A SUGGESTED METHOD FOR DEVELOPING AUTOMOBILE RATES

BY

HARMON T. BARBER

The majority of the rates in the automobile casualty manual in effect today were determined by the rate making system which is described in Mr. H. P. Stellwagen's paper on "Automobile Rate Making" in Volume XI of the *Proceedings*. This method has been used with minor variations for the last four years and has produced rates which have proved to be satisfactory as a general rule. Recently there has been evident a growing restiveness as regards automobile manual rates. Several supervisory officials have rejected proposed rates for their states, presumably because they were not convinced of the propriety of the recommended change in manual rates. More recently there has appeared among the carriers a tendency for individual companies to act independently in the matter of introducing various modifications of the rates for individual risks. A brief consideration of the situation hints at a rather general lack of complete confidence on the part of the carriers in the published rates, for otherwise it would be impossible for a few independents to lead the field into a state of rating disorder such as has threatened in the past month or so.

What is wrong with present manual rates? The fact that the present plan for developing automobile rates has been used for several years without material change seems to preclude the possibility of there being any fundamental error in the theory of the method. Possibly there has been too great a lapse of time between rate revisions during a period of rapidly rising loss cost. A succession of minor rate increases might have succeeded in retaining public confidence where a sharp advance after a two year interval failed. It may be that supervisory officials do not look with favor on national rate revisions based on countrywide experience trends without more importance being attached to the indications of local experience. Or the answer to the question may lie in the observation that the rate making method calls for too much reliance on underwriting judgment and an inherent reluctance on the part of others to accept that judgment without adequate supporting

statistical evidence. When rates are seriously challenged the weakest links in the chain, as a general rule, prove to be the points which were determined on a more or less judgment basis. It is quite probable that this is the most severe criticism which can be directed at present rates and at the method by which they were developed. Yet in the opinion of some this characteristic is largely responsible for the spirit of disquietude which surrounds current rates.

One remedy for the situation is obvious. The development of a plan for rate making which will reduce the element of judgment to a minimum will do much to settle the automobile casualty situation. With rates which are known to be neither redundant nor inadequate the temptation to depart from standard practice will be largely removed. It was with this idea in mind that there has been developed, through the collaboration of several individuals, a method for determining automobile rates which provides for a substitution of mechanical methods in place of judgment and opinion. It is presented here with the hope that it may prove useful when automobile rate making methods are next undergoing study and revision.

The suggested method, as it will be referred to for purposes of identification, has no official status and has not received the benefit of review and criticism by any regularly constituted rate making committee or authority. It has been submitted to what might be termed a laboratory test by using it in the development of a complete set of private passenger public liability rates. Frequent references to this test will be made to illustrate the description of the method. The results of this study in many instances agreed closely with present manual rates and in other instances showed a considerable difference. A review of the actual experience in the latter instances favored the rate developed by the suggested method.

One feature of the suggested method which possesses considerable merit is the proposal that rates for individual states be based insofar as possible solely on the state's own experience. With a volume of experience available sufficient to produce dependable indications, it seems unnecessary to go beyond the state boundaries for rate making material. This feature should carry considerable weight with supervisory officials in making the resulting rates more acceptable to the public. It will produce rates which are

free from the distorting influence of the experience of widely separated though otherwise apparently similar localities. To illustrate the variations in hazard which will be found between two territories of essentially the same density of population and with other physical characteristics not entirely dissimilar, the following private passenger public liability pure premiums by class of car based upon the experience of policy years 1924-1927 inclusive are cited:

Territory	Pure Premiums				Ratio To Average Pure Premium		
	W	X	Y	Average	W	X	Y
Philadelphia	34.85	40.19	40.97	37.92	.919	1.060	1.080
Chicago	12.96	15.00	17.68	14.94	.867	1.004	1.183
Minnesota—Remainder of State	8.52	11.99	17.31	11.48	.742	1.044	1.508
Iowa—Remainder of State	3.08	6.26	8.53	4.80	.631	1.304	1.777

Each of these territories produced a substantial volume of exposure and it is safe to conclude that the material variation in hazard represented by these figures is actual and is not due to chance. The possibility of improper rate deductions from a combination of data as dissimilar as in these examples is readily apparent even if used only to determine classification relativity. It will be noted that the idea of sectional rate revisions as opposed to a national rate revision has been followed recently in the publication of manual rate changes effective in 1929. This is a desirable change from past practice and should be incorporated in any future plan for calculating automobile rates.

Preliminary to a description of the suggested method of automobile rate making it seems advisable to define and illustrate certain terms which are referred to frequently. The examples cited are taken from a study of private passenger public liability rates based on the National Bureau of Casualty and Surety Underwriters' experience for policy years 1924-1927 inclusive (the last year's experience with 12 months development only).

District—A district is an individual state or group of geographically adjacent states with sufficient experience to warrant the development of rates for all communities within the limits of the district solely on the basis of the experience of the district.

Examples:

District 2—New York State
District 5—Maryland, Delaware, District of Columbia, Virginia and West Virginia
District 14—Washington and Oregon

District Rate-Group—Within each district as defined above there are certain localities with experience which indicates a hazard distinctive from that of other localities. A district rate-group is, therefore, an individual community or territory with a distinctive hazard or a group of such territories exhibiting substantially the same common hazard.

State Rate-Group—In districts composed of more than one state the district rate-groups are subdivided into state rate-groups consisting of all the territories of individual states which are included in the district rate-group. In the event that a district rate-group consists of only one territory, the district rate-group and state rate-group are synonymous.

Examples (in District 5):

District Rate-Group	State Rate-Group	State	Territory (see definition below)
A	A	Md.	Baltimore (03)
B	B1	W. Va.	Wheeling (92), Fairmont and Parkersburg (97) and Various Counties (98)
	B2	Va.	Norfolk (90)
	B3	Del.	Wilmington (57)
	B4	D. C.	District of Columbia (entire)
C	C1	W. Va.	Clarksburg (94) and Various Counties (87)
	C2	Md.	Annapolis, Hagerstown, Frederick (94)
	C3	Va.	Richmond (39)
D	D1	W. Va.	Charlestown (93) and Remainder of State (96)
	D2	Del.	Remainder of State (96)
	D3	Va.	Various Counties (93) Small Cities (94)
	D4	Md.	Various Counties (87) Remainder of State (96)

Territory—A territory is the smallest geographical unit for which past experience has been kept separately. A territory may be an individual city, the suburban towns adjacent to a city, or a group of small cities located within a state and having approximately the same population. It is customary to assign the re-

mainder of a state not included in any other specific territory to a single territory.

Examples (Rhode Island):

Territory Code	Description
30	Providence (See manual for exact definition)
91	Providence Suburban (See manual for exact definition)
94	Newport (Comprises all of Newport County)
96	Remainder of State

Classification—Private passenger cars are classified in the rate manual according to make and model of car. There are three classifications for public liability and property damage coverage denoted by the symbols "W," "X" and "Y."

Proposed Manual Territorial Assignments

Before proceeding to the actual calculation of pure premiums and rates it is first necessary to give consideration to the question of which localities shall be combined for experience purposes and which shall be considered individually. Obviously those territories in the first group will each be assigned the same final rates as indicated by the combined experience while those in the latter group will be rated independently.

(*1*) *Assignment of States to Districts*

The assignment of states to districts should be made with due regard for the practical advantages which result from giving independent consideration to the experience of each individual state. In fact it may prove expedient in certain cases to depart slightly from the restrictions which are imposed by a strict theoretical consideration of the volume of experience necessary for dependable results in order to profit by the independence granted to individual states. The volume of experience available depends directly on the number of policy years experience which is used in the rate calculation. In the present study 3½ years have been used—1924, 1925, 1926 and 1927 (12 mos.)—but with the principle of sectional rate revisions firmly established it will be possible to use more than this number in those districts where it is necessary to augment the volume of experience.

