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COMMITTEE FOR MORTALITY STUDIES

OF ASSURED LIVES

SINGAPORE

FURTHER REPORT ON THE

PREPARATION OF GRADUATED MORTALITY RATES

FOR INSURED LIVES

ORDINARY INSURANCES - FIVE YEARS ENDED 31 DECEMBER 1988

(0304c)

INTRODUCTION

In February 1990, the Committee for Mortality Studies of Assured Lives issued a report which dealt with the preparation of graduated mortality rates for male and female lives insured in Singapore, under Ordinary insurances, based on experience during the five years ended 31 December 1988.

2.   The resulting mortality tables were entitled -

Singapore 1983/88 (M-ORD) Table
Singapore 1983/88 (F-ORD) Table

3.   This report summarises and updates the details of the investigations undertaken in order to produce the graduated mortality tables listed above. A revised table has been prepared for male lives, but not for female lives. It is in the following Parts -

Part	Subject
	Graduated Mortality Rates for -
1	Male Lives Insured
2	Female Lives Insured

THE STANDARD LIFE TABLES

4.   Standard life tables for male and female lives have been calculated using the rates of mortality obtained by the methods described in Parts 1 and 2 of this report, for individual ages from age 10 to age 99.   The tables present the following items for each age -

Item	Definition
l_x	The number of lives surviving at exact age x.
d_x	The number of deaths in the year of age x to x + 1 among the l_x males or females who enter on that year.
p_x	The probability of a male or female aged x living a year.
q_x	The probability of a male or female aged x dying within a year.
e_x	The complete expectation of life or the average number of years lived after x by each of a group of males or females aged exactly x.

5.   The life tables are included in the Appendices to each Part. Extended tables to ages in excess of 100 years can be prepared if found necessary in future.

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PART 1 - GRADUATED MORTALITY RATES FOR
MALE LIVES INSURED - SINGAPORE - 1983 TO 1988

1.1 This investigation is based on the experience of male lives insured in Singapore, under Ordinary insurances, during the five years ended 31 December 1988.

1.2 The total data available for the purposes of the investigation is shown in Table 1.

Table 1 - Summary of the Data
Singapore - Ordinary Insurances
Males - Five Years to 31 December 1988

Item	Whole Life and Endowment Insurances	
	With Medical	Without Medical
In Force at 31 December -		
1983	52,977	169,681
1984	55,726	177,801
1985	56,761	186,463
1986	57,458	209,351
1987	64,689	256,520
1988	71,139	294,449
TOTALS	358,750	1,294,265
Deaths During		
1984	155	231
1985	113	233
1986	104	235
1987	153	297
1988	115	299
TOTALS	640	1,295

1.3 A summary of the mortality experience derived from this data is presented in the next table.

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Table 2 - Summary of the Mortality Experience
Singapore - Ordinary Insurances
Males - Five Years to 31 December 1988

Duration of Policy	Exposed to Risk	Deaths		Ratio of Actual to Expected Deaths
		Actual	Expected	
(Years)	(1)	(2)	(3)	(4)

With Medical Examination

0	33,606	23	56.6	0.41
1	30,455	28	54.6	0.51
2	27,046	39	50.5	0.77
3	25,367	26	50.9	0.51
4	22,992	32	52.1	0.61
5+	156,687	492	849.4	0.58
Totals	296,153	640	1,114.1	0.57

Without Medical Examination

0	187,404	85	183.1	0.46
1	144,532	96	144.5	0.66
2	107,113	83	109.9	0.75
3	92,047	75	100.3	0.75
4	82,718	79	94.7	0.83
5+	435,844	840	953.9	0.88
Totals	1,049,658	1,258	1,586.4	0.79

1.4 The expected numbers of deaths shown at each duration in column (3) of the above table have been calculated by reference to the rates of mortality in the Singapore 1977/83 (Ordinary) table.

1.5 Appendix A to the 1985 Report describes a study made of the effect of the initial selection exercised by the company contributing the data, either by a medical examination made prior to the issue of the policy or by means of the personal statement made by the applicant for insurance. It was concluded that for Singapore, this initial selection had a diminished effect after the policies had been in force for more than 2 or 3 years.

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1.6 Consideration of the experience now available (e.g. see Column (4) of Table 2 above), has led to a similar conclusion. The result is that the new graduated mortality table is also based on the total experience of Ordinary policies which have been 2 or more years in force.

1.7 For information, the table on the next page presents for Ordinary policies on male lives which have been 2 or more years in force, for successive age-groups, the following -

(a) the actual rates of mortality experienced under Singapore Ordinary policies during five years ended 31 December 1988, showing separate details for policies effected with or without a medical examination and for all policies combined;

(b) the weighted average rate of mortality for each age group of the total data according to the Singapore 1977/83 (Ordinary) Table. The weights adopted are the numbers exposed to risk at each age in each age-group;

(c) the ratios for the total data of the actual rates of mortality experienced to the comparative rates derived from the Singapore 1977/83 (Ordinary) Table.

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Table 3 - The Rates of Mortality
Singapore - Ordinary Insurances - Duration 2+ Years
Males - Five Years ended 31 December 1988

| Age Group | Actual Rates of Mortality | | | Singapore 1977/83 (Ordinary) | Ratios | |
| | With Medical | Without Medical | All Policies | | | |
	(1)	(2)	(3)	(4)	(1)/(2) (5)	(3)/(4) (6)
19 -	.00055+	.00084	.00082	.00104	0.65	0.79
24 -	.00093	.00054	.00057	.00070	1.72	0.81
29 -	.00070	.00058	.00060	.00058	1.21	1.03
34 -	.00060	.00093	.00085	.00089	0.65	0.96
39 -	.00126	.00161	.00150	.00165	0.78	0.91
44 -	.00185	.00223	.00210	.00319	0.83	0.66
49 -	.00321	.00412	.00377	.00559	0.78	0.67
54 -	.00665	.00942	.00797	.01056	0.71	0.75
59 -	.00944	.01691	.01191	.01806	0.56	0.66
64 -	.01522	.02704	.01682	.02837	0.56	0.59
Total Number of Deaths (All ages)	590	1,077	1,667	2,260	-	-

+ Less than 5 deaths

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1.8 A further comparison of male mortality rates experienced since 1977 is in the next table.

