A PROCEDURE FOR MAKING RATES FOR WORKMEN'S COMPENSATION INSURANCE BASED ON A CONSISTENT APPLICATION OF THE THEORY OF PROBABILITIES

BY

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During the course of working with the method of ratemaking outlined in the papers by Mr. Michelbacher and the writer in PROCEEDINGS Vol. VI. Pages 201 to 284, the National Council on Workmen's Compensation Insurance encountered certain difficulties which led to the whole subject matter of ratemaking procedure being referred by the General Rating Committee to the Actuarial Committee of the Council for intensive study and for its recommendations with respect to revision of existing methods. In consequence of that reference I have given extensive consideration to the theory of workmen's compensation ratemaking and particularly the application of past experience to the development of future rates. In the course of this study I have not, as have apparently those who have written heretofore on the subject, started out with the presumption that past experience must in some way be used in order to determine future rates but have endeavored to make a fundamental analysis of the problem and determine how far and under what circumstances the use of such experience is justified. As a result of my investigation there has developed a procedure for the use of past experience that has commended itself to others as well as myself, as sound in theory and workable in practice and it would therefore seem appropriate to bring the method and the underlying reasoning to the attention of the Society.

An insurance rate, particularly the pure premium portion of it, may be looked upon as a mathematical expectation, that is, the product of a probability and the sum at stake on the trial of the event.[1] The pure premium which is loaded to make the rate is certainly the company's estimate of the future loss cost

[1] It may not be necessary to exclude the expense element in this connection but I think the conception will be simpler if we deal with pure premiums, and pure premiums for a particular benefit, for, after all, the total pure premium is but the sum of several partial pure premiums for individual benefits.

for the benefit under consideration per unit of exposure. The gross loss cost is the sum of the amounts payable when the event has occurred and in turn the pure premium is the quotient of these sums by the exposure out of which the accidents arose which occasioned these payments. If, then, we separate the losses into the product of the number of cases by the average cost per case and consider the denominator to be associated with the first factor we have the two elements of a mathematical expectation, i. e. the probability (which is the quotient of the number of cases of occurrence by the exposure covered) and the sum at stake on the issue of the event.

It is not necessary to this conception that the probability be calculated in the traditional way or even that it be correctly estimated.[2] This conception is possible under all conditions and is particularly fit if the fixing of correct rates is under consideration.

The amount at stake under an insurance contract is fixed within reasonable limits by the contract of insurance. This is so as respects life, fire, personal accident and many other forms and when the compensation law is read in conjunction with the policy it is also true of workmen's compensation insurance. Objection may here be raised that the amount of loss may vary considerably according to circumstances but it should be noted that we are considering a partial premium for a particular type of benefit and therefore the range of variation in the amount of indemnity is so relatively slight that the average may properly be substituted for the individual values.

Approaching the matter from this point of view it must become apparent that pure premium ratemaking is primarily the estimate of the underlying probabilities of occurrence of the events insured against. There may be involved a certain element of estimate of the amount of loss per case because of changes in wage levels and like conditions but even this extra element does not alter the underlying fact that a part at least, and a large part of pure premium determination really lies in estimating, consciously or unconsciously, the underlying probabilities of occurrence of the events insured against.

[2]It is of course necessary that it be correctly estimated if correct rates are to result unless perchance, there is a compensating error in the estimate of probability and of the amount at stake. Compensating errors of this kind, however, are relatively infrequent of occurrence.

In general, the experience of the past is a guide to the future if and so long as there is reason to believe the same forces which have been at work in the past will continue to work in the same way in the future or in that part of the future which it is attempted to forecast. Sometimes the period of the future is so indefinite that we can practically consider it perpetual. An example of a case of this kind is our knowledge from the experience of the past that an unsupported object will fall toward the center of the earth, the knowledge which we describe as the natural law of gravitation. Experience of this kind leads us to the belief that natural forces always act in the same way and that where, for example, successive throws of a die bring up different faces, it is not because the natural forces which have governed the way the die falls fail to act in their normal and usual way but that the actual forces operating are not precisely the same even though we are not able fully to appreciate their differences. Where all the forces acting are known both in power and trend and it is known that the forces and direction of their action cannot be changed, then we are dealing not with probability but with certainty. When, however, this is not known but it is known that so far as outward appearances go conditions remain unaltered, we are dealing with a case of probabilities and our tests in this field prove to us that in a great mass of cases we may accept the indications of the past as indications of probabilities for the future.[3]

This does not hold, however, if actual known changes have occurred in the forces at work unless the extent of these changes is known. Of course, in that case where the extent and trend can be measured, their influence may be taken into account and the indicated results may be modified in recognition of them. We then reach the conclusion that the justification for the use of past experience as regards the future must lie in the either known or assumed fact that all the important changes in the underlying forces at work can be measured both as to extent and trend.