For the purposes of the present study, it was decided to establish

sixteen districts covering the entire country with the exception of Massachusetts which requires separate consideration owing to the compulsory insurance law which is in effect in that state. The states of New York, New Jersey, Pennsylvania, Ohio, Illinois and California were each assigned to separate districts while the remaining states were grouped into 10 districts. The assignment to district was made with a view to obtaining an exposure of from 250,000 to 300,000 earned car-years in each district. Consideration was also given to the comparative loss cost level of each state as represented by state average pure premiums by class although this point was not given too much importance, since the suggested method provides for partial recognition of the state's individuality even though it may be one of several states comprising a district. The state assignment to district as used in the present study is shown in Exhibit I. In actual practice it would be advisable to make a permanent assignment of states to districts and to adhere to it unless future developments warrant a change.

(2) Composition of Rate-Groups

Since all territories comprising a single rate-group should involve a common distinctive hazard, it is necessary to set up a method for measuring the relative hazard of each territory within a district. Heretofore territories have been grouped for rate making purposes largely on the basis of underwriting judgment supported by the available statistical evidence. As a first attempt in an effort to substitute a purely mechanical plan of assignment, the average pure premium for all classes combined was calculated for each territory. It was recognized, however, that a comparison of average pure premiums on this basis might lead to erroneous conclusions unless consideration was also given to the distribution by class of the number of cars exposed.

This point may be simply illustrated by the following example: Suppose that the individual class pure premiums indicated by the experience of one territory are respectively the same as the class pure premiums of another territory. In the first territory, however, the distribution of cars by class is as follows: W—40%; X—40%; Y—20%; whereas in the second territory the distribution is: W—20%; X—40%; Y—40%. Since the "W" class is the lowest hazard class while the "Y" class is the highest hazard class it is evident that the first territory will show a lower average

pure premium than the second territory. For example, if the class pure premiums of both territories were found to be W—$10; X—$20; and Y—$30; the average pure premium of the first territory would be $18 and the average pure premium of the second territory would be $22. Consequently if consideration was to be limited to the comparison of average pure premiums we should erroneously conclude that rates for the first territory should be lower than those for the second, but as a matter of fact the rates should properly be identical.

To eliminate the chance of improper assignment of territories to rate groups because of the effect of the distribution of cars within each territory, the following procedure was adopted. First the three average class pure premiums for the district were calculated. These were then applied to the earned car exposure of the individual territory by class in order to determine the amount of losses which would be expected to develop if the average *district* conditions had prevailed in the individual *territory*. The actual losses of the territory were next divided by this amount of expected losses in order to arrive at a territorial differential which would serve as a measure of relative hazard. The following example illustrates the procedure:

ACTUAL EXPERIENCE

Territory	Class	Cars	Losses	Pure Premium
Territory.....	W	4,000	80,000	20
	X	8,000	240,000	30
	Y	8,000	320,000	40
	Total....	20,000	640,000	32
District.....	W	100,000	1,000,000	10
	X	60,000	1,200,000	20
	Y	40,000	1,200,000	30
	Total....	200,000	3,400,000	17

CALCULATION OF TERRITORY DIFFERENTIAL

Class	Territory Cars	District Pure Premium	Expected Losses	Terr. Actual Losses	Territory Differential
W	4,000	10	40,000		
X	8,000	20	160,000		
Y	8,000	30	240,000		
Total	20,000		440,000	640,000	1.455

It is apparent that a comparison of the territory average WXY pure premium of $32 with the district average WXY pure premium of $17 (producing a ratio of 1.882) would result in an improper measure of the relative hazard of the territory because of the different distributions of cars by class in territory and district. The territorial differential of 1.455 developed as above eliminates the distortion due to class distribution and provides a simple index of territory hazard.

A territorial differential for each territory in the district was similarly calculated and the territories with differentials of approximately the same value were grouped into rate-groups. In the present study, territories with a small volume of experience were assigned to rate-groups not solely on the basis of the differential—but also with consideration for geographical location and in certain instances, where the almost total lack of experience made it necessary, in accordance with the present manual assignment. In actual practice it may prove desirable to eliminate even this small element of judgment by calculating the territorial differential as outlined above and then tempering the indicated departure from district conditions by the application of a credibility factor which is dependent on the number of cars exposed and accident rate of the territory (see later comments on credibility). Such a scheme would provide for the automatic assignment of territories to rate-groups.

In districts composed of more than one state the territories of each state assigned to any district rate-group are segregated into state rate-groups. The Exhibit II attached presents the basis for the selection of rate-groups in District 5—Delaware, Maryland, District of Columbia, Virginia and West Virginia.

It should be noted that the differentials discussed above are used solely for the purpose of rate-group assignment and do not otherwise enter into the calculation of rates.

Determination of Pure Premiums

The calculation of pure premiums by the suggested method may be divided conveniently into several steps which will be described separately.

(1) Calculation of Average WXY Pure Premium for each District Rate-Group

The actual experience of the individual territories comprising the district rate-group was combined without modification since by hypothesis the experience of all territories in the rate-group was homogeneous. The average WXY pure premium for the district rate-group was calculated by dividing the total losses of the rate-group by the total number of earned cars. A similar pure premium was determined for each district rate-group.

(2) Determination of Average WXY Pure Premium for each State Rate-Group

In the case of those districts composed of a single state the district rate-group average WXY pure premium and the state rate-group average WXY pure premium are the same. In the case of other districts composed of two or more states the procedure for determining state rate-group average WXY pure premiums is more involved. It will be remembered that lack of experience was the only reason which prevented assigning each individual state to a separate district and the desirability of preserving as far as possible the individuality of each state's own experience has been stressed. The problem is therefore to adjust the indicated pure premium for the state rate-group by comparison with the pure premium indication of the district rate-group in order to eliminate the effect of an inadequate experience basis in the state rate-group.

It has been previously pointed out that the distribution of cars by classification is one factor which may lead to erroneous results unless corrective measures are taken. The first step in the process of determining a state rate-group pure premium is to obtain a district rate-group pure premium based on the distribution of cars by class of the state rate-group. District rate-group pure premiums by class are figured. These are applied to the actual number of cars by class for the state rate-group. The resulting products are summed and divided by the total number of cars for the state rate-group. The result is a weighted district rate-group pure premium which is comparable with the state rate-group pure premium. An example taken from District 5—Rate-Group D—State Rate-Group D4 (see page 194 for definition) will serve to illustrate this process:

Class	Cars	Losses	Pure Premium	District Rate-Group D Pure Premium	Product of Cars × Dist. Pure Premiums	Weighted Dist. Rate-Group Pure Premium
W	9,912.7	51,688	5.21	5.67	58,188	
X	7,515.2	47,469	6.32	9.32	70,042	157,916
Y	2,494.6	25,791	10.33	11.90	29,686	$\frac{157,916}{19,922.5}=7.93$
Total	19,922.5	124,948	6.27		157,916	

In this example the state rate-group WXY pure premium based on actual experience is 6.27. The corresponding district rate-group WXY pure premium adjusted to the state rate-group distribution of cars by class is 7.93. It remains to determine an adjusted state rate-group pure premium which will reflect as far as possible the state experience but which will give due weight to the district indications which are based on a dependable volume of experience.

