PREMIUMS AND RESERVES OF THE SWISS ACCIDENT INSURANCE INSTITUTION.

BY

JOSEPH H. WOODWARD.

Recent publications of the Swiss Accident Insurance Institution of Lucerne* furnish an exceptionally rich material for studying the technical methods followed in the administration of the compulsory industrial accident insurance law of Switzerland. The United States is indebted to European countries in a peculiar degree for the various systems of work accident insurance which have been established in the several states, and considerable has been written in this country concerning the European systems of social insurance. Some European statistics have also been available on this side of the Atlantic, but their use has been very limited—partly by reason of the lack of a more precise knowledge of European practices in the computation of premiums and reserves. The publications of the Swiss government, above referred to, are notable in that they supply a clear and unambiguous exposition of those technical methods which are of most immediate interest to underwriters and actuaries. The present Swiss law may be taken to represent the latest and possibly most enlightened European thought upon the subject of compensation for industrial accidents and together with the technical methods developed or followed by the Swiss actuaries constitutes a system which may fairly be considered to reflect the accumulated wisdom of thirty years' experience in furnishing work-accident indemnity. As such it deserves the closest attention of American students.

Before proceeding to a description of the Swiss actuarial methods, it seems desirable to briefly outline the essential provisions of the Swiss accident insurance law and the status of work accident in-

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Prämientarif für die obligatorische Versicherung der Betriebsunfälle, 1916.

Die Elemente zur Berechnung der Renten-Deckungskapitalien.

surance in the Federation. The present law was enacted June 13, 1911, and accepted by referendum February 4, 1912.* Previous to the becoming effective of this law, industrial accidents in Switzerland had been compensated under what was known as the Law of Civil Responsibility, under which the employer in most industries was liable to his employee for the cost of medical and surgical attendance, for full loss of the wages from the date of injury in cases of temporary disability, for indemnities based on loss of earning power but with a maximum of six thousand francs in cases of permanent disability, and for specified indemnities to dependents in case of death. Insurance under the Law of Civil Responsibility was voluntary and was carried in stock companies, mutual companies, and mutual trade associations.

The law of 1911 provides for compulsory insurance in a national fund, and is hence known as the Insurance Law. It compensates occupational accidents and occupational diseases due to the action of injurious substances used in the establishment. Manufacturing, mining, contracting and transportation industries are covered.

The benefits provided in the law are

1. Death.
   - *a.* Funeral benefit, 40 francs.
   - *b.* To the widow or dependent widower 30 per cent. of the wages until death or remarriage, with three years' compensation in a lump sum at remarriage of the widow.
   - *c.* To each child 15 per cent. of the wages until age sixteen, or 25 per cent. if orphaned of both parents.
   - *d.* Parents and grandparents and brothers and sisters under age sixteen are entitled to a total annuity of 20 per cent., distributed pro rata.

   Limitation. The total death benefit is subject to the limitation that compensation shall not exceed 60 per cent. of the wages.
2. Disability.
   - *a.* Medical attendance, medicine, surgical apparatus, and necessary traveling expenses.
   - *b.* For temporary total disability 80 per cent. of the wages during disability, commencing with the third day after the

* For an analysis of the principal features of this law see Bulletin No. 203, U. S. Bureau of Labor Statistics, "Workmen's Compensation Laws of the United States and Foreign Countries."

accident. The maximum daily wage considered is 14 francs.

c. For permanent disability 70 per cent. of the wages where the disability is total, with a proportionate percentage where disability is partial. The maximum annual earnings considered are 4000 francs.

Revision of Compensation.—Awards of compensation are subject to revision at any time within three years from the date of accident, provided the degree of disability undergoes any essential change. Later revision may be had only at the expiration of the sixth and ninth years.

Basis of Premium Rates.

The first problem to be considered by the Accident Insurance Institution was how the value of the benefits provided by the Insurance Law would compare with the value of the benefits provided by the Law of Civil Responsibility. Under the regime of civil responsibility the measure of damages corresponded to the entire wages paid from the first day. Under the Insurance Law only 80 per cent. of the wages is granted, and this from the third day after the accident. At this point it was evident that the new law would be much less costly than the old. On the other hand, the abolition of the maximum of indemnity and the consequent replacement of lump sum payments by annuities could not fail to materially increase the cost of insurance in respect of permanent disabilities. For the purposes of rate-making the Institution had at its disposal the statistical experience and rate manuals of European countries in which various forms of social insurance had existed for several decades. In addition, comprehensive statistical data for certain branches of industry were obtainable from the various Swiss trade associations and insurance offices.