The same limitations apply whether the experience of the past has been derived from the same jurisdiction whose future rates are under consideration or from a different jurisdiction. The

[3]For discussion of the criteria on this point see J. M. Keynes' "A Treatise on Probability" Part V "The Foundation of Statistical Inference" and Fisher "The Mathematical Theory of Probabilities" Chap. XII.

experience of the past is a guide to the future so far, but only so far, as the forces operating in the future may be expected to remain the same as those operating in the past.

It seems to me that these considerations are fundamental and that the faults and defects we have encountered in ratemaking procedure in the past have been due to the efforts to use past experience without analytic study of the changes in conditions which have taken place and the nature and extent of the modifications in the indications of that past experience which may be necessary in order to make it truly indicative for the purposes for which we wish to use it. At the outset the attempt was made to use the experience of the past and of other jurisdictions modified for changes in statutory benefits only. Such a procedure is equivalent to the assumption of a constant probability of accident per unit of wages. This system did not prove satisfactory because it fails to recognize that when the probabilities are taken to the base we are accustomed to use, namely, payroll, then they are subject to modification by reason of other changes such as for example, changes in wage levels.

On the other hand, where experience differentials and projection factors are resorted to we have known that mechanically we have made the aggregate of a bulk of experience reproduce another bulk but whether in so doing we have actually added to our data and gotten a better basis of indication for making classification rates or whether we have simply made the volume of data appear larger and perhaps in the process brought in a characteristic peculiarity or an eccentric variation of the latest year's data on which the experience modification factor or projection factor is based, we have not known.

Starting from the new point of view I have outlined, the questions which naturally first arise are "What are the forces at work producing the probability of loss of a particular type and amount with reference to our basic unit (in the case of workmen's compensation insurance, payroll)? Which of these are constant, which are variable and how do they vary?"

When the question is put in this form I think we are all prepared to agree that an exhaustive answer cannot be furnished from our present knowledge nor do I think we can devise any form of investigation which will correctly answer these questions.

We can, however, pick out certain elements we know or suspect

to be variables, find their measure in certain past periods and in the light of this investigation eliminate their apparent influence over particular periods of the past. We can then test the residue for constancy or trend. If the variation in the residue lies within reasonably narrow limits and there appears no pronounced trend then, I think, we may for practical purposes consider this residue of forces as constant for the period and after modifying the experience data for the influence of the variable forces we may put the data for several years and for several states together with confidence that in so doing we are in effect getting a larger volume of records of trials, under similar conditions, of the event we are considering and therefore coming closer to a correct estimate of the underlying probability.

In the field of workmen's compensation the statutory benefit provisions of the several compensation laws and the level of wages are notably variable factors. We can, however, measure with a considerable degree of accuracy the effect of changes in these statutory benefits and the same is true as respects wage levels. It therefore is a natural suggestion in the light of the above reasoning that we first eliminate from our experience data the effect of variation in the statutory benefit provision and in the wage levels and test the residue to determine the probable presence of a constant underlying probability. The residue when these items have been eliminated, is of course, the rate of accident by type of disability per 1000 hour-worker (or some other standard time exposure unit). It is not necessary at the outset to assume that this is constant but eliminating the other variable elements we may resort to an actual test and determine whether or not this is a constant or variable factor and if the latter we may determine whether the variation is wide or narrow and of regular or periodic type.

I have attempted to check up this theory and test out whether or not the accident frequency rate by type of injury per unit of time exposure was reasonably constant. As will appear, my tests were not entirely conclusive but seem to indicate a reasonable probability of this theory. For the purpose of the test I used Schedule Z experience for policy years 1916, 1917 and 1918 from the State of New York, for policy years 1917 and 1918 from Massachusetts and for policy years 1916 and 1917 from New Jersey, selecting a number of classifications more or less common

to the three states although some of the classifications were found in only two. I found difficulty in reducing the payrolls to number of employes but roughly approximated the conversion in the following way:—

For Massachusetts from the analysis of wages in the report of the Industrial Accident Board for the fiscal years from July 1, 1916, to June 30, 1917, and from July 1, 1917 to June 30, 1918, I worked out the average wage for each fiscal year and assumed that this corresponded to the average wage for the policy years '16 and '17 respectively. For the State of New York I took the average for the same period on the basis of monthly averages deriving the basic figures from the Labor Market Bulletin issued by the Labor Department; and for New Jersey I obtained calendar year figures from the Labor Department interpolating these figures roughly to get at the figures on a policy year basis.

