DISABILITY INSURANCE IN CONNECTION WITH REGULAR LIFE INSURANCE CONTRACTS IN SWITZERLAND

BY

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Disability insurance in connection with regular life insurance, of which the principles are outlined in the following text, has been issued by the life insurance companies of Switzerland for many years. This kind of insurance has always been a source of profit to the companies. It may be of interest to mention that the business in force at the end of 1929 of the oldest and most important Swiss company, the *Société suisse d'Assurances générales sur la vie humaine, Zurich*, was about 25,000 policies for more than 22 millions of Swiss francs† annual income benefits in event of disability. These figures embrace 319 disability claims with disability annuities amounting to 300,000 Swiss francs (annuities for the waiver of premium benefit included). This company has issued disability insurance since 1894.

The present paper deals with five points:

1. Definition of Disability, and General Insurance Provisions.
2. Technical Bases.
3. Net Premiums.
4. Gross Premiums.
5. Reserves.

1. Definition of Disability, and General Insurance Provisions

The following general insurance provisions relating to the disability insurance in connection with regular life insurance are very liberal and meet the requirements of the insured, without burdening the companies too much.

Art. 1. Definition of disability.

Disability, according to the insurance provisions, exists if the insured becomes totally or partially unable to earn his living as

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†Swiss franc = 19.3 cents

a result of sickness or physical injury; in determining disability, his profession or occupation and social status are to be taken into consideration.

(*Note:* It is here a question not of ability to follow one's occupation, but of working capacity in general, *viz.*, capacity to perform *any* work for compensation or profit. The last sentence, which provides in due form that the profession and social standing of the insured be taken into consideration, tends to correct, to a certain degree, a too strict definition).

In case of partial disability, the total disability income benefits will be reduced according to the degree of working capacity existing.

A reduced working capacity of less than 25% of the full working capacity however does not entitle to any claim on the benefits granted in event of disability.

Disability not positively traceable to sickness or physical injury does not entitle the insured to any claim on the benefits granted in event of disability.

Art. 2. Benefits.

The benefits granted in event of disability consist of the waiver of premiums and—in case an annuity has been simultaneously insured—the payment of this annuity. The annuity as well as the premium is payable yearly, half-yearly or quarterly.

Art. 3. Beginning of the benefits.

The benefits granted in event of disability begin:

(a) at the beginning of the insurance year following the occurrence of the disability, in case of probable permanent disability;

(b) at the beginning of the second insurance year, following the occurrence of the disability, in case of probable temporary disability.

Art. 4. Proof of claim.

The person claiming the benefits granted in event of disability has to furnish to the Society:

(a) a description of the sickness or the physical injury which caused the disability, and of its origin;

(b) a detailed report of the physician or the physicians

treating or having treated the insured, stating the cause, nature, development, duration and consequences of the sickness or physical injury;

(c) proofs showing that the insured is really unable to work, or stating the degree of his reduced working capacity.

The Society can demand that the proofs and certificates be issued on its own forms and with an attested signature. Furthermore the Society is entitled to ask for supplementary information and proofs, to make inquiries at its own expense and to subject the insured to suitable medical examination by physicians appointed by the Society. The insured is compelled to supply on request full and true information to the Society or its representatives.

Art. 5. Establishment of the claim.

On the basis of the information obtained, the Society notifies the insured by registered letter, within one month after receipt of all the proofs mentioned in Art. 4, whether the claim is allowed or disallowed; and if allowed, the recognized extent and date of occurrence of such disability. If the parties do not agree, the case must be referred to the proper court.

Art. 6. Continued payment of premiums. Refunds.

The payment of the premiums has to continue until the final establishment of the claim, otherwise there is a reduction to paid-up insurance. Should the case later on be decided against the Society, the benefits withheld in the meantime are refunded with 4% interest, according to the extent of disability.

Art. 7. Alteration or suppression of the benefits.

If the degree of disability alters or if the insured regains his full working capacity, the future benefits payable by the Society have to be newly determined. Articles 3 to 5 have to be adapted analogically.

Art. 8. Termination of disability coverage.

Disability benefits terminate:

(a) if the life insurance contract is terminated;

(b) if there is misrepresentation or intentional concealment on submitting proof of claim or in connection with recovery from disability;

(c) if the insured participates in a war. The Society can reinstate the coverage for future disability after termination of the war. Reinstatement is based on a medical certificate furnished by the insured;

(d) if the disability is caused by attempted suicide or intentional self-injury, unless it is proved that such act was committed when the insured was mentally irresponsible.