Table 4 - Experienced Rates of Mortality
Singapore - Ordinary Insurances - Duration 2+ years
Males - Various Periods

Age Group	Total Data		Singapore 1977/83 (Ordinary)	Ratios	
	1983/88	1977/83		(1)/(2)	(1)/(3)
	(1)	(2)	(3)	(4)	(5)
19-	.00082	.00122	.00104	0.67	0.79
24-	.00057	.00070	.00070	0.81	0.81
29-	.00060	.00059	.00058	1.02	1.03
34-	.00085	.00081	.00089	1.05	0.96
39-	.00150	.00154	.00165	0.97	0.91
44-	.00210	.00278	.00319	0.76	0.66
49-	.00377	.00532	.00559	0.71	0.67
54-	.00797	.00935	.01056	0.85	0.75
59-	.01191	.01498	.01806	0.80	0.66
64-	.01682	.01711	.02837	0.98	0.59

1.9 The following comments are made on the rates and ratios presented in Table 4 -

(a) Column (4) - Except for ages 29 to 43, significant reductions have occurred in the mortality rates applicable to male lives insured under Ordinary policies.

(b) Column (5) - As a result of the lower mortality rates experienced at many ages during 1983 to 1988, the rates in the Singapore 1977/83 (Ordinary) Table are out of line with recent experience at ages in excess of, say, 45 years. This feature is also a partial reflection of the decision made in 1985 to adopt for this table, the rates in the A1967/70 (Ultimate) Table for the higher ages. At that time, insufficient data was available to determine suitable mortality rates for ages in excess of 64 years.

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1.10 The position regarding the availability of data at older ages and the proportions of business in force which was written without completing a medical examination are presented in Table 5.

Table 5 - The Age Distribution of the Exposed to Risk
Singapore - Ordinary Insurances - Duration 2+ years
Males - Five Years Ended 31 December 1988

| Age Group | Exposed to Risk | | | Proportion which is Without Medical | |
	With Medical	Without Medical	Total	1983/88	1977/83
	(1)	(2)	(3)	(4)	(5)
19-	2,709	47,029	49,738	0.95	0.91
24-	11,247·	122,095	133,342	0.92	0.90
29-	29,936	154,470	184,406	0.84	0.79
34-	47,981	156,411	204,392	0.77	0.72
39-	45,484	103,023	148,507	0.69	0.69
44-	35,677	67,779	103,456	0.66	0.66
49-	24,607	38,973	63,580	0.61	0.56
54-	17,312	15,686	32,998	0.48	0.44
59-	9,014	4,428	13,442 ·	0.33	0.23
64-	4,564	712	5,276	0.13	0.09
Total (All ages)	232,092	717,726	949,818	0.76	0.72

1.11 An increasing proportion of the exposed to risk is made up of With Medical policies as the age attained increases. There is a notable degree of consistency between the ratios shown in columns (4) and (5) of Table 5.

THE GRADUATED MORTALITY RATES

1.12 Graduated mortality rates have been prepared for ages 10 to 99 years, using Spencer's 21 Term Summation Formula.

1.13 The technical bases and formulae involved are explained in detail in Appendix C.

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1.14 It will be noted that the procedure outlined in Appendix C involves the preparation of the graduated rates of mortality over two sectors of age, i.e. -

Spencer's 21 Term Summation Formula

Ages 10 to 21 - By reference to the average rates of mortality for the central ages of the age groups 9 1/2 to 13 1/2 years, 14 1/2 years to 18 1/2 years and 19 1/2 years to 23 1/2 years.

Ages 22 to 99 - By application of Spencer's Formula to the actual or derived rates of mortality for successive ages.

1.15 Two problem areas were encountered -

(a) Ages 10 to 21 - Lack of adequate data

(b) Ages 54 onwards - Lack of adequate data.

Ages 10 to 21 Years

1.16 Data tabulations for male lives show that only one death was recorded during 1983 to 1988, in the age range 9 to 18 years; a significant accident peak occurred in the early twenties.

1.17 After consideration of a series of trials, it was decided to adopt the following rates.

Table 6 - Pivotal Mortality Rates
Males - Ages 9 1/2 to 23 1/2 Years

Age Group	Central Age	Adopted Rate	Bases
9 1/2 -	11 1/2	.00026	0.70 x Q
14 1/2 -	16 1/2	.00065	0.80 x Q
19 1/2 -	21 1/2	.00082	Experienced Rate

Note: Q equals rate for age by A1967/70 (Ultimate) Table

1.18 These rates were adopted in revised tabulations distributed during February 1990 but, for reasons not yet determined, incorrect results were produced and recalculation is necessary.

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Ages 56 Years Onwards

1.19 It will be observed from Table 5, that the data available for ages 59 onwards is not sufficient to enable the calculation of reliable rates of mortality for those ages. An assumption is required therefore, as to the levels of mortality likely to be experienced at these ages.

1.20 A similar problem occurred with the preparation of the Singapore 1977/83 (Ordinary) Table. The basis then adopted, as stated in the 1985 Report was -

> "22.   It is essential that the mortality rates at the high ages be not understated. The data summarised in Table 3 suggests a reasonable assumption would be that the rates of mortality for Singapore insured lives from age 57 onwards may be represented by the rates of mortality contained in the A1967/70 (Ultimate) table."

1.21 Examination of the ratios set out in columns (4) and (5) of Table 4 above, suggest -

(a) Clearly, the rates of mortality experienced by male insured lives in Singapore, during 1983 to 1988, at the older ages were lower than the rates experienced for those ages during 1977 to 1983;

(b) The previous assessment that the rates of mortality for the older ages should be aligned with the rates shown in the A1967/70 (Ultimate) Table requires reconsideration.

1.22 Examination of the ratios in column (5) of Table 4 and of the limited data available at ages 59 and over indicate that a range of alternatives exist. A ratio of 65% of the rates in the A1967/70 (Ultimate) Table was originally adopted for ages 56 onwards. For the purposes of this further report, the ratio of 75% proposed by the Insurance Commissioner, Singapore has been used.

1.23 The details of the graduation by Spencer's Method are set out in Appendix C. A summary of the results is in Table 7.

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Table 7 – Comparison of Actual and Expected Deaths
Spencer's 21 Term Formula – Total Data
Singapore – Ordinary Insurances – 2+ years
Males – Five Years ended 31 December 1988

Age Group	Deaths		Difference = (1) - (2)		
	Actual	Expected	+	−	Sum
	(1)	(2)	(3)	(4)	(5)
22 1/2 −	71.5	72.7		1.2	-1.2
27 1/2 −	98.0	101.3		3.3	-4.4
32 1/2 −	128.5	145.3		16.8	-21.3
37 1/2 −	233.5	229.9	3.6		-17.7
42 1/2 −	209.0	218.9		9.9	-27.5
47 1/2 −	247.5	251.9		4.4	-32.0
52 1/2 −	266.5	285.1		18.6	-50.5
57 1/2 −	205.0	213.6		8.6	-59.1
62 1/2 −	101.0	130.5		29.5	-88.7
Totals	1,560.5	1,649.2	3.6	92.3	-88.7

1.24 Examination of Table 7 shows that –

(a) Apart from the relatively large excesses of 16.8 expected deaths for age-group 32 1/2 to 36 1/2 years and the excess of 29.5 expected deaths for age group 62 1/2 to 66 1/2 years, the deviations between the numbers of actual and expected deaths are small.

