \$1 of premium to be \$21.06. How many dollars of premium will be precessary to give a value equal to \$287.63? Manifestly \$20.63 divided by \$21.06, or \$13.65.

#### Whole Life or Endowment.

"There is in the minds of many a very considerable difference between whole life and endowment insurance in so far as the calculation of premiums is concerned. As a matter of fact there is little difference, and an endowment policy can be calculated in the way indicated above quite as easily as a life policy. All that we need to do is to suppose that all those living at the end of the endowment term die at that point. Thus, taking the same mortality table as above, we can readily calculate the annual premium for a 30-year endowment insurance by supposing that of the 85,000 living at age 50 the whole 85,000 die at that time instead of the 25,000 provided for in the table. We then have only two calculations to make, both for the single premium and for the annual premium. The work may be set out as follows:—

Endowment term. 15 years 30 years	Amount of claim. \$15,000,000 85,000,000	Discounted value of \$1. × .596891 × .356278		Value of benefits. \$ 8,953,365 30,283,630	Single premium. \$392.37
	Sec.			\$39,236,995	
Term of premium N	umber V	Value of	1	V Value of ye	alue of 30- ar annuity of \$1.

0	years .	8	5,000	×	19.0358 =	1,018,043	\$17.97
	Nº P					\$1,796,851	1
			1				

× \$11.9205

= \$ 178,808

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Dividing the one result by the other, we have \$21.83 as the annual premium for a 30-year endowment at age 20.

## Calculating the Results.

15 years . 15,000

"It must be remembered that these figures are not intended to be in any way accurate. Deaths from so large a number as 100,000 occur year by year, and exact results are obtained by carrying out a calculation for every year from the age for which the premium is required until the last death occurs. The principle underlying the calculation, however, is fully illustrated in the examples taken, and if this method were extended to include each year of age from 20 to the limit of the mortality table, exact net premiums on the basis of whatever table is adopted would result.

"It must not be supposed that the actual calculation of premiums at all ages is carried out in the way here illustrated. Another very efficient tool that is used in the calculation of premium rates is one by which the single calculation of the present value of the claims and the present value of the payments year by year of those living is made in such a manner as to serve for the calculation of premiums at all ages, but it is not at all necessary to explain the construction and the use of this tool to appreciate the basis upon which the whole business of life insurance rests.

"It will be seen that the sufficiency of the premiums charged as calculated on the basis of any given mortality table depends on how closely that table expresses the actual mortality experienced, and how nearly the rate of interest