Of great interest to those who have followed the recent controversies in this country as to the validity of using a constant differential for all industries in passing from one scale of benefits to another is the following discussion of this question by the Swiss actuaries:

"One might at first glance think that the premium rates of the National Institution might be established by investigating, in respect of the totality of enterprises subject to the Insurance Law,

the relationship between the aggregate cost of such benefits under the Insurance Law and the aggregate cost under the Law of Civil Responsibility. To find the charges under the new law it would then be only necessary to calculate them for each classification by modifying the existing rates by the quotient thus determined. *Such a mode of procedure would lead to the grossest errors,** for the benefits provided by the Insurance Law would not influence in the same degree the rates for the different insured industries, but would have a different effect for each kind of industry. Hence it is not possible to determine the premiums by applying a single coefficient to the premiums under the Law of Civil Responsibility."

After showing that the rates for compulsory accident insurance in other countries could not be directly used in Switzerland by reason of the difference in the benefits, the report discusses the transformation of the existing Swiss material and available foreign material so as to make it applicable to the new conditions. The similarity of this problem to many which are of vital importance in the technical development of workmen's compensation insurance in the United States is striking.

The first step was to divide the premium unit into four component parts, which are treated separately in determining the differential or "coefficient of transformation" to be used in passing from the rates under the Law of Civil Responsibility to the rates under the Insurance Law. These four components, with the percentage of the aggregate cost under the Law of Civil Responsibility which they severally represent, are as follows:

	Per Cent.
1. Medical	20
2. Temporary disability	45
3. Permanent disability	25
4. Death	10
Total	100

Medical.

Under the head of medical, the report discusses, with examples, the variation in the percentages of total cost among various industries. It was considered that as respects medical and temporary disability the existing Swiss data were sufficient to give satisfactory results without resort to statistics of other countries. It is pointed out that where serious accidents predominate, medical constitutes a proportionately small part of the total cost and vice

* Italics not in original.

versa; for example, in woodworking industries it fell to 16 per cent. while in glass works it amounted to 33 per cent. The general conclusion reached was that the cost of medical under the new law might be taken as exactly equivalent to the cost under the old law.

Temporary Disability.

As respects temporary disability, wide variations were shown between the proportionate cost in different industries. In electrical power plants, under the old law, it comprised 39 per cent. of the total cost, while in glass works it amounted to 65 per cent. of the total cost. A discussion of the reduction in the proportionate cost of temporary disability to be expected under the Insurance Law led to the conclusion that the introduction of a waiting period of three days would result in an average reduction of 21 per cent. in the cost of the temporary benefit. Further, the reduction from 100 per cent. to 80 per cent. in the indemnity would, it was estimated, involve a further diminution of 16 per cent. in the cost of temporary disability. Finally, the elimination of indemnity for the first three days and the reduction of the benefit to 80 per cent. of the wages would have the effect of diminishing not merely the number of accidents to be compensated but also the average duration of disability except in those industries where the workers receive through private insurance or in some other manner indemnities supplementary to those which the Insurance Law provides. Taking all of these factors into account, it was felt that under the new law indemnity for temporary disability would not exceed 60 per cent. of the cost under the old law. Consequently, in respect of temporary disability a differential or coefficient of transformation of 0.6 was established.

Permanent Disability.

As to invalidity or permanent disability (including dismemberment) a wide experience as a basis of calculation was recognized as necessary and the material furnished by observations in Switzerland was supplemented by foreign data. Austrian and Norwegian statistics relating to accidents of a greater duration than four weeks were referred to, and the tariffs of the German trade associations, which indemnify for accidents whose duration exceeds 13 weeks, were also utilized. As respects the cost of permanent in-

juries or invalidity, it was pointed out that in those branches of industry where relatively few machine tools are employed the cost is below the average. For example, under the old law, in watch manufacturing it was 16 per cent.; quarries, 17 per cent.; construction work, 19 per cent.; while it rose to 32 per cent. in machine shops and to 44 per cent. in woodworking establishments using machinery. Under the new law these charges were to be notably augmented. It was observed that the cost of such benefits appeared to average not less than five times as high in those countries where indemnity was paid in the form of an annuity as where (as under the previous Swiss law) a lump sum benefit was provided and a maximum of indemnity imposed. It appeared that the maximum indemnity of 6,000 francs provided by the Law of Civil Responsibility rendered useless in most cases any exact determination of the loss of earning power, since the legal maximum was often reached when the impairment of earning power amounted to only 12 per cent. Above this limit the determination of the degree of impairment had no practical interest, and consequently, under previously existing conditions, the more serious dismemberments and permanent injuries were not accompanied by any precise determination of the loss of earning capacity. On the other hand, there were certain factors tending to reduce the cost of permanent disability under the Insurance Law as follows:

1. The fixing of the compensation at 70 per cent. of the wage loss.

2. The effect of the legal provision for a periodical revision of the compensation.

3. The elimination of that indemnity which, as a matter of fact, had previously been paid in cases not really involving any decrease in earning capacity.

The final conclusion reached was that for permanent disability the Insurance Institution would be compelled to pay an amount equivalent to 2.5 times the cost of the benefit under the regime of civil responsibility. Hence the coefficient of transformation in the case of permanent disability was fixed at 2.5.

Death.

With respect to fatal cases it is pointed out that this component of the benefit presents the greatest differences of any as between

one branch of industry and another.* While for some branches of industry it was almost negligible, it amounted to 18 per cent. of the total cost in quarries and to 26 per cent. in electrical power plants. A study of the average present value of the death benefit payable led to the conclusion that under the Insurance Law it would on the average amount to three and one half times the annual wages.† Comparing the cost of death benefits with that under the Law of Civil Responsibility, it was found that this component of the premiums would be about doubled under the new law. Hence, for the death benefit a coefficient of transformation of 2.0 was adopted.

A summary of the subdivision of the relative cost of the two laws is as follows:

	Coefficient of Transformation.	Law of Civil Responsibility.	Insurance Law.
1. Medical	1.0	20	20
2. Temporary disability	0.6	45	27
3. Permanent disability	2.5	25	62.5
4. Death	2.0	10	20
		100	129.5

The average differential or coefficient of transformation to be used in passing from the old law to the new law was thus ascertained to be 1.295.

A table was then prepared showing for each classification in the rate manual the proportionate cost of each of the four component elements of the benefit under both the Law of Civil Responsibility and the Insurance Law. In this way the relation of the total cost for each separate classification was ascertained, so that the rates under the new law were computed by using a separate coefficient of transformation for each classification in the manual.‡

* The prime importance of this fact appears to have only recently received adequate recognition in the United States.

† In New York State the death benefit amounts to nearly four and one half times the annual wages, the difference being in part accounted for by the higher maximum compensation payable, the higher age up to which compensation to children is payable, and the lower rates of mortality and interest assumed in computing present values.

‡ This method of computing pure premiums is in marked contrast to the cruder methods up to the present employed in the United States. See, however, the suggestion by Mr. H. E. Ryan on pp. 188–189 of Vol. III of the *Proceedings*.

Expense Loading.

Having thus determined a scale of pure premiums to be charged under the new law, the actuaries of the Insurance Institution proceeded to a consideration of the loading necessary to provide for expenses. It was considered that expenses were fairly divisible into two parts, (1) those proportional to the cost of accidents, and (2) those proportional to the insured payroll. It was decided that for the first calculation of premiums the administration expenses should be equally divided, one half in proportion to the cost of the benefits and one half in proportion to the payroll. From a consideration of the experience of the private companies it was estimated that the administration expenses would amount to 16 per cent. of the pure premiums. Under the law, the government contributes one half of these expenses, and there thus remained 8 per cent. to be provided for in the premiums. To this was added 4 per cent. to provide a factor of safety. Hence the loading to be imposed upon the pure premiums was 12 per cent. Of this, one half or 6 per cent. was to be assessed in proportion of the payroll, and for this purpose the average pure premium was required to be known. It was estimated that the average pure premium would be 3.5 per cent. of the payroll. Six per cent. of the premium expressed as a percentage of the payroll was, therefore, $.06 \times 3.5$ or 0.21 per cent., which was taken as 0.2 per cent. Hence, denoting by e the pure premium per thousand francs wages the formula for the gross premium became

$$p = e + 0.06e + 2^*$$

In the final determination of the rates the results of the foregoing calculations were examined as to their consistency between various classifications of industry, and for classifications where the exposure was small, rates were interpolated with the help of the Austrian, Norwegian and Dutch tariffs.