To determine the amount of credibility which may be attached to the state rate-group experience the credibility table described in Appendix A is consulted. This table shows the percent of credibility which may be assigned to a specific volume of experience depending on the number of cars exposed and the claim rate per 100 cars. In the consideration of credibility in connection with the previous automobile rate making method the element of claim rate was not considered of sufficient importance to warrant varying the credibility for different claim rates and there was used a single table based on the countrywide average claim rate of five per 100 cars. As a matter of fact the exposure necessary for 100% credibility varies practically inversely with the claim rate and owing to the extreme variation in the claim rate for various localities it was considered essential in connection with the suggested method to erect a series of credibility tables as is explained in Appendix A.

In the example cited the state rate-group experience shows 449 claims with an exposure of 19,922.5 earned cars or a claim rate of 2.26 per 100 cars. This exposure and claim rate warrant a credibility factor of .44 as will be evident by reference to the credibility table.

With this information it is possible to proceed with the determination of the adjusted state rate-group WXY pure premium. The method consists of determining a weighted average of the state rate-group and district rate-group pure premiums, assigning a

weight corresponding to the credibility factor to the state rate-group indication and the complement of the credibility factor to the district rate-group pure premium. This step has parallels in compensation insurance rate making and also in the previous automobile rate making method, although in the latter case this operation is not performed at this stage of the rate calculation.

Continuing with the example, the adjusted state rate-group WXY pure premium is determined as follows:

State rate-group pure premium × Credibility factor
+ District rate-group pure premium × (1 − Credibility factor)
= Adjusted state rate-group pure premium

$$6.27 \times .44 + 7.93\ (1 - .44) = 7.20$$

The adjusted state rate-group WXY pure premium is found to be 7.20 in this instance. Proceeding in this manner adjusted pure premiums were established for each state rate-group in each district.

It will be noted in those cases where the exposure and claim rate of the state rate-group are sufficient to warrant 100% weight being given to the average pure premium of the state rate-group that the district rate-group pure premium will have no effect in the determination of the final average pure premium for the state rate-group and that the indicated and adjusted state rate-group pure premiums are identical. Also as the volume of exposure of the state rate-group approaches the requirements for 100% credibility the influence of the district rate-group experience is minimized.

(3) Calculation of Preliminary Class Pure Premiums

Class pure premiums (i. e. W, X and Y pure premiums) were derived from the adjusted state rate-group WXY pure premium by the use of class differentials, which are the ratios of the individual class pure premiums to the average combined WXY pure premium. The class differentials were based upon the experience of the district rate-group. In certain instances where there was insufficient volume in a single district rate-group to produce reliable results the differentials were based upon a combination of two or more district rate-groups located, of course, within the same district.

In the study which was made of class differentials it was observed that in densely populated areas the average WXY pure premium

is very close to the X class pure premium and the spread between the W and Y class pure premiums is comparatively small, while in rural communities the average WXY pure premium is usually considerably less than the X class pure premium and the range between the W and Y pure premiums is comparatively great. Since in most districts the large centers of population show high pure premiums and the rural areas show low pure premiums, it is to be expected that the higher the average pure premium the smaller is the variation in class differentials, and conversely, the lower the pure premium the greater is the spread in class differentials. This observation is helpful in pointing out that where the combination of district rate-groups is necessary because of an inadequate experience volume, such combination should be restricted to include only those district rate-groups of about the same average pure premium.

To illustrate, the class differentials obtained by dividing the district rate-group individual class pure premiums by the average WXY pure premium for District 5 are as follows:

District Rate-Group	Indicated Class Differentials		
	W	X	Y
A	.909	1.063	1.118
B	.800	1.086	1.293
C	.866	1.089	1.177
D	.736	1.168	1.491

The difference in character of the class differentials for Rate-Group A—Baltimore and those for Rate-Group D, which is composed principally of rural territories, bears out the observations expressed above. It was found that the exposure of the Y class in Rate-Group C was less than 9,000 cars—an insufficient volume for dependable results. If the Y pure premium for Rate-Group C had been higher than it actually developed to be it will be apparent that the average pure premium for this rate-group would be higher and the class differentials would then appear to be more in keeping with those indicated for the adjacent rate-groups B and D. Because of this lack of volume in Class Y for Rate-Group C it was deemed advisable to combine rate-groups B and C for the purpose of obtaining a single set of class differentials applicable to both. The combination was effected by weighting the differentials shown above separately by class by the relative exposure

in each rate-group. The resulting differentials which were adopted for the purpose of the present study therefore became:

Rate-Group	W	X	Y
A	.909	1.063	1.118
B & C	.827	1.087	1.258
D	.736	1.168	1.491

As stated previously the class differentials based on district rate-group experience were applied to the state rate-group adjusted WXY pure premiums to obtain preliminary class pure premiums. These pure premiums are termed preliminary because of the necessity for a further minor adjustment as explained in the description of the next step.

(4) Calculation of Final Class Pure Premiums

In order to conform to the principle that rates for each state should be based upon the individual state's own experience insofar as possible, the preliminary class pure premiums for states with a sufficient exposure (approximately 50,000 earned cars or more) have been uniformly adjusted upward or downward, so that the products of exposure times pure premium will exactly reproduce the actual losses used in the calculation of pure premiums. The correction factor which is applied to the preliminary class pure premiums is the ratio of the total actual losses for the state to the total of the products of exposure and preliminary class pure premiums. The state balance sheet for Maryland is attached as Exhibit III and illustrates the calculation of the correction factor and the manner in which final class pure premiums are obtained from the preliminary class pure premiums. In practically every state the correction or adjustment was found to be very small. For those states whose experience is insufficient in volume to justify this correction the preliminary pure premiums were accepted as final.

It may be well to summarize the various steps in the suggested method as described up to this point.

(*1*) *Assignment of States to Districts*—States with sufficient experience constitute individual rate making districts. Combinations of other states are made on the basis of geographical location.

(*2*) *Determination of Rate-Groups within Districts*—Statistical territories are combined into rate-groups on the basis of territorial differentials.

(*3*) *Calculation of Average WXY District Rate-Group Pure Premiums*—These are the actual average pure premiums for each district rate-group.

(*4*) *Determination of Adjusted State Rate-Group WXY Pure Premiums*—In districts composed of more than one state the state rate-group actual WXY pure premium and the district rate-group WXY pure premium are averaged using a weight equivalent to the credibility factor on the state experience and a weight of one minus the credibility factor applied to the district experience.

(*5*) *Calculation of State Rate-Group Class Pure Premiums*—These are computed by applying the district rate-group class differentials to the state rate-group adjusted WXY pure premiums.

(*6*) *Adjustment of State Rate-Group Class Pure Premiums*—The state rate-group class pure premiums are adjusted uniformly upward or downward in order to balance with the actual losses for the state.

The Determination of Rate Level

At this stage in the development of rates there is available a complete set of pure premiums representing the proper relativity according to both class of car and territorial location. The next step is to adjust this system of pure premiums to conform to current conditions or rather to conditions that may be expected to prevail in the near future when the revised rates are to be in effect.

Before continuing with the description of the method followed in the present study a brief review of certain features of automobile underwriting may assist in obtaining a better perspective of the problem of rate level.

The automobile public liability and property damage lines of insurance are susceptible to rapidly changing conditions which have a material influence on loss cost and which may make experience of a few years ago obsolete as far as being useful as a guide in establishing rate level. To name a few of these factors which have a tendency to increase the insurance cost, there is the increased traffic congestion on the highways resulting from a greater number of cars in use and an increased annual mileage per car, the construction and better maintenance of improved roads which have stimulated the desire for more speed and have made possible all-year driving in northern states, the production of cars which are capable of greater speed, and the increased liberality of courts and

juries as evidenced by the "guest liability" decisions and higher damage awards of recent years. Among the factors which have been influential in holding down insurance costs are the ambulance chasing investigations which have done much to eliminate non-meritorious claims at least temporarily; public safety movements and campaigns; increased and improved traffic control by progressive police authorities; financial responsibility laws; and improved mechanical equipment of cars such as four wheel brakes, etc. The instability of these conditions and their varying influence in different sections of the country point to the necessity of using only the most recent experience available and of establishing rate levels at least by district and preferably by state.

