2. a. When a lower than manual level is produced but the losses are lower to the same degree, and
   b. When a higher than manual level is produced but the losses are higher to the same degree.

Someone more learned than the writer will have to answer this question.

If the general belief of those using merit rating is that it adjusts the premium commensurate with the hazard for the class—maybe it should be added that other measurable characteristics should also be included in rating; such as occupation, environment, and then the age-old symbols of recklessness, of bootees hanging from the sun visor or an extra tail pipe.

Even though this discussion takes the form that the writer is not sold on merit rating—deep down within me there is a yearning for merit rating because of being lucky enough to be without accidents or convictions. (Probably will regret the day this was written). But to get back to my point—the yearning in my case is not so much for merit rating but for a lower cost of insurance—and thereby tells the tale of the real want—lower cost.

AUTHOR'S REVIEW OF DISCUSSION

Mr. Muetterties' discussion of my paper is indeed welcome, for such exchange helps to sharpen the tools of the ratemaker and tailor the price paid by insureds more appropriately to the hazards which they present.

Mr. Muetterties' view that the need for recognition of driving performance is along the lines of more enforcement in the motor vehicle departments is more of a social comment rather than an actuarial or insurance comment. I like to believe that the insurance industry is concerned with objective evaluation of potential risk more than merely finding a plausible but erroneous basis for risk evaluation.

Regarding the inter-relationship of accidents and abstracts, 37.1% of the individuals exhibited a greater number of accidents than abstracts. The following summary of average number of abstracts by number of accidents derived from the California data is noteworthy:

TABLE A

		Increment from Preceding Line	
Number of Accidents	Average Number of Abstracts	Number of Accidents	Average Number of Abstracts
0	0.7	—	—
1	1.6	1	0.9
2	2.5	1	0.9
3	3.2	1	0.7
4	3.8	1	0.6

It should be noted that on the average, those with no accidents during the three-year experience period have 0.7 abstracts; thereafter, an increment

of one accident is associated with an increment of 0.9 abstracts on the average. After two accidents are reached, the increment in the average number of abstracts decreases to 0.7 and then to 0.6. It is almost as if the first abstract is expected to occur unaccompanied by an accident but thereafter, each abstract is accompanied by an accident in most instances.

In the matter of collecting reliable experience for the many merit plans, the answer would appear to lie in the individual company's evaluation of the merit plan which it uses. If, on the other hand, merit rating by the insurance industry is contemplated, there may be great merit to the adoption of a uniform merit rating plan, or at least one with a minimum of variations.

It is clear that for a merit rating plan to be successful, a company must have available to it satisfactory accident and traffic violation records. For the Bureau type plan this means that the Motor Vehicle Department must keep for every driver a record which shows both violations and accidents in such a manner that separate instances may be identified. Such records should be available at nominal cost (say $.50 or less). If reliance is placed on a system of company interchange of information, the resultant expenditure of money and effort would probably be excessive. Of subordinate concern is the question of availability of records from other states. Here major reliance might have to be placed on the signed statement of the insured.

To the degree that the question of "fault" as opposed to "involvement" enters in counting accidents or violations, a plan becomes more costly and more difficult to administer. There are, however, certain situations in which the insured, although involved in an accident, is obviously not at fault—e.g., if his car were parked. Such instances do not present real administrative difficulties and can be recognized in a plan. (The records kept by the Motor Vehicle Department would have to be such as to permit identification of these situations.)

It would be necessary for the carriers concerned to keep statistics in greater detail in order periodically to reevaluate a plan once it becomes effective. This, together with the other elements already mentioned, means that administrative costs will increase. Estimates of this increase could probably be made before embarking on a merit rating program.

Among other administrative problems would be the question of treatment of the new driver, the more-than-one-car risk and in general, the fact that a one-to-one correspondence does not necessarily exist between cars and drivers.

Concerning the balance of a merit rating plan, it appears to me that Mr. Muetterties' two possibilities might be summarized as being either a static balance or a dynamic balance. For my own view, I believe a merit rating plan may be said to be in balance when the sum of the expected losses and expected expenses can reasonably be expected to produce a reasonable profit margin or dividend margin.

Apropos of measurable characteristics, some of these are daily being recognized in premium determination. For example, use is made of such categories as farms, clergymen, territory, driver training, age and sex.

It seems that the majority of individuals yearn for a lower cost of insurance, the lower the better; yet for the most part people tend to be entirely satisfied,

or less dissatisfied if their insurance premiums are lower than that charged their "reckless" neighbors.

I believe the problems posed by merit rating would be more susceptible of evaluation if its consequences could be expressed in quantitative terms. Questions of efficiency, adequacy, discrimination and public interest might come clearly into focus if we had some idea of the numbers and percentages of risks involved.