Art. 9. Suspension of disability coverage.

Disability benefits are suspended:

(a) during absence from Europe;

(b) as long as the demands of the Society (Art. 4-7) are not complied with, unless such omission was neither intentional nor gravely careless.

Art. 10. Reduction and surrender.

If an annuity is insured, it is reduced proportionally to the sum insured in case the life insurance is reduced. Aside from this possibility the disability insurance can not be reduced or separately surrendered.

2. Technical Bases

It is not the intention of the present paper to give a mathematical theory about disability insurance. For this purpose please refer to the two works:

E. Hamza, Note sur la théorie mathématique de l'assurance contre le risque d'invalidité d'origine morbide, sénile ou accidentelle.—Documents du Troisième Congrès international d'Actuaires, Paris 1900, page 154.

G. Schaertlin, Zur mathematischen Theorie der Invaliditätsversicherung.—Premier Bulletin de l'Association des Actuaires suisses, 1906, page 45.—(The second work, published separately, has been translated into French.)

Supposing that the annual probability of death is the same for active and disabled lives (this assumption is of course not quite correct, but helps to simplify considerably the technical calculations) we must know:

(a) the rate at which the active life becomes disabled in the course of the next year,

(b) the annual rate of mortality for any person of the group, be it an active or disabled life.

The annual probabilities adopted for the special case of the present paper are:

(a) Probability that an active life aged x will become disabled within the next year:

$$i_x = i_{15} \cdot \zeta^{x-15}$$

where $i_{15} = 0.000125$ and $\zeta = \sqrt[5]{2}$.

This law starts from the supposition that the probability of becoming disabled doubles during each five year interval between ages 15 and 80. This assumption has already been admitted by Behm (Thesis of Mr. Louis Weber: Etudes sur les tables de mortalité d' invalides et sur les tables d'invalidité, au point de vue des calculs d'assurance—Bulletin de l'Institut des Actuaires français, 1897, page 186.)

Below is shown the experience of the "Société suisse d'Assurances générales sur la vie humaine" for the two years 1928 and 1929:

Age	Number of Persons Exposed to Risk	Expected Number Becoming Disabled	Actual Number Becoming Disabled	Difference
15½–19½	347	0	0	0
20½–24½	2,272	0.8	2	−1.2
25½–29½	5,087	3.7	6.15	−2.45
30½–34½	5,995	8.5	5.45	3.05
35½–39½	5,445	15.5	10.21	5.29
40½–44½	4,254	24.4	12.18	12.22
45½–49½	3,358	38.2	17.15	21.05
50½–54½	2,467	56.0	20.4	35.6
55½–59½	1,339	59.7	30.8	28.9
60½–64½	613	53.4	30.4	23.0
	31,177	260.2	134.74	125.46

Since the actual disability rate is about 48.2% lower than the expected, the adopted probabilities seem to have been chosen very conservatively.

(The Swiss Office of Superintendence in Bern intends to prescribe minimal technical bases for group insurance. The minimal probabilities of disability are just the same as provided in the present paper, at least for men. For women we have

$$i_y = k \cdot i_x$$

where $k = 4 - 0.05\ (x - 15)$

From the age of 75 the probabilities for men and women are the same.)

(b) The annual probabilities of death among active and disabled lives have been supposed to be the same as stated in table A. F. (Table de mortalité des assurés français).

Technical rate of interest = 4¼% per annum.*

Establishment of the Mortality and Disability table:

I. Age x

II. Probability of death within the next year q_x

III. Probability of disability within the next year i_x

IV. Probability of disability within the next year and of death in the same year $q_x^{ai} = \frac{1}{2}\, i_x \cdot q_x$

V. Probability of active life at the end of the year $p_x^{aa} = 1 - q_x - i_x + q_x^{ai}$

VI. Number of active lives l_x^{aa}

VII. $D_x^{aa} = l_x^{aa} \cdot v^x$

VIII. $N_x^{aa} - N_{66}^{aa} = \sum_{k=0}^{65-x} D_{x+k}^{aa}$

*Interest at 3½% is employed in office practice, but 4¼% is here assumed for illustrative purposes.