Having approximated the weekly earnings I took 50 weeks as the annual earnings and divided the Schedule Z payroll by these average earnings to derive the number of full time workers in each of these exposures. I then tabulated these numbers with the number of accidents by the several types set up in Schedule Z and added together the data for all seven policy years involved. From these aggregate figures I determined the frequency of each type of accident and applied this frequency back against the exposure in each policy year and state, thus deriving an expected number of cases which might be compared with the actual number. The relation between the actual and expected was generally found to be reasonable considering the limited volume of exposure in each of the policy years. Taking any one classification in a state it was generally found that the ratio of actual to expected was not constant from year to year nor was there apparently any regular development. For one classification and one type of injury the first year might show an excess of actual over expected and the third year the reverse and so on, the changes being apparently purely accidental and due to limited exposure. I did not attempt to test out this question by the use of the criteria of Lexis or Charlier as outlined by Mr. Fisher in his Mathematical Theory of Probabilities as I do not believe the data sufficient in volume to give valid results with these tests. At least the test applied did not indicate that the hypothesis above set forth was untenable.

The application of this theory for ratemaking is relatively simple and the indicated procedure would be to obtain approximately accurate average wages for the exposure period, divide the payroll by these wages and thus reduce the exposure to terms of fulltime workers; ignoring the monetary loss, to tabulate the number of accidents by type, get the total of all the data, divide the number of cases by the exposure in fulltime workers and thus obtain an indicated probability or frequency of occurrence of the type of accidents in question, smoothing out irregularities in the results by whatever process may be available. When the probability of occurrence per employee has been ascertained it is a simple matter of arithmetic to apply the average wage to the denominator of this fraction and the cost per case to the numerator in order to obtain a pure premium in form for application to payroll exposure. Of course, the average wage and cost per case would have to be keyed to expected conditions for the period during which the rates are to be used.

This procedure is almost exactly analogous to the procedure in determining life insurance premium rates but is impracticable in workmen's compensation insurance for a number of important reasons. In the construction of mortality tables after the crude probabilities have been worked out from the basic data it is necessary to resort to a smoothing process to eliminate the errors due to limited data. The natural relationship between the classifications used to determine these probabilities (years of age) is such that these difficulties may be met by comparison of the probabilities from classification to classification in the process known as graduating. There is no such relation between the classifications used in workmen's compensation insurance and therefore some other process must be substituted for the process of graduation. This has usually been examination of the data and comparison of results between classifications by skilled underwriters. But these underwriters are not accustomed to think in terms of basic probabilities but rather in terms of premium and of pure premium. It is therefore necessary to express the results in these terms if effective work is to be done.

Of course, if this were the only objection, this could be met fairly readily by converting the probabilities into pure premiums on some standard basis which is familiar to the carriers. There would still remain, however, the objection of a very voluminous detail of calculation.

But an even greater difficulty stands in the way. If we are to get the correct number of fulltime workers to derive these probabilities it is a first essential that we have a correct average wage for the experience period by classification and it is also essential if correct pure premiums are to be determined that we have a very approximately correct estimate of the probable average wage by classification for the period for which the rates are to be applied. The figures, at least under present methods, are unobtainable and the suggested method therefore requires modification to meet the exigencies of practical conditions.

Just as in life insurance work it is sometimes found desirable to construct a mortality table on the basis of "amount insured" rather than "lives exposed" and the table when so constructed is found to be equally satisfactory for many uses so we may substitute for the number of fulltime workers a volume of payroll on some standard wage level. There is a general tendency for wage levels to change in about the same way and at about the same time for groups of industries if not for all industries in a given locality. This being so, instead of finding it necessary to have an exact average wage by which to convert a payroll exposure to terms of fulltime workers we may take an average relationship between wage levels and convert a payroll at a given wage level to the corresponding payroll at a new wage level. While it is difficult to obtain precise average wages for industrial classifications at two given periods it is much less difficult to obtain general average factors expressing relations between wage levels.