(b) It is evident that the graduation has resulted in a table of mortality rates which, whilst adopting a conservative basis for older ages, provides a satisfactory standard for use and for comparisons in future reports.

1.25 Rates of mortality for each age, together with first and second differences, are shown in Appendix A, following this Part. The second differences for the mortality rates at successive ages flow evenly and are small.

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SINGAPORE – THE GRADUATED MORTALITY RATES

AND COMPARISONS

OF ACTUAL AND EXPECTED DEATHS

MALES

COMMITTEE FOR MORTALITY STUDIES OF ASSURED LIVES

SINGAPORE   -ORDINARY INSURANCES

MORTALITY EXPERIENCE-1983 TO 1988-MALES

WHOLE LIFE AND ENDOWMENT INSURANCES

GRADUATED MORTALITY RATES - SPENCERS 21 TERM SUMMATION FORMULA

AGE	GRADUATED RATE	ACTUAL RATE	ACTUAL DEATHS	EXPECTED DEATHS	ACTUAL-EXPECTED +	−	SUM
22	.00079						
23	.00071						
24	.00069						
25	.00066						
26	.00065						
22-	.00067	.00066	71.5	72.7		−1.2	−1.2
27	.00063						
28	.00062						
29	.00061						
30	.00060						
31	.00060						
27-	.00061	.00059	98.0	101.3		−3.3	−4.4
32	.00061						
33	.00062						
34	.00066						
35	.00074						
36	.00084						
32-	.00071	.00063	128.5	145.3		−16.8	−21.3
37	.00097						
38	.00112						
39	.00125						
40	.00140						
41	.00153						
37-	.00128	.00130	233.5	229.9	3.6		−17.7
42	.00163						
43	.00173						
44	.00183						
45	.00196						
46	.00211						
42-	.00188	.00180	209.0	218.9		−9.9	−27.5
47	.00233						
48	.00263						
49	.00300						
50	.00345						
51	.00402						
47-	.00314	.00309	247.5	251.9		−4.4	−32.0

52	.00471					
53	.00550					
54	.00634					
55	.00721					
56	.00809					
52-	.00643	.00601	266.5	285.1	-18.6	-50.5
57	.00899					
58	.00992					
59	.01086					
60	.01182					
61	.01291					
57-	.01085	.01041	205.0	213.6	-8.6	-59.1
62	.01412					
63	.01531					
64	.01669					
65	.01827					
66	.02012					
62-	.01677	.01300	101.0	130.5	-29.5	-88.7
Totals			1560.5	1649.2	3.6 -92.3	-88.7

SINGAPORE - THE STANDARD LIFE TABLE

MALES

COMMITTEE FOR MORTALITY STUDIES OF ASSURED LIVES
SINGAPORE — MALES — ORDINARY

SINGAPORE 1983/88 (ORD)
BASED ON 5 YEARS EXPERIENCE ENDED 31 DECEMBER 1988

ULTIMATE VALUES

AGE	LIVING AT AGE	DEATHS AT AGE	PROBABILITIES LIVING	PROBABILITIES DYING	EXPECTATION OF LIFE
10	1000000	190	.99981	.00019	67.05
11	999810	210	.99979	.00021	66.07
12	999600	310	.99969	.00031	64.58
13	999290	400	.99960	.00040	63.60
14	998890	479	.99952	.00048	62.63
15	998411	559	.99944	.00056	61.66
16	997852	619	.99938	.00062	60.69
17	997233	678	.99932	.00068	59.73
18	996555	718	.99928	.00072	58.77
19	995837	757	.99924	.00076	57.81
20	995080	786	.99921	.00079	56.85
21	994294	805	.99919	.00081	55.90
22	993489	785	.99921	.00079	54.94
23	992704	705	.99929	.00071	53.99
24	991999	694	.99930	.00070	53.02
25	991305	664	.99933	.00067	52.06
26	990641	644	.99935	.00065	51.09
27	989997	624	.99937	.00063	50.13
28	989373	613	.99938	.00062	49.16
29	988760	593	.99940	.00060	48.19
30	988167	583	.99941	.00059	47.22
31	987584	583	.99941	.00059	46.25
32	987001	592	.99940	.00060	45.27
33	986409	602	.99939	.00061	44.30
34	985807	641	.99935	.00065	43.33
35	985166	719	.99927	.00073	42.35
36	984447	817	.99917	.00083	41.38
37	983630	954	.99903	.00097	40.42
38	982676	1091	.99889	.00111	39.46
39	981585	1227	.99875	.00125	38.50
40	980358	1363	.99861	.00139	37.55
41	978995	1478	.99849	.00151	36.60
42	977517	1574	.99839	.00161	35.65
43	975943	1659	.99830	.00170	34.71
44	974284	1754	.99820	.00180	33.77
45	972530	1867	.99808	.00192	32.83
46	970663	2000	.99794	.00206	31.89
47	968663	2199	.99773	.00227	30.95
48	966464	2484	.99743	.00257	30.02
49	963980	2824	.99707	.00293	29.10
50	961156	3249	.99662	.00338	28.18
51	957907	3784	.99605	.00395	27.28
52	954123	4446	.99534	.00466	26.38
53	949677	5185	.99454	.00546	25.50
54	944492	5969	.99368	.00632	24.64
55	938523	6757	.99280	.00720	23.79
56	931766	7538	.99191	.00809	22.96
57	924228	8318	.99100	.00900	22.14