I. x	II. q_x	III. i_x	IV. q_x^{ai}	V. p_x^{aa}	VI. $^{aa}l_x$	VII. $^{aa}D_x$	VIII. $^{aa}N_x - {}^{aa}N_{66}$
15	0.00515	0.00012	0.00000	0.99473	849446	454983	8375058
16	0.00565	0.00014	0.00000	0.99421	844969	434134	7920075
17	0.00610	0.00016	0.00000	0.99374	840077	414024	7485941
18	0.00648	0.00019	0.00000	0.99333	834818	394660	7071917
19	0.00675	0.00022	0.00000	0.99303	829250	376045	6677257
20	0.00690	0.00025	0.00000	0.99285	823470	358201	6301212
21	0.00692	0.00029	0.00000	0.99279	817582	341141	5943011
22	0.00681	0.00033	0.00000	0.99286	811687	324874	5601870
23	0.00662	0.00038	0.00000	0.99300	805892	309405	5276996
24	0.00641	0.00044	0.00000	0.99315	800251	294714	4967591
25	0.00628	0.00050	0.00000	0.99322	794769	280763	4672877
26	0.00640	0.00057	0.00000	0.99303	789380	267491	4392114
27	0.00653	0.00065	0.00000	0.99282	783878	254797	4124623
28	0.00667	0.00075	0.00000	0.99258	778250	242655	3869826
29	0.00682	0.00087	0.00000	0.99231	772475	231035	3627171
30	0.00698	0.00100	0.00000	0.99202	766535	219913	3396136
31	0.00717	0.00115	0.00000	0.99168	760418	209264	3176223
32	0.00736	0.00132	0.00000	0.99132	754091	199063	2966959
33	0.00758	0.00152	0.00001	0.99091	747545	189290	2767896
34	0.00781	0.00174	0.00001	0.99046	740750	179923	2578606
35	0.00807	0.00200	0.00001	0.98994	733683	170941	2398683
36	0.00835	0.00230	0.00001	0.98936	726302	162323	2227742
37	0.00866	0.00264	0.00001	0.98871	718574	154048	2065419
38	0.00899	0.00303	0.00001	0.98799	710461	146100	1911371
39	0.00936	0.00348	0.00002	0.98718	701928	138461	1765271
40	0.00975	0.00400	0.00002	0.98627	692929	131113	1626810
41	0.01019	0.00459	0.00002	0.98524	683415	124041	1495697
42	0.01066	0.00528	0.00003	0.98409	673328	117228	1371656
43	0.01118	0.00606	0.00003	0.98279	662615	110660	1254428
44	0.01174	0.00696	0.00004	0.98134	651211	104322	1143768
45	0.01236	0.00800	0.00005	0.97969	639059	98201.5	1039446.2
46	0.01303	0.00919	0.00006	0.97784	626080	92285.0	941244.7
47	0.01376	0.01055	0.00007	0.97576	612206	86561.1	848959.7
48	0.01456	0.01213	0.00009	0.97340	597366	81019.5	762398.6
49	0.01543	0.01393	0.00011	0.97075	581476	75649.3	681379.1
50	0.01638	0.01600	0.00013	0.96775	564468	70442.7	605729.8
51	0.01742	0.01838	0.00016	0.96436	546264	65391.8	535287.1
52	0.01855	0.02111	0.00020	0.96054	526795	60490.4	469895.3
53	0.01978	0.02425	0.00024	0.95621	506008	55734.7	409404.9
54	0.02112	0.02786	0.00029	0.95131	483850	51121.5	353670.2
55	0.02259	0.03200	0.00036	0.94577	460291	46649.7	302548.7
56	0.02420	0.03676	0.00044	0.93948	435329	42321.2	255899.0
57	0.02592	0.04222	0.00055	0.93241	408983	38139.0	213577.8
58	0.02782	0.04850	0.00067	0.92435	381340	34111.5	175438.8
59	0.02988	0.05572	0.00083	0.91523	352492	30245.6	141327.3
60	0.03213	0.06400	0.00103	0.90490	322611	26553.1	111081.7
61	0.03458	0.07352	0.00127	0.89317	291931	23048.4	84528.6
62	0.03725	0.08445	0.00157	0.87987	260744	19746.9	61480.2
63	0.04015	0.09701	0.00195	0.86479	229421	16666.4	41733.3
64	0.04331	0.11143	0.00241	0.84767	198401	13825.3	25066.9
65	0.04674	0.12800	0.00299	0.82825	168179	11241.6	11241.6

It is desirable not to provide disability insurance in connection with regular life insurance contracts for ages older than 65, *viz.*, not to combine it with Endowment or Children's Educational Endowment policies with older terminal ages than 65 years or with Limited Payment life policies for which the premiums must be paid beyond the age of 65. It is also desirable to limit the payments of the disability benefits to the normal maturity date.