A probability fraction expressed in terms of payroll, however, would be no more intelligible to the underwriters reviewing the data than one in terms of fulltime workers and it is necessary to substitute monetary losses for numbers of accidents in order to derive a pure premium fraction for these purposes. One method of doing this would be to revalue the individual losses case by case and set up the cost on the new level of wages and the new law if there have been changes. This method, however, would be extremely laborious, in fact prohibitively so. The second method would be to work out the average cost per case and apply to the number of cases in each classification but this average will vary from classification to classification and as it is mainly caused by the limits of the compensation law would require a knowledge of the average wage for the future by classi-

fications almost as much as though we were proceeding from the pure probability fraction. Applying, however, the same principle as that on which payrolls were converted we may determine differential factors in the manner heretofore used and modify these for the difference in wage levels.

The soundness of this procedure will be seen from the following:—

Let π = pure premium L = losses P = payroll and designate the data from the experience period by the subscript a and data for the future period by the subscript b. We then have

$$\pi_b = \pi_a \left(\text{differential } \frac{b}{a}\right)$$

Where (differential $\frac{b}{a}$) means the differential computed in the usual way comparing the cost under the new law and conditions to that under the old law and conditions, the limit factors being calculated with respect to the general level of wages for both periods. Substituting for π the equivalent fraction $\left(\frac{L}{P}\right)$ we get

$$\frac{L_b}{P_b} = \frac{L_a}{P_a} \times \left(\text{diff. } \frac{b}{a}\right)$$

But payroll is the product of the time worked (or the number of fulltime workers covered) by the average wage and if we so analyze the payroll we may read:

$$\frac{L_b}{\text{Time} \times W_b} = \frac{L_a}{\text{Time} \times W_a} \times \left(\text{diff. } \frac{b}{a}\right)$$

But if we assume that our accident rate is constant per unit of time exposure then since our losses are presumed to be the same except for the difference in law and wage level, the time must be the same and therefore cancels out from both sides of the equation. Multiplying through by W_b we get the final result:

$$L_b = L_a \times \left(\text{diff. } \frac{b}{a}\right) \times \frac{W_b}{W_a}$$

In the industrial development of the country there has been a tendency for certain industries to concentrate in particular localities and for these industries the local experience, particularly over a number of years, is usually broad enough to be indicative of appropriate rates for workmen's compensation insurance and the

local authorities having jurisdiction over workmen's compensation insurance rates in such cases usually insist that the rate be made primarily from such local experience. Even when this is done it is necessary, however, to bring the experience of two or three policy years to a common level for the purpose of ratemaking and it will be apparent that by the above procedure when the terms of the law and the approximate future wage level are known, it is about as easy to make the combination of experience in such terms as to produce pure premiums for the future conditions as to do so in other terms.

There will, however, be many classifications for which local data are not sufficient in any case and it will be necessary to combine the experience of the entire country for determining these rates. This experience will have to be brought together upon some standard basis.

Any practical method of ratemaking must recognize and make suitable provision for these two conditions. These conditions will be recognized if the Schedule Z data is brought together for each state upon a basis suitable for application to its rate requirements for the future and then the experience of the several states converted to a basic experience for the second type of work.

In the above discussion nothing has been said about what analysis of the total pure premium should be made. In order that the partial pure premiums may rest upon the most homogeneous (from point of view of cost) possible data I suggest the analysis in the present Schedule Z as appropriate. But there is need of further discussion as to the medical cost. The medical cost is created by the requirements of the injured man which follow from the nature of the accident and injury and it would therefore seem a reasonable conclusion that the medical cost is closely associated with the type of injury, *i. e.* that it is a part of the sum at stake and not an element having a separate probability. It is true that the requirements with respect to medical aid in the provisions of the several compensation laws differ from state to state but in the development of the practice of workmen's compensation insurance the companies have come to disregard the limitation upon the requirements in respect to medical aid and to furnish the medical aid without respect to the statutory limitations. Of course, the cost will differ from state to state in accordance with the general level of fees paid in that jurisdiction.

It would therefore seem that the correct procedure in ratemaking would be to consider the medical cost part of the compensation for the type of injury and associate it with the indemnity in determining the pure premium. This, however, would greatly complicate the comparison of benefits under the several different laws. Moreover, Schedule Z until very recently has not provided for this analysis and it will be necessary in any problem of ratemaking in the near future to use data in which the medical losses have not been analyzed.[4] The problem of conversion of such data, however, to the basis of state future requirements or to a basic level is apparently not susceptible to theoretical solution. A suggestion which has been made and which appears reasonable is that the entire medical for a given year of issue in a particular state be compared with the total number of compensable accidents, after modifying this number for the difference between the waiting period in the actual experience and the conditions to which the experience is converted. In this way, we will get a figure which might be referred to as the cost per compensable case.[5] A comparison of this value as found for the data to be converted with the same value for the latest policy year or basic level will give a ratio which might be applied to the actual medical in the experience to convert it to the basic level.