ULTIMATE VALUES

AGE	LIVING AT AGE	DEATHS AT AGE	PROBABILITIES LIVING	DYING	EXPECTATION OF LIFE
58	915910	9095	.99007	.00993	21.34
59	906815	9857	.98913	.01087	20.55
60	896958	10602	.98818	.01182	19.77
61	886356	11443	.98709	.01291	18.99
62	874913	12354	.98588	.01412	18.24
63	862559	13206	.98469	.01531	17.49
64	849353	14176	.98331	.01669	16.75
65	835177	15259	.98173	.01827	16.03
66	819918	16497	.97988	.02012	15.31
67	803421	17916	.97770	.02230	14.62
68	785505	19481	.97520	.02480	13.94
69	766024	21165	.97237	.02763	13.28
70	744859	22927	.96922	.03078	12.64
71	721932	24668	.96583	.03417	12.02
72	697264	26329	.96224	.03776	11.42
73	670935	27884	.95844	.04156	10.85
74	643051	29310	.95442	.04558	10.30
75	613741	30613	.95012	.04988	9.76
76	583128	31792	.94548	.05452	9.25
77	551336	32838	.94044	.05956	8.75
78	518498	33718	.93497	.06503	8.27
79	484780	34400	.92904	.07096	7.81
80	450380	34837	.92265	.07735	7.37
81	415543	34997	.91578	.08422	6.94
82	380546	34858	.90840	.09160	6.53
83	345688	34403	.90048	.09952	6.14
84	311285	33616	.89201	.10799	5.77
85	277669	32498	.88296	.11704	5.41
86	245171	31058	.87332	.12668	5.07
87	214113	29316	.86308	.13692	4.74
88	184797	27309	.85222	.14778	4.42
89	157488	25083	.84073	.15927	4.11
90	132405	22681	.82870	.17130	3.81
91	109724	20143	.81642	.18358	3.52
92	89581	17538	.80422	.19578	3.23
93	72043	15006	.79171	.20829	2.93
94	57037	12675	.77777	.22223	2.61
95	44362	10540	.76241	.23759	2.26
96	33822	8627	.74493	.25507	1.87
97	25195	7007	.72187	.27813	1.41
98	18188	5588	.69279	.30721	.85
99	12600	4313	.65767	.34233	.09

COMMITTEE FOR MORTALITY STUDIES OF ASSURED LIVES

SINGAPORE   - MALES   - ORDINARY

SINGAPORE 1983/88 (ORD)
BASED ON 5 YEARS EXPERIENCE ENDED 31 DECEMBER 1988

ULTIMATE RATES OF MORTALITY

AGE	RATE	DIFFERENCE	DIFFERENCE
10	.00019	-.00002	.00008
11	.00021	.00010	-.00001
12	.00031	.00009	-.00001
13	.00040	.00008	.00000
14	.00048	.00008	-.00002
15	.00056	.00006	-.00000
16	.00062	.00006	-.00002
17	.00068	.00004	.00000
18	.00072	.00004	-.00001
19	.00076	.00003	-.00001
20	.00079	.00002	-.00004
21	.00081	-.00002	-.00006
22	.00079	-.00008	.00007
23	.00071	-.00001	-.00002
24	.00070	-.00003	.00001
25	.00067	-.00002	.00000
26	.00065	-.00002	.00001
27	.00063	-.00001	-.00001
28	.00062	-.00002	.00001
29	.00060	-.00001	.00001
30	.00059	.00000	.00001
31	.00059	.00001	.00000
32	.00060	.00001	.00003
33	.00061	.00004	.00004
34	.00065	.00008	.00002
35	.00073	.00010	.00004
36	.00083	.00014	.00000
37	.00097	.00014	.00000
38	.00111	.00014	-.00000
39	.00125	.00014	-.00002
40	.00139	.00012	-.00002
41	.00151	.00010	-.00001
42	.00161	.00009	.00001
43	.00170	.00010	.00002
44	.00180	.00012	.00002
45	.00192	.00014	.00007
46	.00206	.00021	.00009
47	.00227	.00030	.00006
48	.00257	.00036	.00009
49	.00293	.00045	.00012
50	.00338	.00057	.00014
51	.00395	.00071	.00009
52	.00466	.00080	.00006
53	.00546	.00086	.00002
54	.00632	.00088	.00001
55	.00720	.00089	.00002
56	.00809	.00091	.00002
57	.00900	.00093	.00001

ULTIMATE RATES OF MORTALITY

AGE	RATE	DIFFERENCE	DIFFERENCE
58	.00993	.00094	.00001
59	.01087	.00095	.00014
60	.01182	.00109	.00012
61	.01291	.00121	-.00002
62	.01412	.00119	.00019
63	.01531	.00138	.00020
64	.01669	.00158	.00027
65	.01827	.00185	.00033
66	.02012	.00218	.00032
67	.02230	.00250	.00033
68	.02480	.00283	.00032
69	.02763	.00315	.00024
70	.03078	.00339	.00020
71	.03417	.00359	.00021
72	.03776	.00380	.00022
73	.04156	.00402	.00028
74	.04558	.00430	.00034
75	.04988	.00464	.00040
76	.05452	.00504	.00043
77	.05956	.00547	.00046
78	.06503	.00593	.00046
79	.07096	.00639	.00048
80	.07735	.00687	.00051
81	.08422	.00738	.00054
82	.09160	.00792	.00055
83	.09952	.00847	.00058
84	.10799	.00905	.00059
85	.11704	.00964	.00060
86	.12668	.01024	.00062
87	.13692	.01086	.00063
88	.14778	.01149	.00054
89	.15927	.01203	.00025
90	.17130	.01228	-.00008
91	.18358	.01220	.00031
92	.19578	.01251	.00143
93	.20829	.01394	.00142
94	.22223	.01536	.00212
95	.23759	.01748	.00558
96	.25507	.02306	.00602
97	.27813	.02908	.00604
98	.30721	.03512	-.37745
99	.34233	-.34233	

PART 2 — GRADUATED MORTALITY RATES FOR
FEMALE LIVES INSURED — SINGAPORE — 1983 TO 1988

2.1 This Part of this report records the experience of female lives insured in Singapore, under Ordinary insurances, during the five years ended 31 December 1988, as advised in the earlier report.