The wisdom of adopting a permanent and standard method of establishing rate levels is too obvious to require elaboration but the question of the fundamentals of such a method is controversial and resolves itself into a matter of opinion. Undoubtedly there are many advocates of a method which would employ the average of the latest three or five policy years' experience as a key to the level of rates. It is the contention of these that such a basis is definite and that over a period of years' premiums collected would be adequate but not redundant. However, this would be true only in the event that automobile insurance costs were cyclical in trend with comparatively short periods. During a sustained period of increasing costs or decreasing costs, rates produced under such a plan would be either consistently inadequate or consistently redundant. Furthermore, a plan of this nature which may prove practical in a closely regulated line such as compensation insurance, is likely to prove untenable in a highly competitive line such as automobile insurance. The public is quick to demand a decrease in rate if one appears warranted and it is a matter of good business to immediately reward and thus encourage civic movements which will tend to reduce loss costs such as have recently occurred in Schenectady and Youngstown. If the public is insistent on early recognition of favorable changes in cost, and if certain carriers show a willingness to depart from manual rates which may possess stability though may not be in exact accord with current costs, it seems imperative and desirable to adopt a method for determining rate level which will be responsive to the indications of the most recent experience available, regardless of whether its trend is upward or downward.

The use of the experience of the latest policy year or of the two most recent policy years as the basis for rate level will meet this requirement of responsiveness. It may appear advisable in some instances where there has been a continued trend either upward or downward in the cost level to anticipate the probable development during the period subsequent to the latest year for which complete experience is available and to adjust the rate level to conform with the expected level of cost during the year that the revised rates are to be operative. The principal objection to a plan for utilizing the latest policy year as an index of rate level is the immaturity of the experience which under present procedure for reporting experience is only 12 months developed. As a matter of fact the defect of immaturity is not limited to the last year but is a material factor in the experience of earlier years which is commonly assumed to be practically completely developed as reported at the end of 24 months.

In the present study of automobile rates consideration was given to both of the alternatives of (a) keying rates to the experience level of 1927 policy year and (b) using the experience of 1926-27 policy years combined. The mechanics of adjusting the pure premiums based on the four years of experience to either level are comparatively simple and will be similar regardless of the basis ultimately adopted for rate level.

(1) Determination of the Earned Factors for the Latest Policy Year

Since it is of great importance that the experience of the latest policy year be utilized on as accurate a basis as it is possible to obtain, considerable study was devoted to the matter of calculating appropriate earned factors for individual states to be used in converting the written exposure of the latest policy year to an earned basis. The earned factors as used in the past and as used in the present study not only represent that proportion of exposure written during the first twelve months which is earned during the first twelve months of the policy year but they also reflect the expected development of incurred losses from their status at 12 months to an ultimate basis. Consequently, the determination of the earned factors was undertaken in two parts, (a) the exposure element which was computed on a state basis and (b) the development of losses element which was computed on a countrywide

basis. The exposure element was calculated by preparing a tabulation of the private passenger exposure of a large individual carrier for policy year 1926 at the end of 12 months showing by state the total exposure divided by months exposed during the first calendar year and during the second calendar year of the policy year. The ratio of the first calendar year's exposure to the total written exposure for each state was accepted as the basis for the earned factor. In the case of states with small exposure it was necessary to combine adjacent states. The results of this study were substantiated by a subsequent similar calculation using policy year 1927 at the end of 12 months of development which showed only minor variations from the original. The state exposure ratios varied from less than .50 in some southern states up to .68 in northern New England, reflecting the effect of seasonal driving and automatic suspensions. The countrywide average was .557. See Exhibit IV attached.

The available data having a bearing on the development of losses were not as complete nor as detailed as might be desired. There were no reliable figures by state or section of the country which dealt with the development of private passenger liability losses. The following figures, which were taken from a series of tabulations of National Bureau calls for loss ratio experience, present the countrywide automobile public liability loss ratios of all reporting companies at various stages of development. It seems logical to infer that the development of private passenger losses will not be far different from these figures since the private passenger type of coverage, which predominates in point of volume, is included in these figures and there is little reason to suspect a marked difference in the development of automobile public liability experience by type of coverage.

NATIONAL BUREAU LOSS RATIOS
Automobile Public Liability

At End of	Policy Years				
	1922	1923	1924	1925	1926
12 months	....	....	.449	.454	.509
24 months	....	.486	.487	.505	.544
36 months	.476	.512	.515	.540	
48 months	.489	.521	.531		
60 months	.490	.526			

By comparing the loss ratios for each policy year at successive

reports with the loss ratio of the preceding report the following development factors were obtained:

Period	Policy Years					Selected Average
	1922	1923	1924	1925	1926	
12 to 24 months	.....	.....	1.085	1.112	1.069	1.08
24 to 36 months	.....	1.053	1.057	1.069	.....	1.06
36 to 48 months	1.027	1.018	1.031	.....	.....	1.02
48 to 60 months	1.002	1.010	.....	.....	.....	1.01
Total 12 to 60 months						1.18
Total 24 to 60 months						1.09

These figures indicate that there is an adverse development in losses as reported at the end of 12 months which requires a loading of approximately 1.18 (the product of the average development factors shown above) in order to adjust the 12 months' experience to an ultimate cost level. The state exposure factors previously figured were therefore divided by this development factor in order to obtain proper earned factors to apply by state to the 1927 policy year exposure. The average countrywide exposure factor of .557 when modified in this way indicates an average countrywide earned factor of .472. In the development of adjusted pure premiums as previously described it was not considered essential to use individual state earned factors on the written exposure of policy year 1927 because the preponderance of the experience of the other years made this refinement unnecessary and therefore an earned factor of .47 was used on the 1927 written exposure of each state. In dealing with rate level the importance attached to the latest year's experience requires the use of an accurately determined individual earned factor for each state as has just been described. Note that the preceding exhibit also indicates that losses reported at the end of 24 months require a loading factor of 1.09 to adjust them to an ultimate cost level. With this information available it was possible to proceed with the determination of rate level.

(2) Calculation of Indicated Necessary Change in Manual Rates

Proceeding on the hypothesis that rates were to be keyed to the experience indications of the latest policy year, 1927, the written exposure of this year for the district was modified by the application of the state earned factors previously derived. The current manual

rates were next applied to this exposure by territory and by class to obtain the total premium at current manual rates for the district. This premium was next adjusted to exclude the provision for expenses by multiplying by the expected loss ratio of the manual rates, namely .545. The actual incurred losses for the district for 1927 policy year were then divided by this amount of expected losses to obtain a ratio which represented the indicated necessary change in manual rates for the district.

To determine the indicated rate change on the basis of the two latest years' experience, the 1926 policy year exposure was added to the 1927 earned exposure before applying current manual rates. The actual 1926 incurred losses were increased by the factor 1.09 to place them on an ultimate cost level before combining them with the 1927 actual losses. This separate step was necessary to place the 1926 losses on a comparable basis with those of 1927, the loss development factor for 1927 having been incorporated in the earned factor for that year. The combined losses for 1926 and 1927 were then divided by the expected losses of the premium at manual rates for the two years to obtain the indicated change in manual rates.

In districts composed of two or more states, the indicated rate change based on each state's own experience was determined, as well as the district indication. A weighted combination of state and district indications using the standard credibility table was then calculated to obtain the indicated rate change for each state included in the district.