* Expressed in notation more usual in the United States and in terms of $100 wages instead of 1,000 francs the formula is

$$P = p(1 + 0.06) + .20,$$

that is to say, the gross premium equals the pure premium loaded by 6 per cent. of itself plus 20 cents per $100 payroll. According to American notions, the proportionate part of the loading assessed as a percentage of the payroll is very high.

Rating of Risks.

The rate manual or tariff of premiums, as it is called, issued by the Swiss Insurance Institution in 1916 is a document of extraordinary interest and doubtless reflects the most recent European methods of classifying and rating workmen's compensation risks. The manual is divided into three parts. First comes a statement of the general principles to be followed in assigning enterprises to the proper classification and also to the proper degree of risk within a classification (the latter process being the correlative of the schedule and experience rating of risks practised in the United States). The second part consists of the manual proper, the industries subject to the operation of the law being arranged in upwards of fifty industry groups, comprising in all about 350 classifications. It is noteworthy that rates are quoted in such a way that the relative hazards of the various classifications within each group are evident at a glance.* Seven different rates are provided for each classification, each rate representing what is described as a "degree of risk" within the classification. A risk, after being classified, is assigned to one of these degrees of risk by following principles somewhat analogous to those upon which schedule and experience rating in the United States is based. A curious but natural feature of the tariff is the relative multiplication and diversity of classifications in those industries for which Switzerland is noted —for example, the watch-making and jewelry industries and the manufacture of laces, embroideries and the finer textiles.

The third part of the manual consists of a very complete and carefully compiled index, which permits instant reference to any desired classification.

Division of Payroll.

The perplexing questions surrounding the determination of proper principles for the division of payroll are not peculiar to the United States, and elaborate rules covering this subject are provided in the manual, although differing somewhat from those with which we are in this country familiar. For the purpose of assigning risks to their proper classification, enterprises are divided into two classes: (*a*) simple enterprises, and (*b*) complex enterprises.

* This contrasts with the American method where the classifications are arranged alphabetically and the natural relationships between them are consequently lost sight of.

Simple enterprises are considered to be those comprising but a single branch of industry or cases where several branches of industry are so organically related that they constitute a single industry. Where accessory branches of an enterprise are lacking or do not have a normal development, this is taken account of in assigning the risk to a particular degree of risk within the classification.

Complex enterprises are considered to be those made up of component parts which are not necessarily or generally found in combination—for example, saw mills and carpenter shops. Such enterprises are rated on the basis of a division of payroll for the separate branches, except that where the locations are the same, the employees interchangeable, or the payroll not separable, the enterprise is treated as a simple enterprise and rated under the governing classification. Branches of an enterprise which are not incidental to the principal business may be separately classified, however many workmen are employed; on the other hand, those which are incidental may be separated only when they employ more than ten workmen. Box and crate manufacturing and container manufacturing generally is considered as not incidental to the general enterprise and hence to be rated separately. Auxiliary personnel, such as those connected with the power plant, with industrial management, with carting, repairing, warehousing, shipping, etc.—all, in fact, which are not exclusively attached to any one branch—are rated under the classification producing the largest proportion of the premium, which is considered to be the governing classification. Small and large enterprises are distinguished at many points throughout the manual, a small enterprise being one employing ten or fewer workmen. For purposes of determining the number of employees, the number of working years in the enterprise is computed by dividing the number of days of actual work during one year by 300.

Degrees of Risk.

A feature of predominant interest in the rate tariff is the plan for taking account of varying degrees of risk within a classification. In the explanation of the rates it is pointed out that this factor is many times of vastly more importance in reaching an equitable rating than is the determination of the classification itself. It is the apparent intent to adjust the premium for the individual risk

in substantially the manner in which premiums in the United States are adjusted through the application of schedule and experience rating. The explanation of the practices of the Institution in administering this feature of the rating is, unfortunately, limited and inadequate. We are given a general outline of the factors which it is intended to take into account through the assignment of enterprises to various degrees of risk, but that detailed explanation of exactly how these factors are utilized, which would be of such intense interest to us, is lacking. In general, the first consideration in determining the degree of risk is the previous accident experience for the enterprise. Where sufficient statistics as to indemnities paid under the Law of Civil Responsibility existed it was possible to take account of the indication of such statistics. It is emphasized that for large enterprises first importance should be given to the statistical history. Other factors considered in the fixing of the degree of risk are as follows:

(*a*) machinery, apparatus and tools employed;
(*b*) general measures for the prevention of accidents and general organization of the enterprise, for example, the use of machines separately started by electric motors, the character of the work place, a free space about the machines, order and neatness, lighting, ventilation, buildings;
(*c*) factory and working rules, prohibition of the use of alcohol, discipline;
(*d*) special measures for the prevention of accidents—for example, safety guards for polishing wheels, safety clothing, rules regarding scaffolding;
(*e*) operation of machines by specially qualified workmen;
(*f*) employment of machines during the full working day or only during a part thereof;
(*g*) piece work;
(*h*) the operation of the enterprise during the entire year or only seasonally;
(*i*) the nationality of the employees;
(*k*) the proportions between the payroll in different branches of the enterprise presenting different hazards;
(*l*) the proportionate number of apprentices and young workmen in relation to the total number of workers;
(*m*) proportionate number of female workers as related to the total workers;

(*n*) proportionate amount of the wages of office employees as related to the total wages;
(*o*) medical service and first aid;
(*p*) supplementary insurance—for example, of the part of the wages not insured by the Insurance Institution;
(*q*) statistical results of accident insurance or of civil liability insurance before the going into effect of compulsory insurance.

Provision is made for the ultimate use of ten differing degrees of risk within a given classification. At present, however, only seven of these are incorporated in the tariff, to which are assigned the Roman numerals I, III, IV, V, VI, VII, X. The degree of risk V is applicable to an enterprise normally composed and representing the average or standard risk.

An examination of the rates shows a striking divergence for the various degrees of risk within a classification. The highest-rated degree of risk oftentimes carries a rate three times as great as that of the lowest-rated degree of risk. It would appear that a free application of this system must produce a general diversity of rates within a given classification far more considerable than the diversities produced by the application of schedule and experience rating in this country.

Comparison of Rates.

In order to permit a rough comparison for a few of the more important classifications between the Swiss tariff and the present premium rates* in force in New York State the following table has been compiled, showing in column (1) the wording of the New York manual classification, in column (2) the nearest corresponding Swiss classification, in column (3) the New York pure premium, in column (4) the Swiss pure premium, and in column (5) the ratio per cent. of column (4) to column (3). Industrial conditions being assumed to be the same in both countries, and pure premiums being assumed to reflect the true hazard in each case, it is evident that column (5) should show the differential between the New York and Swiss laws for the classification in question. It should be borne in mind in this connection that the actuarial value of the benefits of the Swiss law is probably at least 40 per cent. greater than the actuarial value of the benefits of the New York law. The figures in column (3) are taken as 61 per cent. of the

* Effective March 31, 1917.

COMPARISON OF RATES.

(1). New York Classification.	(2). Swiss Classification.	(3). New York Pure Premium.	(4). Swiss Pure Premium.	(5). Percentage of (4) to (3)
1. Cement mfg. — no quarrying	Mfg. of cement, lime, gypsum and mortar, *without* extraction of raw materials	3.36	4.15	124
2. Cement mfg. — including quarrying	Mfg. of cement, lime, gypsum and mortar, *with* extraction of raw materials	5.58	5.47	98
3. Jewelry mfg.	Jewelry work, mfg. of precious stones for clock and watch making, diamond cutting	.41	.38	93
4. Plumbing — including house connections — must include shop payroll	Installation of gas, water, electric and heating apparatus—no mfg. and no work outside building	1.13	3.21	284
5. Machine shops — with foundry	Foundries with machine shops and the mfg. of machine parts	1.48	3.58	242
6. Foundries — iron	Foundries for commercial castings, stoves, heating apparatus, furnaces, fittings, mechanical and structural castings	1.48	3.58	242
7. Rolling mills — operated in connection with steel works rolling products of every description, including rod mill	Rolling mills	2.92	4.53	155
8. Hardware mfg. n. o. c.	Hardware mfg.	.88	2.64	300
9. Motorcycle and motorcycle parts mfg. — including the assembling of motorcycles	Mfg. of automobiles, motorcycles and bicycles	1.03	3.02	293
10. Sewing machine mfg.	Mfg. of sewing machines, typewriters, calculating machines, cash registers, water and gas meters	.68	2.26	334
11. Clock mfg.	Clock mfg.	.85	2.26	266
12. Watch mfg.	Mfg. of watches by machinery —no mfg. of precious stones or watch crystals	.26	.38	146
13. Saw mills	Saw mills (more than 10 workmen) without accessory industries	5.82	6.42	110
14. Wool spinning and weaving — excluding shoddy mfg.	Spinning of combed wool	.68	1.13	166
15. Bakeries	Bakeries, including confectionery mfg.	.98	2.26	231
16. Quarries — with or without blasting — n. o. c.	Granite quarries	5.08	7.36	145
17. Wrecking (not marine) no blasting	Demolition operations	13.35	14.91	112

COMPARISON OF RATES (*continued*).