2.2 The total data available for the purposes of the investigation dealt with in the earlier report is shown in Table 8.

Table 8 — Summary of the Data
Singapore — Ordinary Insurances
Females — Five Years to 31 December 1988

Item	Whole Life and Endowment Insurances	
	With Medical	Without Medical
In Force at 31 December —		
1983	14,384	76,585
1984	16,132	83,147
1985	17,219	90,852
1986	18,873	102,383
1987	23,218	143,812
1988	26,466	196,582
TOTALS	95,866	556,776
Deaths During		
1984	23	37
1985	32	41
1986	34	58
1987	23	84
1988	29	91
TOTALS	141	311

2.3 A summary of the mortality experience derived from this data is presented in the next table.

(0304c)

Table 9 - Summary of the Mortality Experience
Singapore - Ordinary Insurances
Females - Five Years to 31 December 1988

| Duration of Policy | Exposed to Risk | Deaths | | Ratio of Actual to Expected Deaths |
		Actual	Expected	
(Years)	(1)	(2)	(3)	(4)
With Medical Examination				
0	15,537	6	28.3	0.21
1	13,193	10	24.8	0.40
2	10,844	6	21.5	0.28
3	9,355	6	20.3	0.30
4	8,061	10	20.0	0.50
5+	38,878	103	224.8	0.46
Totals	95,868	141	339.7	0.41
Without Medical Examination				
0	122,114	32	111.5	0.29
1	87,424	31	82.5	0.38
2	64,393	27	62.9	0.43
3	52,039	16	54.1	0.30
4	46,268	24	51.0	0.47
5+	186,735	172	328.7	0.52
Totals	558,973	302	690.7	0.44

2.4 The expected numbers of deaths shown at each duration in column (3) of the above table have been calculated by reference to the rates of mortality in the Singapore 1977/83 (Ordinary) table.

2.5 Consideration of the size of the data presented in Table 9 (in particular, the numbers of deaths during 1983 to 1988) suggests quite strongly that the current investigation should be regarded as an initial study only, pending the collection of future data.

(0304c)

2.6 This view is confirmed by Table 10 on the next page.

2.7 Table 10 presents for Ordinary policies on female lives which have been 2 or more years in force, for successive age-groups, the following -

(a) the actual rates of mortality experienced under Singapore Ordinary policies during five years ended 31 December 1988, showing separate details for policies effected with or without a medical examination and for all policies combined;

(b) the weighted average rate of mortality for each age group of the total data according to the A1967/70 (Ultimate) Table which is the standard table for comparisons for female lives. The weights adopted are the numbers exposed to risk at each age in each age-group;

(c) the ratios for the total data of the actual rates of mortality experienced to the comparative rates in the A1967/70 (Ultimate) Table.

(0304c)

Table 10 - The Rates of Mortality
Singapore - Ordinary Insurances - Duration 2+ Years
Females - Five Years ended 31 December 1988

Age Group	Actual Rates of Mortality			A1967/70 Ultimate Table	Ratios	
	With Medical	Without Medical	All Policies		(1)/(2)	(3)/(4)
	(1)	(2)	(3)	(4)	(5)	(6)
19-	- *	.00023 +	.00026	.00080	- *	0.33
24-	.00016 +	.00021	.00020	.00067	0.76	0.30
29-	.00038 +	.00045	.00045	.00068	0.84	0.66
34-	.00093	.00066	.00069	.00095	1.41	0.73
39-	.00087	.00069	.00072	.00160	1.26	0.45
44-	.00094	.00132	.00124	.00296	0.71	0.42
49-	.00184	.00249	.00226	.00527	0.74	0.43
54-	.00386	.00288	.00340	.01037	1.34	0.33
59-	.00576	- *	.00692	.01572	- *	0.44
64-	- *	- *	.01134	.02452	- *	0.46
Total Number of Deaths	125	239	364	-	-	0.47

* Less than 2000 Exposed to Risk
+ Less than 5 Deaths

2.8 Column (6) of Table 10 shows that the experienced rates of mortality for female insured lives in Singapore during 1983 to 1988 were in the range of 42% to 46% of A1967/70 (Ultimate) rates for ages 39 years or more.

2.9 The division of the exposed to risk between policies written with and without a medical examination is shown in Table 11.

Table 11 - The Age Distribution of the Exposed to Risk
Singapore - Ordinary Insurances - Duration 2+ years
Females - Five Years Ended 31 December 1988

Age Group	Exposed to Risk			Proportion which is Without Medical
	With Medical	Without Medical	Total	
	(1)	(2)	(3)	(4)
19-	– *	19,913	21,513	0.93
24-	6,401	70,588	76,988	0.92
29-	10,526	85,889	96,415	0.89
34-	11,858	74,525	86,383	0.86
39-	9,784	47,723	57,506	0.83
44-	7,956.	27,625	35,581	0.78
49-	6,770	12,636	19,406	0.65
54-	5,040	4,504	9,544	0.47
59-	3,376	– *	4,683	0.28
64-	– *	– *	2,104	0.12
Total (All ages)	67,138	349,438	416,576	0.84

* Less than 2000 Exposed to Risk

2.10 A very high proportion of the exposed to risk is made up of policies issued without a medical examination for ages up to say, 40 years after which the proportions in this category decrease quite rapidly as the age attained increases.

THE GRADUATED MORTALITY RATES

2.11 Graduated mortality rates for female lives have been prepared for ages 10 to 99 years, using Spencer's 21 Term Summation Formula.

2.12 The technical bases and formulae involved are explained in detail in Appendix C, similar procedures having been adopted for male and female lives.

2.13 The procedures outlined in Appendix C involve the preparation of the graduated rates of mortality over two sectors of age, i.e. -

Spencer's 21 Term Summation Formula

Ages 10 to 21 - By reference to the average rates of mortality for the central ages of the age groups 9 1/2 to 13 1/2 years, 14 1/2 years to 18 1/2 years and 19 1/2 years to 23 1/2 years.

Ages 22 to 99 - By application of Spencer's Formula to the actual or derived rates of mortality for successive ages.

Ages 10 to 21 Years

2.14 Reference to data tabulations for female lives show that only two deaths were recorded during 1983 to 1988, in the age range 9 to 18 years. A small accident peak occurred in the early twenties.

2.15 The following pivotal mortality rates have been adopted.

Table 12 - Pivotal Mortality Rates
Females - Ages 9 1/2 to 23 1/2 Years

Age Group	Central Age	Adopted Rate	Bases
9 1/2 -	11 1/2	.00017	0.45 x Q
14 1/2 -	16 1/2	.00022	0.25 x Q
19 1/2 -	21 1/2	.00026	Experienced Rate

Note: Q equals rate for age by A1967/70 (Ultimate) Table.

(0304c)

Ages 54 Years Onwards

2.16 It is evident from Table 11, that the data available for ages 59 onwards is not sufficient to enable the calculation of reliable rates of mortality for those ages. It was necessary, therefore to make a judgement as to the mortality rates which might be experienced in future at these ages.

2.17 The formula decided upon for the older ages for female lives is -

45% of A1967/70 (Ultimate) Table from age 56 years.

2.18 The details of the graduation by Spencer's Method are set out in Appendix C. A summary of the results is in Table 13.