In appendix A to this paper is given an exhibit sheet which has been worked out to present the combined experience of a classification converted by the method outlined above and a detailed statement of each step involved in the process.[6]

It will be noted that this exhibit sheet shows the actual experience by states as well as the converted experience both on state level and on a basic level. The number of accidents of each type are also shown and if such a sheet is prepared for each classification and each year of issue entering into the experience and then summary sheets in the same form are prepared for

[4]Even when the medical is treated as a separate pure premium unit it is desirable to have the cost analyzed by nature of injury to facilitate judging the dependability of the medical indication.

[5]It will not actually be the cost per case since it will include the cost of medical in noncompensable cases spread over the number of compensable cases.

[6]This process stated in such detail seems very long and involved but is not more so in fact than those used in previous revisions of workmen's compensation rates.

groups of classifications and schedules the underwriters reviewing the data before them can reach their own conclusions as respects the principle of the underlying assumption of a uniform accident frequency per unit of time exposure since wages at the basic level will be approximately equivalent to a time exposure. If examination of the data in this way reveals a trend or drift in the accident frequency it will be possible to take cognizance of this and give it due weight. In the exhibit the columns "State Latest" refers to the conditions at which it is anticipated the rates may be required but in practice a law may be amended subsequent to the time when the revision work begins and it may be necessary therefore to take cognizance of this in a later step. With the pure premiums on the same basis for several policy years available it will be possible to review the stability of these pure premiums and determine whether or not the local data is sufficient for the determination of rates solely on local experience and where this is determined upon the indicated pure premium is then shown. Where, however, the combined data is necessary for the determination of pure premiums the indication may be worked out and inserted in the pure premium column for each type of benefit on the grand total line. These will be the pure premiums reviewed by the underwriters' committee and from these selections will be made. They can, of course, be converted to the state latest basis by applying the reciprocals of the factors by means of which the state latest material were brought to basic level. To the pure premiums as so developed it would be necessary to apply suitable differentials for any amendment to the law subsequent to the time as of which the data was put together and the necessary loading for expenses.

This theory of ratemaking and this plan of procedure have been presented to the committees of the National Council on Workmen's Compensation Insurance and have been approved for use in the next general revision of rates undertaken by the Council. Since the procedure was developed there has come to the attention of the companies the apparently adverse experience of policy years 1921 and 1922 and it has been suggested that it may be necessary to introduce a further factor for changes in the accident frequency rate.

There are several possible theories upon which such a factor might be based. We know from various studies that have been

made that when industry begins to revive after a period of depression the introduction of new employes requires a certain amount of training to develop safe efficiency and accident rates tend to rise. Generally, however, the studies have indicated that they go down again as industry again becomes settled. If it is the desire that the rate for workmen's compensation insurance be responsive to these temporary changes then the assumption of a constant rate per time unit will probably not give a rate sufficiently flexible. I doubt, however, whether the other facts required can be ascertained with sufficient exactness to give such a rate. An alternative theory upon which the introduction of such a factor might be based might be that the experience period is not broad enough to give a true frequency and thus a factor of safety becomes necessary. A further alternative would be the assumption that a fall in wages in the future is probable[7] and should be provided for and a fourth, that some new forces have intervened making the past experience not truly representative of the future. This assumption might call for a factor of less than unity as much as a factor greater than unity. The introduction of any of these factors, however, involves passing beyond the statistical basis for ratemaking and the introduction of judgment which finds its basis in something other than the statistical record. As a matter of business judgment this procedure may be not only defensible but highly desirable. In these days, however, of governmental supervision and the desire to make the processes as clearly scientific and statistical as possible, the need for the introduction of such a factor should be demonstrated as clearly as it is possible to do so.

Certain tests of the above procedure have been made to determine whether or not distortion results by the use of factors for wage level changes and law benefits derived from a combination of all classifications as against the determination of these factors from groups of classifications. These tests were made by converting the data for policy years 1918, 1919 and 1920 on a number of classifications in Massachusetts to the basis of 1923 conditions. The test showed that conversion by groups is apparently not necessary as no serious distortion results from the use of a single wage and law factor derived from total experience. A similar

[7]Present indications seem to be for the reverse in the immediate future in the United States.

test was made as respects converting from the Massachusetts level to the New York level and here again the indications were apparently that the conversion by groups was not necessary.