(1). New York Classification.	(2). Swiss Classification.	(3). New York Pure Premium.	(4). Swiss Pure Premium.	(5). Percentage of (4) to (3).
18. Masonry, n. o. c. (no blasting)	Masonry and concrete work *without* extraction of raw materials	5.08	4.53	89
19. Chauffeurs and chauffeurs' helpers—commercial—n. o. c.	Transportation of persons and merchandise by automobile.	1.08	4.53	419
20. Clerical office employees n. o. c..	Technical and commercial staff of large enterprises (more than 10 employees) not including shop work or outside duties	.06	.09	156

gross rates quoted in the New York manual. The figures in column (4) were computed by deducting 2 from the rate quoted in the Swiss tariff, dividing by 1.06, and expressing the result per 100 units of payroll.

RESERVES.

The Swiss Accident Insurance Institution is operated upon a capitalized as distinguished from an assessment basis, the premiums being intended to be adequate to cover the ultimate incurred loss arising by reason of accidents occurring during the period for which the premiums are paid. Hence it became of vital importance, for purposes of determining the liabilities of the Institution and equitably assessing the cost upon the various industries, to provide a method by which the total compensation probably payable in respect of any accident might be capitalized into one sum. Actuarially, this resolved itself into the problem of computing annuity values on the basis of assumed rates of death, remarriage and revision, and at a stipulated rate of interest. The reports wisely caution the reader to distinguish carefully between transactions involving a single annuity value and those extending to a group of annuities among which the law of large numbers will have scope for its operation. It is pointed out that in dealing with the value of a single case of permanent disability, for instance, it would be inequitable to adopt an average rate of mortality and an average probability of revision. In such event, on the contrary, the condition of health of the injured person should be examined

into and the likelihood of a change in his degree of disability specially considered, and these factors taken into account in estimating the real commuted value of the benefit.

Disability Cases.

No reference is made in the publications to the valuation of cases of *temporary* disability and it seems probable, therefore, that no tables for computing reserves on such cases have been compiled by the Institution.

With respect to cases of *permanent* disability it is to be remembered that under the Swiss law these cases are compensated for life on the basis of 70 per cent. of the wages where the disability is total, and in proportion to the adjudged degree of impairment in earning capacity where the disability is partial. Revision of the rate of compensation takes place at any time during the first three years after the accident and thereafter at the end of the sixth and ninth years. There is no schedule of specific dismemberment benefits such as is usual in the United States.

It is therefore evident that as respects permanent disabilities we are dealing with annuities whose values are dependent upon three basic factors:

(1) the rate of revision,
(2) the rate of mortality,
(3) the rate of interest.

The rates of revision adopted were those shown by an investigation into the rates of mortality and revision among disabled lives concluded in the year 1913 by the Austrian Department of the Interior and based upon the experience of the Vienna Accident Insurance Association. For the years of duration 4 to 9 inclusive the collective experience of the Austrian associations was utilized to obtain the rates of mortality and the experience of the Vienna Association to obtain the rates of revision. For the years of duration subsequent to the ninth, revision is no longer a factor in the reserves and the rates of mortality shown by the Swiss Population Table (Males) 1901–1910 were employed. Interest was in all cases taken at 4 per cent.

It was found that during the first three years of duration the reductions in annuity-payments caused by revision were so large as compared with reductions caused by the death of the annuitant

that the age of the annuitant was not a factor of importance in determining the value. Hence for this period the values were tabulated solely according to the duration or time elapsed since the accident.

From the fourth to the ninth years of duration the influence of revision continued to be of greater weight than the influence of mortality, and, accordingly, the values were tabulated not for single years of age but for groups of ages and for durations. Beginning with the tenth year revision ceases and the table assumes the usual form of an annuity table. Values are given for each year of age and the duration is disregarded.