3. Net Premiums

If $\mathrm{a}^{aa}_{x:\overline{n}|}$ represents the value of a temporary annuity due on an active life payable in advance during activity of n years, we have

$$\mathrm{a}^{aa}_{x:\overline{n}|} = \frac{N^{aa}_x - N^{aa}_{x+n}}{D^{aa}_x}$$

If $\mathrm{a}^{ai}_{x:\overline{n}|}$ represents the value of a temporary disability annuity payable from the beginning of working incapacity, but not in any event after age $x + n$, this value is given in the following formula, under the given supposition of probability of death for active and disabled lives:

$$\mathrm{a}^{ai}_{x:\overline{n}|} = \mathrm{a}_{x:\overline{n}|} - \mathrm{a}^{aa}_{x:\overline{n}|}$$

If π_x represents the gross premium of Endowment or Children's Educational Endowment policies or of Limited Payment life policies, which must be waived in the event of disability of the insured, and $P^{ai}_{x:\overline{n}|}$ represents the net premium for the waiver of premium in event of disability, we have:

$$P^{ai}_{x:\overline{n}|} = \pi_x \left[\frac{\mathrm{a}^{ai}_{x:\overline{n}|}}{\mathrm{a}^{aa}_{x:\overline{n}|}} \right] = \pi_x \left[\frac{\mathrm{a}_{x:\overline{n}|}}{\mathrm{a}^{aa}_{x:\overline{n}|}} - 1 \right]$$

and if $P^{ar}_{x:\overline{n}|}$ represents the net premium for the disability annuity of 5% of the sum insured, payable in the event of disability, we have:

$$P^{ar}_{x:\overline{n}|} = 0.05 \left[\frac{\mathrm{a}_{x:\overline{n}|}}{\mathrm{a}^{aa}_{x:\overline{n}|}} - 1 \right].$$

According to the adopted technical bases, the following table states the net premiums for a series of Endowment policies:

I. Age x

II. Duration of policy n

III. $a_{x:\overline{n}|}$

IV. $a^{aa}_{x:\overline{n}|}$

V. $a^{ai}_{x:\overline{n}|}$

VI. Net premium for the disability benefits $\dfrac{a^{ai}_{x:\overline{n}|}}{a^{aa}_{x:\overline{n}|}}$

VII. Gross premium for Endowment policies, minimal rates, sum insured 10,000. π_x

VIII. Net premium for the waiver of premium benefit $P^{ai}_{x:\overline{n}|}$

IX. Net premium for the annuity of 500. $P^{ar}_{x:\overline{n}|}$

I. x	II. n	III. $a_{x:\overline{n}|}$	IV. $a^{aa}_{x:\overline{n}|}$	V. $a^{ai}_{x:\overline{n}|}$	VI. $\dfrac{a^{ai}_{x:\overline{n}|}}{a^{aa}_{x:\overline{n}|}}$	VII. π_x	VIII. $P^{ai}_{x:\overline{n}|}$	IX. $P^{ar}_{x:\overline{n}|}$
20	15	10.9277	10.8948	0.0329	0.00302	588	1.78	1.51
30	15	10.8448	10.7165	0.1283	0.01197	596	7.13	5.99
40	15	10.5769	10.1002	0.4767	0.04720	622	29.36	23.60
20	20	13.1178	13.0497	0.0681	0.00522	424	2.21	2.61
30	20	12.9495	12.6887	0.2608	0.02055	435	8.94	10.28
40	20	12.4728	11.5605	0.9123	0.07892	468	36.93	39.46
20	25	14.8146	14.6894	0.1252	0.00852	330	2.81	4.26
30	25	14.5304	14.0673	0.4631	0.03292	345	11.36	16.46
40	25	13.7954	12.3220	1.4734	0.11957	386	46.15	59.79
20	30	16.1132	15.9002	0.2130	0.01340	272	3.64	6.70
30	30	15.6839	14.9380	0.7459	0.04993	291	14.53	24.97

4. Gross Premiums

The following loading has been provided:

0.16 per thousand of the sum insured on every annual premium payable during the whole duration of the policy for expenses of management,

15% of each net premium for commission,

5% of each net premium in the event of disability annuity, for expenses of payment.