Subsequent to the development of this method, the New Jersey authorities began an examination of data on file with the New Jersey Bureau for the purpose of determining the basis for revising New Jersey rates in view of contemplated changes in the New Jersey Law. In Appendix B attached hereto is produced the summary of results of this study. In converting the pure premiums from the actual basis to the present basis the differentials heretofore calculated were used. These differentials were calculated on the basis of their level of wages corresponding to policy year 1919. Inasmuch as the New Jersey Act then provided for a 50 per cent. rate of compensation with a maximum limit of $10 per week[8], the difference in wage level would not have a material effect on the calculated differentials. An examination of the New Jersey exhibit appears to confirm at least as respects policy years 1918, 1919 and 1920 the general fundamental theory of approximately stable accident frequency per unit of time exposure. It also indicates that pure premiums converted on this basis approach very closely the aggregate indications for the latest policy year. Taken on the whole, these studies appear to indicate that the procedure herein outlined will prove satisfactory for effective ratemaking.

Due to an amendment to the New Jersey Law it has become necessary to revise the New Jersey rates before it will be possible to carry through the proposed scheme of ratemaking to completion and arrangements have been made to conduct this revision by combining the experience on the level of policy year 1920 and applying suitable factors to cover the amendment to the law and the change in wage level at the present time. The experience is to be brought to the 1920 level by modifying the payrolls of the several policy years in the ratio of the average wage at the level of policy year 1920 to the average level of wages for each policy year (the wage levels to be determined by the individual reports on Schedule Z), and by modifying the losses of the policy years by differential factors to cover the law amendment as heretofore calculated. It has been found by test that these factors are substantially the same as those which would

[8]Changed July 4, 1919, to 66⅔% and $12.

have been calculated in accordance with the above outlined procedure and the only essential difference will be that instead of separately considering the pure premiums for all types of benefits the pure premiums will be reviewed in three groups as during the 1920 national revision.   This preliminary work on the rates for the State of New Jersey should give a very satisfactory test of the procedure and it is anticipated that it will be completed in time for comments thereon to be made as an amendment to the paper at the time it is actually presented to the Society.

Classification_____   Appendix A — Part I Work Sheet and Exhibit of Experience   Year Issue_____

State	Payroll			Losses																																		State
	Actual	Converted State Basis	Converted Basic Level	Fatal						Permanent Total						Major Permanent						Minor Permanent						Temporary						Total Medical					
				No	Indemnity Cost				Medical Cost	No	Indemnity Cost				Medical Cost	No	Indemnity Cost				Medical Cost	No	Indemnity Cost				Medical Cost	No	Indemnity Cost				Medical Cost	Actual	State Latest	P.P.	Basic	
					Actual	State Latest	P.P.	Basic			Actual	State Latest	P.P.	Basic			Actual	State Latest	P.P.	Basic			Actual	State Latest	P.P.	Basic			Actual	State Latest	P.P.	Basic						
Conn.																																							Conn.
Me.																																							Me.
Md.																																							Md.
Mass.																																							Mass.
N.H.																																							N.H.
N.J.																																							N.J.
N.Y.																																							N.Y.
R.I.																																							R.I.
Vt.																																							Vt.
Total Eastern States																																							
Ill.																																							Ill.
Ind.																																							Ind.
Iowa																																							Iowa
Kan.																																							Kan.
Mich.																																							Mich.
Minn.																																							Minn.
Neb.																																							Neb.
S.D.																																							S.D.
Wisc.																																							Wisc.
Total Central States																																							
Ariz.																																							Ariz.
Cal.																																							Cal.
Colo.																																							Colo.
Idaho																																							Idaho
Mont.																																							Mont.
N. Mex.																																							N. Mex.
Utah																																							Utah
Total Western States																																							
Ala.																																							Ala.
Ga.																																							Ga.
Ky.																																							Ky.
La.																																							La.
Okla.																																							Okla.
Tenn.																																							Tenn.
Tex.																																							Tex.
Va.																																							Va.
Total Southern States																																							
G. Total																																							

APPENDIX A PART II—DETAILED STEPS IN PROPOSED RATE-
MAKING PROCEDURE

The full procedure is as follows:

(1)   Schedule Z in the usual form is received at the central office from the several carriers and the staff at once proceeds to audit this material.

After the Schedule has been audited in this way, Hollerith cards are cut covering the information in Part I (the classification summary sheet) for each company and by means of Hollerith machines the schedules of the several companies are combined into a single total schedule.