(3) Transition from Adjusted Class Pure Premiums to Proposed Rates

It will be recalled that the pure premium calculations previously described terminated with a complete set of class pure premiums by territory based upon the experience of the period 1924-1927 policy years inclusive. To determine how much these pure premiums differed from the pure premiums of current manual rates the exposure of the four year period by class and by territory was multiplied (a) by the new adjusted pure premiums and (b) by current manual rates. The total premium by state resulting from the second calculation was reduced to expected losses by multiplying by the expected loss ratio of the manual rates of .545 and the result was divided by the expected losses obtained by the first

calculation. This ratio provided a measure of the departure of current manual rate pure premiums from the new adjusted pure premiums by state.

In the previous section was described the procedure for determining the necessary change in current manual rates by state. The product of these two factors (a) the departure of current manual rate pure premiums from the new adjusted pure premiums and (b) the necessary change in current manual rate level represents a multiplier which when applied to the adopted pure premiums places them on the proposed level of rates. By loading these pure premiums by the necessary percentage for expenses the final rates are obtained.

In the preceding discussion of rate level the question of whether to use the latest policy year's experience or that of the two most recent policy years was purposely left open. It is confidently expected, if a standard method for developing rates by an automatic process such as has just been described, should be adopted and placed in operation, that the interval between the time the latest experience was reported and the date when revised rates became effective would be materially decreased. For instance if the experience on the latest policy year was first reported at the end of 18 months (July 1st) instead of at the end of 12 months (December 31st) it may be practical to issue new rates in time to be effective on the succeeding March 1st. Under such a procedure the experience of the latest year would undoubtedly be sufficiently mature and in considerable volume to make it entirely acceptable as the guide for the rate level of the revised rates. The advantages of such a proposition over the present system which calls for committee deliberations at an early stage in the revision are readily apparent. This suggestion is merely noted at this time since it is evident that there are numerous practical considerations to such a proposal which should influence the ultimate decision as to its merits.

This description of the suggested method for developing automobile rates has dealt with its application in the calculation of private passenger public liability rates. It will be evident how the same method may be applied to the calculation of rates for other types of liability coverage and also to the property damage and collision lines. No claim is made that this plan represents the ultimate ideal plan for developing automobile rates. It does

possess certain outstanding advantages over the pre-existing rate making method, namely the substitution of exact formula methods for underwriting judgment, the idea of sectional rate revisions, and a more precise use of statistical data as regards credibility and rate level. If the foregoing description and discussion can assist in the evolution of a standard and permanent method for developing automobile rates the purpose of this paper will be fulfilled.

APPENDIX A

CREDIBILITY TABLES—DERIVATION AND APPLICATION

The question of what constitutes a dependable volume of automobile experience is treated rather briefly in Mr. Stellwagen's paper on "Automobile Rate Making" (*Proceedings*, Volume XI, p. 284-5), in which the author makes an adaptation of the conclusions reached by Mr. A. H. Mowbray in the consideration of a similar question with regard to compensation experience (*Proceedings*, Volume I, p. 26). Whereas in Mr. Stellwagen's paper it appears as though insufficient consideration was given to the possible variation in the amount of individual claims, there is a more serious criticism which may be directed at the practical application of the credibility table which was derived as a result of his observations. The statement is made that an exposure of 50,000 cars is sufficient to base rates upon, or in other words that it may be assumed that the credibility for this number of cars is unity. This is true for a volume of experience which has developed a claim rate per 100 cars of 5 but with some territories showing a claim rate as low as 2 and others as high as 20 per 100 cars it seems imperative to give some recognition to this element as well as to the number of cars exposed. To illustrate the importance of claim rate the number of cars required for 100% credibility with a claim rate of .02 is 129,850 and with a claim rate of .20 is 10,600, both of these numbers being determined in the same manner as the 50,000 exposure for a claim rate of .05.

Accordingly in the development of the suggested method for making automobile rates it was decided to construct a series of credibility tables, one for each of a number of different claim rates. The tables which are attached as Exhibit V were computed in the following manner.

To determine the exposure necessary for 100% credibility for different claim rates the following formula appearing on page 284, Volume XI, *Proceedings*, was employed:

$$P=\frac{2}{\sqrt{\pi}}\int_0^{hsn} e^{-t^2}\,dt$$

$$\text{where } h=\frac{1}{\sqrt{2pqn}}$$

Referring to the table of values in Bowley's "Elements of Statistics," p. 281, it will be found that

$$\text{for } P=f(hsn)=.99, \text{ the value } hsn = 1.82$$

$$\text{that is } \frac{sn}{\sqrt{2pqn}}=1.82$$

When the limit of variation is taken as 5% the value of s becomes .05p.

$$\text{Therefore } \frac{.05pn}{\sqrt{2pqn}}=1.82$$

$$\frac{.0025p^2n^2}{2pqn}=3.3124$$

$$.0025pn=6.6248q$$

$$n=2650\,q/p$$

Interpreting this expression as applied to the present problem it may be stated that the number of cars (n) required to assure that the resulting actual

number of claims will be, in 99 times out of a 100, within 5% of the true average or expected number of claims, is equivalent to the product of 2650 and the ratio of one minus the claim rate to the claim rate. By applying this formula the following results were obtained:

Claim Rate (p)	Number of Cars For 100% Credibility (n)	Claim Rate (p)	Number of Cars For 100% Credibility (n)
.020	129,850	.080	30,475
.025	103,350	.090	26,794
.030	85,683	.100	23,850
.035	73,064	.110	21,441
.040	63,600	.120	19,433
.045	56,239	.130	17,738
.050	50,350	.140	16,279
.055	45,532	.150	15,020
.060	41,517	.160	13,913
.065	38,119	.180	12,072
.070	35,207	.200	10,600
.075	32,683		

To obtain the number of cars for credibility values (Z) of less than 100%, it was assumed that the credibility varied in proportion to the square root of the number of cars or that $Z = c\sqrt{n}$. The value of "c" depends of course on the number of cars required for 100% credibility and is constant for each individual claim rate. This procedure is identical with that used to determine the credibility factors of less than 100% in connection with the previous automobile rate making method. As stated previously the resulting tables are shown in Exhibit V attached.

It will be noted that the suggested method provides for the use of the credibility factors in connection with the determination of state rate-group pure premiums. As pointed out previously the state rate-group WXY pure premium is multiplied by the credibility factor and the product is added to the product of the district rate-group WXY pure premium and unity minus the credibility factor. The result is the adjusted WXY pure premium for the state rate-group. The similarity of this process to the present compensation experience rating method will be apparent to those who are familiar with the mechanical operations of experience rating. The suggested method also provides for the use of credibility in determining state rate levels where the volume of state experience is insufficient by itself and district experience must be relied upon to make up the deficiency. In each of these instances the comparison or experience rating is made between experiences which are nearly homogeneous. In the case of the previous automobile rate making method the experience rating has been theoretically weak in that the comparison has been made between the newly developed indicated rates and the existing manual rates, which were established by two independent calculations using different basic data. The expectation of similarity of results is far less in the latter case and it may be assumed that the experience rating operation was performed simply as a means of smoothing out unusual and abrupt rate changes. In other words the experience rating process in the past has been used to promote stability in final rates; it is employed in the suggested method to strengthen the experience indications of an inadequate volume.

EXHIBIT I

ASSIGNMENT OF STATES TO DISTRICTS

District Number	STATES	Number of Earned Cars*
0	Maine	54,834
	Vermont	33,874
	New Hampshire	56,304
	Total	145,012
1	Connecticut	266,584
	Rhode Island	54,242
	Total	320,826
2	New York	1,180,701
3	Pennsylvania	621,877
4	New Jersey	466,179
5	Maryland	104,902
	Delaware	9,401
	District of Columbia	55,724
	West Virginia	78,649
	Virginia	99,607
	Total	348,283
6	North Carolina	86,551
	South Carolina	26,082
	Georgia	74,349
	Florida	101,890
	Alabama	52,604
	Total	341,476
7	Mississippi	32,541
	Oklahoma	46,374
	Arkansas	30,377
	Louisiana	58,251
	Texas	100,615
	Total	268,158

EXHIBIT I (Cont.)