The symbols employed by the Swiss actuaries in this connection are as follows:

x = age at date of accident,

n = year of duration,

$\bar{q}_x$ = probability of the termination of the annuity by death within one year,

$r_{x,n}$ = probability of the reduction of an annuity issued at age x by 1 through revision during the nth year of duration,

p_x = the probability that the life (x) will survive one year.

Then

$u_{x+n,n} = 1 - \bar{q}_{x+n} - r_{x+n,n}$ = the probability at the commencement of the nth year that 1 will be payable at the end of the year.

(For the first two years a table of u_m is given showing the probability at the beginning of the mth month that 1 will be payable at the end of the mth month.)

R_m = the present value of a disability annuity of 1, during the first 3 years of duration, where m denotes the quarter or year of payment.

$R_{x+n,n}$ = the present value, for the 4th to 9th years of duration, of an annuity of 1, where x is the age as of date of accident and n denotes the year of payment.

R_x = the present value, for the 10th year of duration upward, of an annuity of 1, where x = current age attained at date of valuation.

Tables of the elementary functions u_m, q_{x+n}, $u_{x+n,n}$ and p_x are given in the report.

The values of disability annuities for the first three years are given in Table A.

TABLE A.

PRESENT VALUE OF DISABILITY ANNUITIES FOR AN ANNUAL SUM OF "1" PAYABLE MONTHLY IN ADVANCE.

Disability Annuities for the First Three Years (R_m).

m = quarter or year of payment of annuity.

$R_{i.}$	$R_{ii.}$	$R_{iii.}$	$R_{iv.}$	$R_{v.}$	$R_{vi.}$	$R_{vii.}$	$R_{viii.}$	$R_{3.}$
6.5912	7.1289	8.1664	9.2369	10.103	10.867	11.650	12.353	12.929

Thus, if the award were for 1,000 francs per annum the reserve at the end of the 3d quarter would be 1,000 × 8.1664 or 8,166.4 francs. At the end of the 7th quarter it would be 1,000 × 11.650 or 11,650 francs. At the end of the 3d year it would be 1,000 × 12.929 or 12,929 francs.

The values of the disability annuities for the 4th to 9th years are given in Table B.

TABLE B.

DISABILITY ANNUITIES FROM THE 4TH TO THE 9TH YEAR OF PAYMENT.

($R_{x+n,\ n.}$)

x = original age at entry of annuitant.

n = year of payment.

$x.$	$R_{x+4,\ 4.}$	$R_{x+5,\ 5.}$	$R_{x+6,\ 6.}$	$R_{x+7,\ 7.}$	$R_{x+8,\ 8.}$	$R_{x+9,\ 9.}$	$x.$
-19	17.394	17.227	17.052	18.192	18.067	17.937	-19
20-24	16.827	16.638	16.439	17.505	17.351	17.191	20-24
25-29	16.020	15.797	15.566	16.495	16.311	16.126	25-29
30-34	14.980	14.736	14.489	15.295	15.102	14.912	30-34
35-39	13.823	13.573	13.322	13.993	13.794	13.596	35-39
40-44	12.618	12.363	12.105	12.612	12.401	12.189	40-44
45-49	11.408	11.143	10.874	11.203	10.969	10.734	45-49
50-54	10.162	9.8841	9.6002	9.7625	9.5044	9.2456	50-54
55-59	8.8478	8.5555	8.2618	8.2505	7.9876	7.7324	55-59
60-64	7.4152	7.1373	6.8660	6.7576	6.5205	6.2879	60-64
65-69	6.1180	5.8461	5.5808	5.3688	5.1279	4.9025	65-69
70 and over	4.7429	4.5077	4.2882	4.0863	3.9031	3.7393	70 and over

Thus, if the award were for 1,000 francs per annum, the original age at entry 35, the reserve at the end of the 7th year would be 1,000 × 13.993 or 13,993 francs.

Where the duration is over 10 years the values of the annuities are determined by reference to an annuity-table of the usual form giving values for each age attained at date of valuation.

Death Cases.

The valuation of the Swiss death benefit involves the determination or assumption of three basic factors, as follows:

(1) the rate of remarriage,
(2) the rate of mortality,
(3) the rate of interest.

The remarriage table adopted was that of the Dutch Royal Insurance Institution (1912), already familiar to compensation actuaries in this country. For mortality the Swiss Population Table (Male and Female) 1901–1910 was taken. The rate of interest assumed was, as in the case of disability annuities, 4 per cent.