Table 13 - Comparison of Actual and Expected Deaths
Spencer's 21 Term Formula - Total Data
Singapore - Ordinary Insurances - 2+ years
Females - Five Years ended 31 December 1988

| Age Group | Deaths | | Difference = (1) - (2) | | |
	Actual	Expected	+	-	Sum
	(1)	(2)	(3)	(4)	(5)
22 1/2 -	12.5	14.4		-1.9	-1.9
27 1/2 -	38.0	34.0	4.0		-2.1
32 1/2 -	45.5	51.4		-5.9	-3.8
37 1/2 -	56.5	54.0	2.5		-1.3
42 1/2 -	35.5	40.1		-4.6	-5.9
47 1/2 -	44.5	46.7		-2.2	-8.1
52 1/2 -	38.5	42.4		-3.9	-12.0
57 1/2 -	38.0	40.4		-2.4	-14.4
62 1/2 -	22.0	30.3		-8.3	-22.7
Totals	331.0	353.7	6.5	29.2	-22.7

(0304c)

2.19   Examination of Table 13 shows that –

(a)   The deviations between the numbers of actual and expected deaths at each age-group are small.

(b)   For the age range affected by the blending with 45% of A1967/70 (Ultimate) Table rates, i.e. age groups 52 1/2-onwards, the choice of 45% was made to ensure that no understatement occurred at these ages in this first presentation of graduated rates of mortality for female insured lives.

2.20   Rates of mortality for each age, together with first and second differences, are shown in the Appendix B, following this Part.   The second differences for the mortality rates at successive ages flow evenly and are small.

S.W. CAFFIN
April 1991

(0304c)

SINGAPORE – THE GRADUATED MORTALITY RATES

AND COMPARISONS

OF ACTUAL AND EXPECTED DEATHS

FEMALES

AGE	GRADUATED RATE	ACTUAL RATE	ACTUAL DEATHS	EXPECTED DEATHS	ACTUAL-EXPECTED +	-	SUM
22	.00026						
23	.00027						
24	.00026						
25	.00026						
26	.00026						
22-	.00026	.00022	12.5	14.4		-1.9	-1.9
27	.00028						
28	.00030						
29	.00034						
30	.00038						
31	.00041						
27-	.00035	.00039	38.0	34.0	4.0		2.1
32	.00045						
33	.00050						
34	.00055						
35	.00060						
36	.00066						
32-	.00056	.00050	45.5	51.4		-5.9	-3.9
37	.00070						
38	.00074						
39	.00076						
40	.00076						
41	.00077						
37-	.00074	.00078	56.5	54.0	2.5		-1.4
42	.00077						
43	.00081						
44	.00090						
45	.00100						
46	.00118						
42-	.00095	.00084	35.5	40.1		-4.6	-6.0
47	.00134						
48	.00155						
49	.00179						
50	.00205						
51	.00228						
47-	.00182	.00174	44.5	46.7		-2.2	-8.2
52	.00255						
53	.00287						

54	.00326					
55	.00373					
56	.00426					
52-	.00336	.00306	38.5	42.4	-3.9	-12.1
57	.00488					
58	.00557					
59	.00629					
60	.00700					
61	.00775					
57-	.00633	.00595	38.0	40.4	-2.4	-14.6
62	.00853					
63	.00925					
64	.01005					
65	.01098					
66	.01208					
62-	.01019	.00740	22.0	30.3	-8.3	-22.9

NOTES: GRADUATED RATES FROM AGES 10 TO 99 STORED IN FILE 17
RATES FROM AGE 56 ARE BASED ON 45.0% OF FILE NO. 3
NOTIONAL VALUES OF Qx FOR AGES 100+, ARE BASED ON
AGE 100.5 (.18570) AND INCREASE FACTOR BY AGE (1.06362)

SINGAPORE – THE STANDARD LIFE TABLE

FEMALES

COMMITTEE FOR MORTALITY STUDIES OF ASSURED LIVES

SINGAPORE - FEMALES - ORDINARY
BASED ON 5 YEARS EXPERIENCE ENDED 31 DECEMBER 1988

ULTIMATE VALUES

AGE	LIVING AT AGE	DEATHS AT AGE	PROBABILITIES LIVING	DYING	EXPECTATION OF LIFE
10	1000000	160	.99984	.00016	72.70
11	999840	160	.99984	.00016	71.21
12	999680	180	.99982	.00018	70.22
13	999500	190	.99981	.00019	69.23
14	999310	200	.99980	.00020	68.25
15	999110	210	.99979	.00021	67.26
16	998900	220	.99978	.00022	66.27
17	998680	220	.99978	.00022	65.29
18	998460	230	.99977	.00023	64.30
19	998230	240	.99976	.00024	63.32
20	997990	249	.99975	.00025	62.33
21	997741	259	.99974	.00026	61.35
22	997482	259	.99974	.00026	60.36
23	997223	269	.99973	.00027	59.38
24	996954	259	.99974	.00026	58.40
25	996695	259	.99974	.00026	57.41
26	996436	259	.99974	.00026	56.43
27	996177	279	.99972	.00028	55.44
28	995898	299	.99970	.00030	54.46
29	995599	339	.99966	.00034	53.47
30	995260	378	.99962	.00038	52.49
31	994882	408	.99959	.00041	51.51
32	994474	448	.99955	.00045	50.53
33	994026	497	.99950	.00050	49.55
34	993529	546	.99945	.00055	48.58
35	992983	596	.99940	.00060	47.60
36	992387	655	.99934	.00066	46.63
37	991732	694	.99930	.00070	45.66
38	991038	733	.99926	.00074	44.69
39	990305	753	.99924	.00076	43.73
40	989552	752	.99924	.00076	42.76
41	988800	761	.99923	.00077	41.79
42	988039	761	.99923	.00077	40.82
43	987278	800	.99919	.00081	39.85
44	986478	888	.99910	.00090	38.89
45	985590	986	.99900	.00100	37.92
46	984604	1162	.99882	.00118	36.96
47	983442	1318	.99866	.00134	36.00
48	982124	1522	.99845	.00155	35.05
49	980602	1755	.99821	.00179	34.10
50	978847	2007	.99795	.00205	33.16
51	976840	2227	.99772	.00228	32.23
52	974613	2485	.99745	.00255	31.30
53	972128	2790	.99713	.00287	30.38
54	969338	3160	.99674	.00326	29.47
55	966178	3604	.99627	.00373	28.56
56	962574	4101	.99574	.00426	27.66
57	958473	4677	.99512	.00488	26.78
58	953796	5313	.99443	.00557	25.91
59	948483	5966	.99371	.00629	25.05