District Number	STATES	Number of Earned Cars*
8	Indiana	102,082
	Kentucky	79,080
	Tennessee	122,031
	Total	303,193
9	Ohio	407,265
10	Illinois	395,061
11	Michigan	158,656
	Minnesota	176,942
	Wisconsin	247,915
	Total	583,513
12	Missouri	173,057
	Iowa	105,164
	Nebraska	54,574
	Kansas	47,983
	North Dakota	14,763
	South Dakota	10,435
	Total	405,976
13	Wyoming	3,696
	Nevada	2,947
	Utah	12,397
	Colorado	41,890
	Arizona	12,697
	New Mexico	6,122
	Montana	19,099
	Idaho	11,668
	Total	110,516
14	Washington	117,269
	Oregon	64,027
	Total	181,296
15	California	710,126

*National Bureau—Auto P. L. Experience—Private Passenger Cars Policy Years 1924-27 inclusive.

EXHIBIT II

ASSIGNMENT OF TERRITORIES TO RATE-GROUPS

District 5—Delaware, Maryland, District of Columbia, Virginia and West Virginia

State	Territory	Code	Number of Cars	Differential	Rate-Group Assignment
W. Va.	Wheeling	92	1,536	1.469	B1
Md.	Baltimore	03	75,990	1.405	A1
W. Va.	Fairmont, Parkersburg	97	2,111	1.327	B1
Va.	Norfolk	90	17,142	1.210	B2
W. Va.	Various Counties	98	1,667	1.093	B1
Del.	Wilmington	57	7,664	1.012	B3
D. C.	Washington	..	55,724	.996	B4
W. Va.	Clarksburg	94	24,939	.979	C1
W. Va.	Various Counties	87	1,043	.954	C1
Md.	Small Cities	94	8,990	.918	C2
Va.	Richmond	39	23,443	.874	C3
Del.	Remainder of State	96	1,736	.873	D1
W. Va.	Remainder of State	96	36,682	.795	D2
W. Va.	Charleston	93	10,671	.788	D2
Va.	Various Counties	93	1,236	.762	D3
Va.	Remainder of State	96	37,946	.699	D3
Va.	Small Cities	94	19,840	.624	D3
Md.	Remainder of State	96	19,205	.594	D4
Md.	Various Counties	87	718	.575	D4

EXHIBIT III

STATE BALANCE SHEET

Maryland

Auto P.L. P.P. Rates
N.B. 1924–27 Experience

	Number of Cars	Actual Losses	Actual P. P.	Preliminary		Final	
				Adj. P. P.	Expected Losses	Adj. P. P.	Expected Losses
A-1	Baltimore						
W	35,734.9	489,027	13.68	13.68	488,853	13.49	482,064
X	28,835.9	461,400	16.00	16.00	461,374	15.78	455,031
Y	11,419.2	192,973	16.83	16.83	192,185	16.59	189,445
Total	75,990.0	1,143,400	15.05	15.05	1,142,412	14.82	1,126,540
C-2	Md. 94						
W	3,115.2	21,897	7.03	8.48	26,417	8.36	26,043
X	4,205.3	38,015	9.04	11.14	46,847	10.98	46,174
Y	1,669.3	32,139	19.25	12.89	21,517	12.71	21,217
Total	8,989.8	92,051	10.24	10.25	94,781	10.39	93,434
D-4	Md. 96–87						
W	9,912.7	51,688	5.21	5.30	52,537	5.23	51,843
X	7,515.2	47,469	6.32	8.41	63,203	8.29	62,301
Y	2,494.6	25,791	10.33	10.74	26,792	10.59	26,418
Total	19,922.5	124,948	6.27	7.20	142,532	7.06	140,562
State Total	104,902.3	1,360,399	12.97		1,379,725	Correction .986	1,360,536

EXHIBIT IV

PROPORTION OF WRITTEN EXPOSURE WHICH IS EARNED DURING FIRST TWELVE MONTHS OF THE POLICY YEAR

Based on the 1926 Policy Year Experience of One Carrier for Individual States and Groups of Adjacent States.

Alabama	.51	Nevada	.52
Arizona	.52	New Hampshire	.61
Arkansas	.51	New Jersey	.54
California	.52	New Mexico	.52
Colorado	.52	New York City	.55
Connecticut	.60	New York State (exclusive N. Y. C.)	.60
Delaware	.54	North Carolina	.51
District of Columbia	.54	North Dakota	.58
Florida	.51	Ohio	.53
Georgia	.51	Oklahoma	.51
Idaho	.52	Oregon	.54
Illinois	.53	Pennsylvania	.54
Indiana	.53	Rhode Island	.56
Iowa	.53	South Carolina	.51
Kansas	.53	South Dakota	.58
Kentucky	.51	Tennessee	.51
Louisiana	.51	Texas	.51
Maine	.66	Utah	.52
Maryland	.54	Vermont	.68
Michigan	.56	Virginia	.51
Minnesota	.61	Washington	.53
Mississippi	.51	West Virginia	.53
Missouri	.53	Wisconsin	.58
Montana	.52	Wyoming	.52
Nebraska	.53	Countrywide	.557

EXHIBIT V

AUTOMOBILE CREDIBILITY TABLE

Number of Cars Under Different Accident Rates for Each Value of Z.

Number of Accidents per 100 Cars Exposed

Z In Per Cent.	2	2½	3	3½	4	4½	5	5½	6	6½	7	7½	8	9	10	11	12
1	13	10	9	7	6	6	5	5	4	4	3	3	3	3	2	2	2
2	52	41	34	29	25	22	20	18	17	15	14	13	12	11	9	9	8
3	116	92	77	65	57	50	45	41	37	34	31	29	27	24	21	19	17
4	206	164	136	116	101	89	80	72	66	61	56	52	48	43	38	34	31
5	322	257	213	181	158	140	125	113	103	95	87	81	76	67	59	53	48
6	438	349	289	247	215	190	170	154	140	129	119	110	103	90	81	72	66
7	632	503	417	355	309	274	245	221	202	185	171	159	148	130	116	104	95
8	799	636	528	450	392	346	310	280	256	235	217	201	188	165	147	132	120
9	1,044	831	689	588	512	452	405	366	334	307	283	263	245	215	192	173	156
10	1,290	1,027	851	726	632	559	500	452	413	379	350	325	303	266	237	213	193
11	1,560	1,242	1,030	878	764	676	605	547	499	458	423	393	366	322	287	258	234
12	1,857	1,478	1,225	1,045	909	804	720	651	594	545	503	467	436	383	341	307	278
13	2,179	1,735	1,438	1,226	1,067	944	845	764	697	640	591	548	511	450	401	360	326
14	2,527	2,012	1,668	1,422	1,238	1,095	980	886	809	742	685	636	593	521	465	417	378
15	2,901	2,310	1,915	1,632	1,421	1,257	1,125	1,017	928	852	786	730	681	599	533	479	434
16	3,301	2,628	2,179	1,857	1,617	1,430	1,280	1,157	1,056	969	895	831	774	681	607	545	494
17	3,727	2,967	2,459	2,097	1,825	1,614	1,445	1,306	1,192	1,094	1,010	938	874	769	685	616	558
18	4,178	3,326	2,757	2,351	2,046	1,809	1,620	1,464	1,337	1,226	1,132	1,051	980	862	768	690	625
19	4,655	3,706	3,072	2,619	2,280	2,016	1,805	1,632	1,489	1,366	1,262	1,171	1,092	960	856	769	697
20	5,158	4,106	3,404	2,902	2,526	2,234	2,000	1,808	1,650	1,514	1,398	1,298	1,210	1,064	958	852	772
21	5,687	4,527	3,753	3,199	2,785	2,463	2,205	1,993	1,819	1,669	1,541	1,431	1,334	1,173	1,045	939	851
22	6,241	4,968	4,119	3,511	3,056	2,703	2,420	2,188	1,997	1,832	1,692	1,571	1,464	1,287	1,147	1,031	934
23	6,821	5,430	4,502	3,838	3,341	2,954	2,645	2,391	2,182	2,002	1,849	1,717	1,600	1,407	1,254	1,127	1,021
24	7,428	5,913	4,902	4,179	3,637	3,217	2,880	2,604	2,376	2,180	2,013	1,869	1,742	1,532	1,365	1,227	1,112
25	8,059	6,416	5,319	4,534	3,947	3,491	3,125	2,825	2,578	2,366	2,184	2,028	1,891	1,663	1,481	1,331	1,206