$\pi^{ai}_{x:\overline{n}|}$ and $\pi^{ar}_{x:\overline{n}|}$ representing the gross premiums, we have the formulae

$$\pi^{ai}_{x:\overline{n}|} = 1.15\, P^{ai}_{x:\overline{n}|} + 0.00016$$

$$\pi^{ar}_{x:\overline{n}|} = 1.20\, P^{ar}_{x:\overline{n}|} + 0.00016$$

The gross premiums of the above-mentioned combinations are:

Age x	Duration of Policies n	Gross Premiums	
		For the Waiver of Premiums	For the Annuity of 500
20	15	4	3
30	15	10	9
40	15	35	30
20	20	4	5
30	20	12	14
40	20	44	49
20	25	5	7
30	25	15	21
40	25	55	73
20	30	6	10
30	30	18	32

For the combination $x = 30$

$n = 20$, sum insured frs. 100,000, *e. g.*,

the premium for the ordinary endowment policy amounts to		frs. 4,350
the additional rate for the waiver of premiums amounts to	frs. 120	
		frs. 4,470
the additional rate for the disability income (annuity) amounts to	frs. 140	
total rate for the policy with premium waiver disability and disability income of 5% of the sum insured		frs. 4,610

5. Reserves

The extra reserve for the disability benefit is in addition to the regular reserve for the policy.

This extra reserve is calculated separately for active and disabled lives. In the event of partial disability, the reserve for such disability is also calculated: the part of the active reserve as for an active life and the remaining part as for a disabled life.

As to an active life, the extra reserve for the waiver of premium benefit ${}_tV_x^{ai}$ will be as follows:

$$ {}_tV_x^{ai} = \pi_x \cdot a^{ai}_{x+t:\overline{n-t}|} - P^{ai}_{x:\overline{n}|} \cdot a^{aa}_{x+t:\overline{n-t}|} $$

and the extra reserve for the waiver of premium benefit and disability income (annuity 5% of the sum insured) ${}_tV_x^{ar}$ will be as follows:

$$ {}_tV_x^{ar} = (\pi_x + 0.05)\, a^{ai}_{x+t:\overline{n-t}|} - (P^{ai}_{x:\overline{n}|} + P^{ar}_{x:\overline{n}|}) \cdot a^{aa}_{x+t:\overline{n-t}|} $$

For an endowment policy $x = 30$, $n = 20$,

sum insured frs. 100,000, annual premium of the principal policy frs. 4,350, the extra reserve according to the above-stated formulae will be as follows:

Number of Years the Policy has been in Force t	Reserves	
	For the Waiver of Premium Benefit	For the Annuity Benefit, 5000
1	39.20	45.
3	104.40	120.
6	161.40	185.50
9	152.70	175.50
12	73.10	84.
15	− 54.40	− 62.50
18	−122.20	−140.50
19	− 89.60	−103.

These reserves will be negative from a certain age—not in general but for certain combinations. This is the case when the present value of future net disability premiums is greater than the present value of the disability benefit. The cancellation of such policies under such conditions would involve losses to the companies, if the disability insurance were written without regular insurance. The negative reserves for the insurance against disability will always be more than compensated by the reserve for the regular insurance.

As to a disabled life, the extra reserve for the waiver of premium benefit will be as follows:

$$ {}_tV_x^{i} = \pi_x \cdot a_{x+t:\overline{n-t}|}; $$

the extra reserve for the annuity benefit of 5% of the sum insured in addition to the premium waiver benefit will be:

$$ {}_tV_x^{ir} = (\pi_x + 0.05)\, a_{x+t:\overline{n-t}|} $$

This paper makes no pretensions to having treated the subject of disability insurance exhaustively. There would remain some other important points to be discussed, especially with regard to the selection of disability risks and the precautions which it is advisable to take in regard to disability insurance covering women.