ULTIMATE VALUES

| AGE | LIVING AT AGE | DEATHS AT AGE | PROBABILITIES | | EXPECTATION OF LIFE |
			LIVING	DYING	
60	942517	6598	.99300	.00700	24.20
61	935919	7253	.99225	.00775	23.37
62	928666	7922	.99147	.00853	22.55
63	920744	8517	.99075	.00925	21.74
64	912227	9168	.98995	.01005	20.94
65	903059	9916	.98902	.01098	20.14
66	893143	10789	.98792	.01208	19.36
67	882354	11806	.98662	.01338	18.59
68	870548	12954	.98512	.01488	17.83
69	857594	14219	.98342	.01658	17.09
70	843375	15577	.98153	.01847	16.37
71	827798	16970	.97950	.02050	15.67
72	810828	18373	.97734	.02266	14.98
73	792455	19756	.97507	.02493	14.32
74	772699	21133	.97265	.02735	13.67
75	751566	22494	.97007	.02993	13.04
76	729072	23848	.96729	.03271	12.42
77	705224	25198	.96427	.03573	11.82
78	680026	26535	.96098	.03902	11.24
79	653491	27819	.95743	.04257	10.68
80	625672	29037	.95359	.04641	10.13
81	596635	30148	.94947	.05053	9.59
82	566487	31134	.94504	.05496	9.08
83	535353	31966	.94029	.05971	8.57
84	503387	32614	.93521	.06479	8.08
85	470773	33058	.92978	.07022	7.61
86	437715	33271	.92399	.07601	7.14
87	404444	33225	.91785	.08215	6.69
88	371219	32916	.91133	.08867	6.24
89	338303	32328	.90444	.09556	5.80
90	305975	31463	.89717	.10283	5.37
91	274512	30323	.88954	.11046	4.93
92	244189	28922	.88156	.11844	4.48
93	215267	27285	.87325	.12675	4.03
94	187982	25451	.86461	.13539	3.55
95	162531	23460	.85566	.14434	3.04
96	139071	21364	.84638	.15362	2.48
97	117707	19219	.83672	.16328	1.86
98	98488	17078	.82660	.17340	1.14
99	81410	14986	.81592	.18408	.29

COMMITTEE FOR MORTALITY STUDIES OF ASSURED LIVES

SINGAPORE — FEMALES — ORDINARY
BASED ON 5 YEARS EXPERIENCE ENDED 31 DECEMBER 1988

ULTIMATE RATES OF MORTALITY

AGE	RATE	DIFFERENCE	DIFFERENCE
10	.00016	.00000	.00002
11	.00016	.00002	-.00001
12	.00018	.00001	.00000
13	.00019	-.00001	.00000
14	.00020	.00001	.00000
15	.00021	.00001	-.00001
16	.00022	.00000	.00001
17	.00022	.00001	.00000
18	.00023	.00001	.00000
19	.00024	.00001	-.00000
20	.00025	.00001	-.00001
21	.00026	.00000	.00001
22	.00026	.00001	-.00002
23	.00027	-.00001	.00001
24	.00026	.00000	.00000
25	.00026	.00000	.00002
26	.00026	.00002	.00000
27	.00028	.00002	.00002
28	.00030	.00004	-.00000
29	.00034	.00004	-.00001
30	.00038	.00003	.00001
31	.00041	.00004	-.00001
32	.00045	.00005	.00000
33	.00050	.00005	-.00000
34	.00055	.00005	.00001
35	.00060	.00006	-.00002
36	.00066	.00004	.00000
37	.00070	.00004	-.00002
38	.00074	.00002	-.00002
39	.00076	.00000	.00001
40	.00076	.00001	-.00001
41	.00077	.00000	.00004
42	.00077	.00004	.00005
43	.00081	.00009	.00001
44	.00090	.00010	.00008
45	.00100	.00018	-.00002
46	.00118	.00016	.00005
47	.00134	.00021	.00003
48	.00155	.00024	.00002
49	.00179	.00026	-.00003
50	.00205	.00023	.00004
51	.00228	.00027	.00005
52	.00255	.00032	.00007
53	.00287	.00039	.00008
54	.00326	.00047	.00006
55	.00373	.00053	.00009
56	.00426	.00062	.00007
57	.00488	.00069	.00003
58	.00557	.00072	-.00001
59	.00629	.00071	.00004
60	.00700	.00075	.00003
61	.00775	.00078	-.00006
62	.00853	.00072	.00008

ULTIMATE RATES OF MORTALITY

AGE.	RATE	DIFFERENCE	DIFFERENCE
63	.00925	.00080	.00013
64	.01005	.00093	.00017
65	.01098	.00110	.00020
66	.01208	.00130	.00020
67	.01338	.00150	.00020
68	.01488	.00170	.00019
69	.01658	.00189	.00014
70	.01847	.00203	.00013
71	.02050	.00216	.00011
72	.02266	.00227	.00015
73	.02493	.00242	.00016
74	.02735	.00258	.00020
75	.02993	.00278	.00024
76	.03271	.00302	.00027
77	.03573	.00329	.00026
78	.03902	.00355	.00029
79	.04257	.00384	.00028
80	.04641	.00412	.00031
81	.05053	.00443	.00032
82	.05496	.00475	.00033
83	.05971	.00508	.00035
84	.06479	.00543	.00036
85	.07022	.00579	.00035
86	.07601	.00614	.00038
87	.08215	.00652	.00037
88	.08867	.00689	.00038
89	.09556	.00727	.00036
90	.10283	.00763	.00035
91	.11046	.00798	.00033
92	.11844	.00831	.00033
93	.12675	.00864	.00031
94	.13539	.00895	.00033
95	.14434	.00928	.00038
96	.15362	.00966	.00046
97	.16328	.01012	.00056
98	.17340	.01068	.00000
99	.18408	.00000	.00000

COMMITTEE FOR MORTALITY STUDIES
OF ASSURED LIVES

THE METHODS ADOPTED FOR THE PREPARATION
OF GRADUATED MORTALITY RATES
AND A STANDARD LIFE TABLE

THE GRADUATION METHOD ADOPTED

1.   The method of graduation adopted is the 21 term formula developed by the late John Spencer F.I.A.

2.   This formula was used in the course of preparing the Singapore 1977/83 (Ordinary) Table and is considered suitable for the present graduations, for the following reasons -

(a) The volume of data available from the tabulations of Ordinary insurances in force in Singapore during 1983 through to 1988 is sufficient to permit the application of graduation procedures involving the use of data for individual ages, over the most important age range of 20 to 60 or 65 years.

(b) The experienced rates of mortality have been found to progress with satisfactory regularity over the main age range.