EXHIBIT V (Cont.)

AUTOMOBILE CREDIBILITY TABLE

Number of Cars Under Different Accident Rates for Each Value of Z.

Number of Accidents per 100 Cars Exposed

Z In Per Cent.	2	2½	3	3½	4	4½	5	5½	6	6½	7	7½	8	9	10	11	12
26	8,717	6,939	5,753	4,904	4,269	3,775	3,380	3,056	2,789	2,559	2,363	2,194	2,045	1,798	1,602	1,440	1,305
27	9,400	7,483	6,204	5,289	4,604	4,071	3,645	3,295	3,007	2,759	2,548	2,366	2,205	1,939	1,728	1,553	1,407
28	10,110	8,048	6,672	5,688	4,951	4,379	3,920	3,544	3,234	2,967	2,740	2,544	2,372	2,085	1,858	1,670	1,513
29	10,845	8,633	7,157	6,101	5,311	4,697	4,205	3,801	3,469	3,183	2,939	2,729	2,544	2,237	1,993	1,791	1,623
30	11,631	9,259	7,676	6,544	5,696	5,038	4,510	4,077	3,721	3,414	3,152	2,927	2,729	2,399	2,138	1,921	1,741
31	12,418	9,885	8,195	6,987	6,081	5,378	4,805	4,353	3,972	3,645	3,366	3,125	2,913	2,562	2,282	2,051	1,859
32	13,204	10,511	8,714	7,429	6,467	5,719	5,120	4,628	4,224	3,876	3,579	3,323	3,098	2,724	2,427	2,181	1,976
33	14,043	11,179	9,267	7,901	6,877	6,082	5,445	4,922	4,492	4,122	3,806	3,534	3,294	2,897	2,581	2,320	2,102
34	14,907	11,866	9,838	8,387	7,300	6,456	5,780	5,225	4,769	4,375	4,040	3,751	3,497	3,075	2,740	2,462	2,231
35	15,796	12,575	10,425	8,887	7,736	6,842	6,125	5,537	5,053	4,637	4,281	3,975	3,706	3,259	2,903	2,609	2,364
36	16,712	13,303	11,029	9,402	8,184	7,238	6,480	5,858	5,346	4,905	4,530	4,206	3,920	3,447	3,072	2,760	2,501
37	17,653	14,053	11,650	9,932	8,645	7,646	6,845	6,188	5,647	5,182	4,785	4,442	4,141	3,642	3,245	2,916	2,642
38	18,620	14,823	12,288	10,476	9,119	8,065	7,220	6,527	5,957	5,466	5,047	4,686	4,368	3,841	3,422	3,076	2,787
39	19,613	15,613	12,944	11,035	9,605	8,495	7,605	6,875	6,274	5,757	5,316	4,936	4,601	4,046	3,605	3,240	2,936
40	20,632	16,424	13,616	11,608	10,104	8,936	8,000	7,232	6,600	6,056	5,592	5,172	4,840	4,256	3,792	3,308	3,088
41	21,676	17,255	14,305	12,196	10,616	9,388	8,405	7,598	6,934	6,363	5,875	5,455	5,085	4,471	3,984	3,581	3,244
42	22,747	18,107	15,012	12,798	11,140	9,852	8,820	7,973	7,277	6,677	6,165	5,724	5,336	4,692	4,181	3,757	3,405
43	23,843	18,980	15,735	13,414	11,676	10,327	9,245	8,357	7,627	6,998	6,462	6,000	5,593	4,918	4,382	3,938	3,569
44	24,939	19,853	16,458	14,031	12,213	10,801	9,670	8,742	7,978	7,320	6,759	6,276	5,850	5,144	4,584	4,119	3,733
45	26,112	20,787	17,232	14,691	12,788	11,310	10,125	9,153	8,353	7,665	7,077	6,571	6,126	5,387	4,799	4,313	3,908
46	27,260	21,700	17,990	15,337	13,350	11,807	10,570	9,555	8,720	8,001	7,388	6,860	6,395	5,623	5,010	4,503	4,080
47	28,485	22,675	18,799	16,026	13,950	12,337	11,045	9,985	9,112	8,361	7,720	7,168	6,682	5,876	5,235	4,705	4,263
48	29,684	23,630	19,590	16,701	14,537	12,857	11,510	10,405	9,496	8,713	8,045	7,470	6,964	6,123	5,456	4,903	4,443
49	30,961	24,646	20,433	17,419	15,162	13,410	12,005	10,853	9,904	9,088	8,391	7,791	7,263	6,387	5,690	5,114	4,634
50	32,238	25,663	21,275	18,138	15,788	13,963	12,500	11,300	10,313	9,463	8,738	8,113	7,563	6,650	5,925	5,325	4,825

EXHIBIT V (Cont.)

AUTOMOBILE CREDIBILITY TABLE

Number of Cars Under Different Accident Rates for Each Value of Z.