For the official Schedule Z states this audit is performed in some instances by the local authorities, in other instances the National Council is the authorized agent for receiving and compiling the Schedule on behalf of the state authorities.

This is the raw material in the nature of experience data upon which ratemaking on a statistical foundation is based.

(2)   The next step in the procedure is to transcribe this raw material to work sheets which are substantially the same as the final exhibit sheets.

(3)   Concurrently with this work the wages of the injured employes are taken from the individual reports of Parts II, III, IV and V of the Schedule for each state and year of issue for the purpose of determining the wage level underlying the experience.

(4)   From such sources as are deemed reliable by those in charge of the work (including the committees) the average wage levels to which rates are to be keyed for each state are estimated. The ratio of this average wage for each state to the average wage for the same state for each of the experience policy years is the factor for converting the payroll exposure of the several policy years to the current level.

(5)   When the payroll conversion factors as determined above have been worked out, the actual payrolls for each policy year and each state will be converted to the present level in that state by multiplying the original payroll as entered on the work sheet by this factor.

(6)   The Standard of basic pure premiums having been determined, the conversion factors for converting the payroll for the several states at their latest level to the basic level are determined in the same way as described for converting the several policy years' experience to the present conditions in each state.

(7)   So far in the above work the technical section of the staff will have had only the comparatively easy task of determining the conversion factors but while this work is going on it will be necessary to compute for each state the cost of compensating a standard distribution of accidents (for this we use the "American Accident" distribution) under the terms of each law in effect over any part of the experience period and the cost of compensating the same distribution under the current law, these costs to be estimated in terms of weeks' wages for each element.

NOTE: This work was done during the 1920 revision and I think much of it can be used over although it is likely some new calculations must be made.

(8)   Using the wage data as referred to in (3), limit factors, the need for which and the calculation of which are described more fully in the separate paper presented at this meeting, must be calculated and applied to the costs in terms of week's wages without limits as determined in (7) and to these values must be applied the average wages in order to put this calculated cost in monetary terms.

(9)   The proportionate exposure of each policy year under the several laws must be determined (usually we assume a uniform distribution of business of the year for this purpose) and an appropriate weighted average of the costs found under (8) must be found.

(10)   The corresponding costs on the basis of the present law and wages are then to be found.

(11)   The ratio of the cost found in (10) to that found in (9) represents the conversion factor to bring the actual losses of each state to the present level.

NOTE: It is not feasible to determine factors in this way for bringing the medical cost to the latest level. The method of converting medical is dealt with in the body of the paper.

(12)   Application of these factors to the losses as entered gives the losses at the state current level.

(13)   In like manner the cost of compensating the standard distribution of losses of the basic law and wage must be calculated for each separate kind of benefit.

(14)   The ratio of this cost to the costs of compensating the same distribution on the several states' current levels determined in (10) must then be taken to get the conversion factors for bringing these state experiences to the basic level.

(15)   Application of these to the losses for each state at its own current level brings the losses to the basic level.

(16)   The next step is the addition of the appropriate items across the exhibit page and such vertical additions as should be made.   These will be evident from an examination of the exhibit sheet.

(17)   The next step will be the assembly of the three years' experience on a cumulative exhibit sheet.

(18)   Division of the losses on the state current basis by the payrolls on that basis and entry of the indicated pure premiums is the next step, followed by the determination and entry of the indicated pure premiums on the basic level.

(19)   Following this, the data on the classification sheets must be assembled into group and schedule total sheets.

(20)   The work sheets must then be type-copied in order to furnish clear copy from which the exhibit sheets are prepared.

(21)   I assume the exhibit sheets for committee work will be prepared by a similar process to that used during the 1920 revision.   When the printer's job has been completed the data will be ready for consideration of the committee.

(22)   The next step will be consideration of the experience data by the Committee and the selection of pure premiums.   In this work it may be necessary to consolidate the data for certain of the sub-divisions upon which the analyzed data is not broad enough to furnish indications.   This will probably be done in the Committee room during the session.

(23)   When the selected pure premiums have been determined, it will next be necessary to apply the reciprocals of the conversion

factors by which state losses were brought to the basic level in order to re-convert the selected pure premiums to the state basis. This reconversion would be to the latest level in each state and the test would be made on this basis. In the test recognition would, of course, be given to state exceptions that had been made during the review of the experience and would presumably have been made on the state level.

(24)   As 1923 is a busy legislative year, it is likely there will be amendments to several of the laws subsequent to the date at which each state's experience has been brought to current level and law differentials by parts along the lines indicated in the above steps will have to be calculated to determine the effect of these amendments.