(c) The procedure adopted produces graduated rates of mortality which adhere closely to the original data. They cope very well with the important features of the ungraduated mortality rates. In particular, the accident lump which is evident about age 20 years and the requirement to blend the graduated rates smoothly with the rates adopted for the young and older ages where there is unadequate data.

(d) Spencer's 21 Term formula is suitable for computer operation.

SPENCER'S 21 TERM SUMMATION FORMULA

3. The rates of mortality for numerous mortality tables have been prepared using the graduation formula known as Spencer's 21 Term Summation Formula. It is considered to be one of the best summation formulae for graduation purposes.

4. The formula, in short form, is as follows –

$$U_x = \frac{[5]^2[7]}{350} ([1] + [3] + [5] - [7]) \; U^1_{\;x}$$

Where: U_x =   the graduated value at age x

[n] U^1_x =   the sum of n ungraduated values, the central value of which is U^1_x.

An expanded version of the formula is in Attachment No 1.

5. For the preparation of the graduated rates of mortality dealt with in this report, the graduation was performed in two sections, as described in the following paragraphs.

Graduated Rates of Mortality
for Ages 10 to 21 Years

6. The data which is available regarding the mortality experience by lives insured who are under 22 years of age is very limited. Data is not available for ages 0 to 8. Only very few policies issued at these ages are included in the annual returns received by COMSAL.

7. In the absence of other evidence, values of the average rates of mortality for the central ages of the age groups 9 1/2 to 13 1/2, 14 1/2 to 18 1/2 and 19 1/2 to 23 1/2 years were adopted (as described in the Report) as follows -

Pivotal Mortality Rates

Central Age	Males	Females
11 1/2	.00026	.00017
16 1/2	.00065	.00022
21 1/2	.00082	.00026

8. An interpolation based on these rates was prepared to obtain rates of mortality for male and female lives, for ages 12 to 21 years. The formulae used are shown in Attachment No. 1.

Graduated Rates of Mortality
for Ages 22 to 99 Years - Spencer's Formula

9. Examination of the volume of the data available indicated that rates of mortality for individual ages could be used for graduation purposes in the range from age 21 1/2 to about age 57 1/2.

Ages 10 1/2 to 20 1/2 Years

10. In order to obtain the greatest benefit from using Spencer's 21 Term Summation formula, it was decided to calculate rates of mortality for individual ages 10 1/2 to 20 1/2 years before applying the formula. The methods used for this task are described in Attachment 1.

(0304c)

Ages 56 1/2 to 99 1/2

11. As a result of the investigations reported in Parts 1 and 2 of this Report, rates of mortality for individual ages 56 to 99 were assumed to equal –

For Males   – 75% of A1967/70 (Ultimate)
For Females – 45% of A1967/70 (Ultimate)

12. Notional rates of mortality were determined for ages 100 to 111 years so that when incorporated in the graduation procedure, the resulting initial rate for age 99 would be equal to the adopted rate for that age.

13. Equivalent rates of mortality for ages 56 to 99 years were derived using the bases set out in paragraph 11 above. Mortality rates for half ages were then obtained by means of the interpolation formula set out in Attachment No 1.

14. As a result of these preliminary arrangements, it was possible to apply Spencer's 21 Term Summation Formula to obtain graduated rates of mortality for ages 22 1/2 through to 99 1/2, without blending problems. Graduated rates for ages 22 to 99 were then calculated using the interpolation formula described in Attachment No 1.

15. The graduations were based on the experience of policies which had been 2 or more years in force. This basis was adopted to allow for the initial selection which might be exercised by companies contributing to the data, through the medical examination made prior to issue of a policy or by means of the personal statement made by the applicant for insurance.

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THE TECHNICAL ASPECTS

Spencer's 21 Term Summation Formula

1. The general form is -

$$U_0 = (X + Y - Z)/350$$

Where -

$$X = 60 \, v^1{}_0 + 57 \, (U^1{}_{+1} + U^1{}_{-1}) + 47 \, (U^1{}_{+2} + U^1{}_{-2}) + 33 \, (U^1{}_{+3} + U^1{}_{-3})$$

$$Y = 18 \, (U^1{}_{+4} + U^1{}_{-4}) + 6 \, (U^1{}_{+5} + U^1{}_{-5}) - 2 \, (U^1{}_{+6} + U^1{}_{-6})$$

$$Z = 5(U^1{}_{+7} + U^1{}_{-7}) + 5(U^1{}_{+8} + U^1{}_{-8}) + 3(U^1{}_{+9} + U^1{}_{-9}) + (U^1{}_{+10} + U^1{}_{-10})$$

2. ### Ages 17½ to 20½ Years

    The formula used is -

    $$U_{1 + t} = U_1 + t \, \Delta U_0 + \frac{t + t^2}{2} \, {}^2U_0$$

Age	t	$\frac{t + t^2}{2}$
17½	.2	.120
18½	.4	.280
19½	.6	.480
20½	.8	.720

3. ### Ages 12½ to 15½ Years

    $$U_t = U_0 + t \, \Delta U_0 + \frac{t \, (t - 1)}{2} \, {}^2U_0$$

Age	t	$\frac{t \, (t - 1)}{2}$
12½	.2	-.080
13½	.4	-.120
14½	.6	-.120
15½	.8	-.080

1.   ## Rates of Mortality

It is assumed that rates of mortality have been derived from the data as follow -

Age Group	Applicable to age	Factor
$9\frac{1}{2}$ -	$11\frac{1}{2}$	U_0
$14\frac{1}{2}$ -	$16\frac{1}{2}$	U_1
$19\frac{1}{2}$ -	$21\frac{1}{2}$	U_2

2.   ## Ages 17 to 21 Years

The formula used is -

$$U_{1+t} = U_1 + t\Delta U_0 + \frac{t+t^2}{2}\Delta^2 U_0$$

Age	t	$\frac{t+t^2}{2}$
17	.1	.055
18	.3	.195
19	.5	.375
20	.7	.595
21	.9	.855

3. **Ages 12 to 16 Years**

The formula used is -

$$U_t = U_0 + t \Delta U_0 + \frac{t^2 - t}{2} \Delta^2 U_0$$

Age	t	$\frac{t^2 - t}{2}$
12	.1	-.045
13	.3	-.105
14	.5	-.125
15	.7	-.105
16	.9	-.045

4. **Ages 10 and 11**

Rate for Age	Formula
11	$q_{14} + 3 \times (q_{12} - q_{13})$
10	$q_{11} - (q_{12} - q_{11})/6$

Note: Value of q_{10} assumes an adjacent turning point. A negative value is replaced by the value for the next higher age.