Number of Accidents per 100 Cars Exposed

Z In Per Cent.	2	2½	3	3½	4	4½	5	5½	6	6½	7	7½	8	9	10	11	12
51	33,540	26,699	22,135	18,870	16,425	14,527	13,005	11,757	10,729	9,845	9,090	8,440	7,868	6,919	6,164	5,540	5,020
52	34,842	27,736	22,994	19,603	17,063	15,091	13,510	12,213	11,146	10,227	9,443	8,768	8,174	7,187	6,404	5,755	5,215
53	36,222	28,834	23,905	20,379	17,739	15,688	14,045	12,697	11,587	10,632	9,817	9,115	8,497	7,472	6,657	5,983	5,421
54	37,602	29,933	24,815	21,156	18,415	16,286	14,580	13,180	12,029	11,037	10,191	9,462	8,821	7,757	6,911	6,211	5,628
55	39,007	31,052	25,743	21,946	19,103	16,895	15,125	13,673	12,478	11,450	10,572	9,816	9,151	8,047	7,169	6,443	5,838
56	40,413	32,171	26,670	22,737	19,791	17,503	15,670	14,166	12,928	11,862	10,953	10,170	9,480	8,336	7,428	6,675	6,049
57	41,896	33,351	27,649	23,571	20,517	18,146	16,245	14,685	13,402	12,297	11,355	10,543	9,828	8,642	7,700	6,920	6,271
58	43,353	34,511	28,611	24,391	21,231	18,777	16,810	15,196	13,868	12,725	11,750	10,910	10,170	8,943	7,968	7,161	6,489
59	44,887	35,732	29,623	25,255	21,983	19,441	17,405	15,734	14,359	13,176	12,166	11,296	10,530	9,259	8,250	7,415	6,718
60	46,164	36,749	30,466	25,973	22,608	19,994	17,900	16,182	14,768	13,550	12,512	11,617	10,830	9,523	8,485	7,625	6,909
61	47,982	38,196	31,666	26,996	23,498	20,782	18,605	16,819	15,349	14,084	13,005	12,075	11,256	9,898	8,819	7,926	7,182
62	49,543	39,438	32,695	27,874	24,262	21,458	19,210	17,366	15,848	14,542	13,428	12,467	11,622	10,220	9,106	8,183	7,415
63	51,180	40,742	33,776	28,795	25,064	22,167	19,845	17,940	16,372	15,023	13,872	12,879	12,006	10,558	9,407	8,454	7,660
64	52,818	42,045	34,857	29,716	25,866	22,876	20,480	18,514	16,896	15,503	14,316	13,292	12,390	10,895	9,708	8,724	7,905
65	54,481	43,370	35,955	30,652	26,681	23,597	21,125	19,097	17,428	15,992	14,766	13,710	12,781	11,239	10,013	8,999	8,154
66	56,145	44,694	37,053	31,588	27,496	24,317	21,770	19,680	17,960	16,480	15,217	14,129	13,171	11,582	10,319	9,274	8,403
67	57,886	46,080	38,201	32,568	28,348	25,071	22,445	20,290	18,517	16,991	15,689	14,567	13,579	11,941	10,639	9,562	8,664
68	59,601	47,445	39,333	33,533	29,188	25,814	23,110	20,891	19,066	17,494	16,154	14,998	13,982	12,295	10,954	9,845	8,920
69	61,393	48,872	40,516	34,541	30,066	26,590	23,805	21,520	19,639	18,020	16,640	15,449	14,402	12,664	11,284	10,141	9,189
70	63,186	50,299	41,699	35,550	30,944	27,367	24,500	22,148	20,213	18,547	17,126	15,901	14,823	13,034	11,613	10,437	9,457
71	65,004	51,746	42,899	36,572	31,834	28,154	25,205	22,785	20,794	19,080	17,618	16,358	15,249	13,409	11,947	10,737	9,729
72	66,822	53,193	44,099	37,595	32,724	28,941	25,910	23,423	21,376	19,614	18,111	16,816	15,676	13,784	12,281	11,038	10,001
73	68,717	54,702	45,350	38,662	33,653	29,762	26,645	24,087	21,982	20,170	18,625	17,293	16,120	14,175	12,630	11,351	10,285
74	70,613	56,211	46,601	39,728	34,581	30,583	27,380	24,752	22,589	20,727	19,139	17,770	16,565	14,566	12,978	11,664	10,569
75	72,534	57,741	47,869	40,809	35,522	31,416	28,125	25,425	23,203	21,291	19,659	18,253	17,016	14,963	13,331	11,981	10,856

EXHIBIT V (Cont.)

AUTOMOBILE CREDIBILITY TABLE

Number of Cars Under Different Accident Rates for Each Value of Z.
Number of Accidents per 100 Cars Exposed

Z In Per Cent.	2	2½	3	3½	4	4½	5	5½	6	6½	7	7½	8	9	10	11	12
76	74,456	59,270	49,137	41,890	36,463	32,250	28,870	26,098	23,818	21,855	20,180	18,737	17,466	15,359	13,684	12,299	11,144
77	76,454	60,861	50,456	43,015	37,442	33,113	29,645	26,799	24,457	22,441	20,722	19,240	17,935	15,771	14,052	12,629	11,443
78	78,427	62,432	51,775	44,125	38,408	33,968	30,410	27,491	25,088	23,020	21,257	19,736	18,398	16,178	14,014	12,955	11,738
79	80,478	64,064	53,111	45,278	39,412	34,856	31,205	28,209	25,744	23,622	21,812	20,252	18,879	16,601	14,791	13,293	12,045
80	82,528	65,696	54,464	46,432	40,416	35,744	32,000	28,928	26,400	24,224	22,368	20,768	19,360	17,024	15,168	13,632	12,352
81	84,604	67,349	55,834	47,600	41,433	36,643	32,805	29,656	27,064	24,833	22,931	21,290	19,847	17,452	15,550	13,975	12,662
82	86,706	69,022	57,221	48,783	42,462	37,554	33,620	30,392	27,737	25,450	23,500	21,819	20,340	17,886	15,936	14,322	12,977
83	88,834	70,716	58,625	49,980	43,504	38,475	34,445	31,138	28,417	26,075	24,077	22,355	20,839	18,325	16,327	14,674	13,296
84	90,987	72,430	60,047	51,191	44,559	39,408	35,280	31,893	29,106	26,707	24,661	22,897	21,344	18,769	16,723	15,029	13,618
85	93,166	74,165	61,485	52,417	45,626	40,352	36,125	32,657	29,803	27,347	25,251	23,445	21,856	19,219	17,123	15,389	13,944
86	95,371	75,920	62,939	53,658	46,706	41,307	36,980	33,430	30,509	27,994	25,849	24,000	22,373	19,673	17,529	15,753	14,274
87	97,602	77,696	64,412	54,913	47,798	42,273	37,845	34,212	31,222	28,649	26,454	24,561	22,896	20,134	17,939	16,122	14,608
88	99,833	79,472	65,884	56,168	48,891	43,239	38,710	34,994	31,936	29,303	27,058	25,123	23,420	20,594	18,349	16,490	14,942
89	102,141	81,309	67,408	57,467	50,021	44,239	39,605	35,803	32,674	29,981	27,684	25,704	23,961	21,070	18,773	16,872	15,288
90	104,450	83,147	68,931	58,766	51,152	45,239	40,500	36,612	33,413	30,659	28,310	26,285	24,503	21,546	19,197	17,253	15,633
91	106,783	85,004	70,471	60,079	52,295	46,249	41,405	37,430	34,159	31,344	28,942	26,872	25,050	22,027	19,627	17,639	15,982
92	109,117	86,862	72,012	61,392	53,438	47,260	42,310	38,248	34,906	32,029	29,575	27,459	25,598	22,509	20,055	18,024	16,331
93	111,529	88,782	73,603	62,748	54,618	48,305	43,245	39,093	35,677	32,736	30,228	28,066	26,163	23,006	20,498	18,422	16,693
94	113,940	90,702	75,194	64,105	55,799	49,349	44,180	39,939	36,449	33,444	30,882	28,673	26,729	23,504	20,941	18,821	17,053
95	116,377	92,642	76,803	65,476	56,993	50,405	45,125	40,793	37,228	34,160	31,542	29,286	27,301	24,007	21,389	19,223	17,418
96	118,815	94,582	78,411	66,848	58,186	51,460	46,070	41,647	38,008	34,875	32,203	29,899	27,872	24,509	21,837	19,626	17,783
97	121,329	96,583	80,071	68,262	59,418	52,549	47,045	42,529	38,812	35,613	32,884	30,532	28,462	25,028	22,299	20,041	18,159
98	123,844	98,585	81,730	69,677	60,649	53,638	48,020	43,410	39,617	36,351	33,566	31,165	29,052	25,547	22,761	20,457	18,536
99	126,384	100,607	83,407	71,106	61,893	54,739	49,005	44,301	40,429	37,097	34,254	31,804	29,648	26,071	23,228	20,876	18,916
100	128,950	102,650	85,100	72,550	63,150	55,850	50,000	45,200	41,250	37,850	34,950	32,450	30,250	26,600	23,700	21,300	19,300

NOTE:—The number of cars required for 100% credibility as determined by formula for different accident rates have been pro-rated so that the required number for an accident rate of 5 will be exactly 50,000. This table then becomes simply an elaboration of that formerly used by the National Bureau.