Since under no circumstances is the death benefit under the law to exceed 60 per cent. of the wages, and since it is only necessary that there be a widow and two children in order that the limit may be reached, it follows that "limit cases" are very frequent. The liberal character of the benefits to ascendants tends to increase this effect. A strictly accurate valuation of such cases involves, as is well known, complications of probabilities which cannot be handled in practice save by the use of approximations and simplifying assumptions. The problem is to reach a solution which will be practical and at the same time sufficiently accurate.

The general method of procedure folowed by the National Institution was to divide every benefit involving the application of the 60 per cent. limit into two parts, (1) a "family annuity" continuing up to the time when, by reason of the attainment of age 16 by the "significant child," the limit is no longer operative and (2) deferred individual annuities for the remainder of the benefit. The family annuity is taken to be simply an annuity-certain for a term equal to 16 minus the age at entry of the significant child. Probabilities of mortality and remarriage are disregarded for this period.

The symbols employed are as follows:

F_z = the present value of a family annuity of 1 per annum payable monthly in advance, where
z = the age at entry of the significant child,
$W_{x,z}$ = a deferred annuity to the widow of 1 per annum, where
x = the age at entry of the widow,
$K_{x,z}$ = a deferred annuity to children or brothers and sisters of 1 per annum, where

x = the age at entry of the child entitled to the annuity,
$A_{x,\ s}$ = a deferred annuity to ascendants of 1 per annum, where
x = the age at entry of the annuitant,
W_x = an immediate annuity to the widow at the attained age x,
K_x = an immediate temporary annuity to a child at the attained age x for the term $16 - x$,
A_x = an immediate annuity to ascendants at age attained x.

Tables of values of all the foregoing functions are given in the report. As an illustration of their use we may assume the following case.

Age of widow	35
Age of children	9, 6, 3
Age of mother	65

Here the total compensation otherwise payable would be

	Per Cent.
Widow	30
Children	45
Mother	20
Total	95

It is evident that not until the attainment of age 16 by the youngest child (3) will the effect of the 60 per cent. limit cease to be operative. Hence (3) is the "significant child." The value of the benefit per 1,000 francs annual wages is therefore

$$600F_3 + 300W_{35,\ 3} + 200A_{65,\ 3} = 600 \times 9.8971 + 300 \times 5.2185 + 200 \times 1.0479 = 7{,}713.39.$$

Although the law provides that a child orphaned of both parents shall receive 25 per cent. of the wages as compensation, it appears from the form of the tables that either this benefit is held to apply only when the child is orphaned at the time of the accident and not when subsequently orphaned through the death of the surviving parent or that the probability of the increase in compensation from 15 to 25 per cent. through the death of the surviving parent is ignored in computing the present value.

Bases of Valuation.

In the selection of standards of valuation the danger of a systematic and continuous adverse change in the rates of mortality,

remarriage, or in the experience as to revision was borne in mind, and to offset the danger from this source a margin of safety was added to the net premium amounting to 4 per cent. This point has been previously referred to in discussing the computation of premiums. With regard to the rate of interest assumed the following paragraph is quoted from the report.

"Regarding the rate of interest at which the funds are to be accumulated, the matter is a difficult one to forecast at the present day. It seems evident that during the next 5–10 years considerably over 4 per cent. can be obtained, which very likely will afterward gradually fall toward this rate. In any event, the present values during the next 5 years can easily be invested at 4 per cent., which interest basis corresponds to the Dutch and Austrian assumption in the case of state accident insurance and also to that of the 'Leipzig' and 'Gotha' private insurance companies."

The use of a mortality table showing rates of mortality among the general population may perhaps be criticized as tending to produce somewhat low annuity-values, for although these annuitants are not self selected, a tendency to superior longevity seems a characteristic of annuitants of all types. The great element of uncertainty in all such calculations, however, lies in the remarriage rates assumed. Among other considerations, it seems not improbable that one of the social after effects of the war will be to reduce rates of remarriage among widows. In view of all the facts, it seems important that standards of valuation hereafter adopted for similar purposes in this country should be more stringent than those of the Swiss Accident Insurance Institution. As to *methods,* however, considered apart from specific standards, American compensation actuaries may profit greatly by a close study of this material which comes to us from a sister republic.