(25)   The next step is the application of the expense loading to the pure premiums as developed at the state latest level and modified for subsequent amendment of the law in order to convert them into gross rates. As noted in the text it may be decided to bring a further factor beside amendment and loading into the multiplier. At any rate this step is the assembly of factors into multipliers to convert pure premiums into rates.

(26)   With the determination of the multipliers out of the way, the next step (the calculation of rates) will consist in applying the multipliers to the selected partial pure premiums and adding the partial gross rates together bringing in the catastrophe pure premium if the past practice of adding $.01 per $100 is to be continued.

(27)   The final step will be the calculation of ex-medical factors for states where this is permitted, experience rating split factors and other supplementary tables necessary to carry through the rates and the Rating Plan.

APPENDIX B

EXPERIMENTAL CALCULATIONS MADE BY THE COMPENSATION RATING AND INSPECTION BUREAU OF NEW JERSEY
PRELIMINARY TO REVISION OF RATES AND IN PARTIAL TEST OF PROPOSED THEORY
Statistics taken from Schedule "Z". Grand Summaries.
All Industries excluding Per Capita.

Policy Year	Audited Payroll (in hds.)	Earned Premium	Incurred Losses	Loss Ratio %	Avg. Earned Rate	Est'd Man. Rate	Pure Premiums actual				Pure Premiums Present Benefit				% of All Cost Present Benefit		
							D.&P.T.	A.O.	Med.	Total	D.&P.T.	A.O.	Med.	Total			
1916	3102069	2303366	1552013	67.38	.743	.85	.113	.274	.113	.500	.124	.359	.170	.653	19.0	55.0	26.0
1917	5171564	5309899	2258539	42.53	1.027	1.05	.111	.234	.092	.437	.122	.307	.138	.567	21.5	54.2	24.3
1918 1st rept	6115538	6677966	2320659	34.75	1.092	1.10	.072	.228	.080	.380	.078	.288	.113	.479	16.3	60.1	23.6
1919	6966702	6456549	2917240	45.18	.927	1.027	.062	.254	.102	.418	.063	.262	.106	.431	14.6	60.8	24.6
1919 1st rept	7295437	6705411	2986826	44.54	.919	1.027	.063	.247	.100	.410	.064	.255	.104	.423	15.1	60.3	24.6
1920	6759097	6094617	2692037	44.17	.902	.978	.060	.224	.114	.398	.060	.224	.114	.398	15.1	56.3	28.6

Policy Year	Average Wage	Wage Ratios 1920 to resp. yrs.	Payroll Modified to 1920 Wage	For Comparison							
				Pure Premium Basis 1920 Wage and Present Benefit				Pure Premium 1920 Basis. Using Exp. Conv. Factor			
1916	18.11 (209)	1.712	5310742	.072	.210	.099	.381	.062	.257	.110	.429
				(.079)	(.212)	(.098)	(.389)	(.061)	(.233)	(.098)	(.392)
1917	21.62 (573)	1.434	7416023	.085	.214	.096	.395	.061	.219	.090	.370
1918	25.82 (537)	1.201	7344761	.065	.240	.094	.399	.059	.257	.096	.412
1919	29.02 (565)	1.068	7791527	.060	.239	.097	.396	.057	.225	.091	.373
1920	31.00 (453)	1.000	6759097	.060	.224	.114	.398	.060	.224	.114	.398
Average				.067	.229	.100	.397				

Accident Frequency per $1,000,000 Payroll on 1920 Wage Basis

Policy Year	Death	Permanent Total	Major	Minor	Temporary	†(Temp. Corrected)	Total (Corrected)
1916	.378	.017	..	*2.395	14.250	18.083	20.873
1917	.356	.018	.391	2.168	11.676	14.817	17.750
1918	.300	.012	.442	2.206	10.737	13.260	16.220
1919	.236	.022	.475	2.466	12.396	12.817	16.016
1920	.254	.009	.395	2.845	12.139	12.139	15.708

*Includes Major.
†Adjusted for waiting period amendment in present Compensation Law.

Compensable Accidents

Policy Year	Death	Permanent Total	Major	Minor	Temporary	Indeterminate	Total
1916	201	9	..	1272	7568	0	9050
1917	264	13	290	1608	8659	1	10835
1918	220	8	325	1620	7886	9	10068
1919	184	17	370	1921	9658	16	12166
1920	172	6	267	1923	8205	44	10617