The following reasonable assumptions may be used to develop a notion of the overall efficiency of grouping by previous accident records for a three-year period:

Let $q = .1$, the annual accident frequency

Let $\frac{\sigma^2}{q} = 1 + b = 1.06$, the ratio of the variance to the mean

Then $b = .06$

The distribution of 100,000 risks and their expected means may then be estimated to form the following table:[1]

TABLE B

No. of Accidents in 3 Years	Risks		Expected Mean (1 Year)		
	Symbol	No.	Value	Indices	
0	A_0	75,893	.085	1.00	.85
1	A_1	19,295	.136	1.60	1.36
2	A_2	3,924	.186	2.19	1.86
3	A_3	732	.237	2.79	2.37
4	A_4	130	.288	3.39	2.88
5	A_5	26	.339	3.99	3.39
		100,000	.1	1.18	1.00

In each category the number of risks associated with the expected mean may be described as having a distribution of accident proneness.[2] It will be seen that risks will have been assigned to a category on the basis of previous accident *record;* some of these risks, however, will have an "inherent accident proneness" which could be better described by the expected mean frequency of a lower or higher category. For purposes of this discussion a figure 20% above or below the expected mean of each category was assumed to separate those risks "misclassified" by the record of past accidents. Tables[3] were used to produce the following results:

[1] See Appendix for formulae used in developing this table.

[2] Corresponding to the Pearson Type III. See L. B. Dropkin, "Some Considerations on Automobile Rating Systems Utilizing Individual Driving Records," CAS XLVI, p. 165.

[3] Ibid. Description is contained in Appendix D therein.

TABLE C

No. of Accidents	No. of Risks	Expected Mean			Percentage of Risks with "Inherent Proneness" Equal to or Less than 80% or 120% of Expected Mean	
		100%	80%	120%	80%	120%
0	75,893	.085	.068	.102	50.5%	70.0%
1	19,295	.136	.109	.163	45.5	70.2
2	3,924	.186	.149	.223	41.6	70.7
3	732	.237	.190	.284	38.4	71.4
4	130	.288	.230	.346	36.	72.
5	26	.339	.271	.407	35.	72.
Total	100,000					

The percentages of the last two columns above may be used to determine the overall efficiency of the merit rating system with the stringent 20% criterion. In this instance we would find 29,921 risks whose "inherent proneness" indicated they belong in a category more than 20% higher than the one to which they have been assigned. At the same time we would find 10,748 risks in other than the 0 accident category whose "inherent proneness" indicated they belong in a category more than 20% lower than the one to which they have been assigned. Lastly, 38,326 risks in the 0 accident category have an "inherent proneness" which indicates they belong in a category more than 20% lower than the lowest category.

If we assume the 38,326 risks in the 0 accident category cannot feasibly be rated any lower, then we conclude that only 40,669 risks out of the 100,000 have been "misclassified," and on a net basis, the number of risks not rated high enough exceed the number not rated low enough by 19,173.

From an individual company viewpoint, lack of the existence of a merit rating program encourages highly selective underwriting. Assuming rates are based on a 10% frequency as above, a company might undertake to write all risks with no accidents in the past three years at an expected mean frequency of .085; in addition it might attempt to identify through other underwriting characteristics, the 45.5% of those involved in one accident in the past three years whose "inherent proneness" is given by the figure .109 or less. Of course, this could leave the 54.5% of those with one accident and all those with more than one accident without a free insurance market at all.

If a plan is to be considered in terms of "balance," rating organization rate levels must be considered; should all or part of industry experience be the basis on which discounts or surcharges are contemplated? Does merit rating involve "unfair" discrimination in some instances?

In this author's view the relative quantitative relationships expressed above may help the individual to decide whether merit rating is a good thing or a bad thing for the insured, the carrier or the rating organization. Whatever inequities may be pointed up by this illustration might be sharply curtailed

if $\frac{\sigma_2}{q}$ could be made more nearly 1.00, that is, if rating territorial, occupational, etc. classifications could be made more homogeneous than they are today.

APPENDIX

Formulae for Computing Distribution of 100,000 Risks and Expected Means on a 3-Year Experience Basis

$(q = .1 \text{ and } b = .06)$

No. of Accidents in 3 Years	Risks		Expected Mean Value (1 Year)	
	Symbol	Formula	Symbol	Formula
0	A_0	$100{,}000\left(\frac{1}{1+3b}\right)^{\frac{q}{b}}$	V_0	$\frac{q}{1+3b}$
1	A_1	$\left(\frac{3q}{1+3b}\right) A_0$	V_1	$V_0 + \frac{b}{1+3b}$
2	A_2	$\frac{3(q+b)}{2(1+3b)} A_1$	V_2	$V_0 + \frac{2b}{1+3b}$
3	A_3	$\frac{3(q+2b)}{3(1+3b)} A_2$	V_3	$V_0 + \frac{3b}{1+3b}$
4	A_4	$\frac{3(q+3b)}{4(1+3b)} A_3$	V_4	$V_0 + \frac{4b}{1+3b}$
5	A_5	$\frac{3(q+4b)}{5(1+3b)} A_4$	V_5	$V_0 + \frac{5b}{1+3b}$

MULTIPLE PERIL RATING PROBLEMS—SOME STATISTICAL CONSIDERATIONS

BY

ROBERT L. HURLEY

Volume XLVI, Page 196

DISCUSSION BY P. M. OTTESON

Mr. Hurley's paper represents a valuable contribution to the literature on multiple peril rating. The paper is most interesting to read and study; it reveals much of the author's thinking and philosophy concerning the general problems of insurance statistics and ratemaking and should provoke thought, study and discussion on a most timely subject.

The Homeowners policy is used to illustrate the multiple peril statistical