Tire Disablements and Accidents
On High-Speed Roads

J. STANNARD BAKER and G. DECLAN McILRAITH, Traffic Institute, Northwestern University

The study of tire disablements and accidents on high-speed roads was undertaken to give, for the first time, reasonably trustworthy numerical answers to questions that have long been bothersome. For example, in what percent of accidents are tire disablements a contributing factor?

The project was a cooperative undertaking of the Traffic Institute of Northwestern University, the Illinois State Toll Highway Commission, the Illinois State Police (Tollway Battalion), and the Rubber Manufacturers Association. No federal funds were involved.

The study was made on a toll road for the following reasons:
1. Toll collections give a very precise measurement of vehicle mileage.
2. Continuous high speed is acknowledged to be severe tire service and it certainly increases accident severity. Hence, tire disablements and associated accidents would probably be maximum rather than minimum on such a road.
3. Accidents are very completely reported on a toll road.
4. Uniform speeds minimize speed as a variable in the study.

To further reduce the number of variables, only four-tired vehicles were included, mainly passenger cars.

Four associated projects were required: Tire Study 1—frequency of tire disablements, Tire Study 2—use and condition of tires, Tire Study 3—tire disablements not followed by accidents, and Tire Study 4—tire disablements followed by accidents.

Data were collected between September 1, 1966, and August 31, 1967. The limited-access Illinois Tollway is 190 miles long and is mostly Interstate, around Chicago (Fig. 1). Use-and-condition studies were made at five service areas; frequency-of-disablement studies were made at two toll plazas.

In this abbreviated report, results rather than methodology are emphasized.

TIRE STUDY 1: FREQUENCY OF TIRE DISABLEMENTS

Three surveys were conducted at two exit toll plazas. Two were made at South Beloit where cars left Illinois to enter Wisconsin. These gave maximum Tollway trip length. One was made where cars left the Tollway to enter Chicago. These were mainly commuter trips giving minimum average trip mileage.

One survey was begun as early in April as practical to give a low mean temperature, actually 39 F. Two were made in July to give a high mean temperature, 69 F.

In each survey, counts were made 16 hours per day, 7 days per week for at least 2 weeks.

Cars stopped to pay toll were asked where they entered the Tollway. This gave an accurate figure for their Tollway travel. They were also asked whether they had had tire or other car trouble on the Tollway. The size of each car and its State of regis-
tration was noted. If a driver said that he had experienced tire or other mechanical trouble, he was asked the following additional questions:

What kind of trouble?
Did you require assistance?
If so was it from police or service vehicles?
How long before help arrived?

If the trouble was a tire disablement, still more questions were asked:

Where on the Tollway did the tire fail?
At what time did it fail?
How long were you delayed?
Was the failure sudden or slow?
Did a patrolman make out a report on it?
If helped, was it by service truck, other motorist, or patrolman?
Did you have a usable spare tire?
Was the disabled tire repairable?

The sex and age of the driver were noted. If the motorist did not know whether the tire was repairable, he was given a return postcard to send in when he found out. About one-fourth of these were returned.

A simple method was used to determine adequacy of sample size. After each disablement reported, the miles per disablement to and including that one were computed and plotted (Fig. 2). When additional disablements had little effect on the rate, the sample size was sufficient. Figure 2 shows these plots and clear differences between the three surveys.

The three surveys (Table 1) gave disablement rates for three temperature-trip length combinations. Disablements per million car miles varied from 29 for low temperature and long trips to 71 for high temperature and short trips. It is reasonable to
believe that still lower temperatures would have given somewhat lower disablement rates and that higher temperatures might give substantially higher rates, but not much of the year would fall outside the 48 F to 69 F range obtained. From the three pairs of conditions represented, the disablement rate for low temperature short trips could be deduced: 46 disablements per million vehicle-miles.

Tollway travel was divided into groups according to approximate mean temperature and trip length. To these group totals were applied the appropriate disablement rates to obtain estimated totals for the entire tollway for 12 months. These estimates of tire disablements were as follows: 46 per 1,000,000 vehicle-miles, 1 per 22,000 vehicle-miles, 1 per 88,000 tire-miles, 1 per 340 hours of Tollway driving, 165 per day for entire Tollway, 7 per hour for entire Tollway, and 1 per mile per day.

Drivers reported whether tire disablement was slow or sudden. This was a subjective evaluation but it is believed useful to dichotomize an experience to which drivers must react: "slow leak," 48 percent; and "sudden blow," 52 percent.

Drivers also reported how tires were changed. The results are shown in Figure 3. About one-third of the drivers required help—many more women than men.

<table>
<thead>
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<th>TABLE 1</th>
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<td>SUMMARY OF TIRE DISABLEMENT FREQUENCY SURVEYS</td>
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<tr>
<td></td>
</tr>
<tr>
<td>Duration of survey, days</td>
</tr>
<tr>
<td>Mean temperature, F</td>
</tr>
<tr>
<td>Number of interviews</td>
</tr>
<tr>
<td>Total miles represented</td>
</tr>
<tr>
<td>Average trip length</td>
</tr>
<tr>
<td>Total disablements reported</td>
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<tr>
<td>Per million car miles</td>
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</table>
Only 3.7 percent of cars experiencing a tire disablement had no usable spare. The lack of a spare, therefore, accounted for only about 1 in 10 of the cases in which assistance was required.

Of the disabled tires, about 2 in 5 were reported to be repairable: reusable—52, not reusable—71, driver did not know—24, total—147.

Tire disablements were a little more common than all other mechanical disablements combined during the survey period. This might not have been true in midwinter. Engine overheating is the most common mechanical disablement; out-of-gas was not considered to be a disablement (Fig. 4).

**TIRE STUDY 2: USE-AND-CONDITION SURVEYS**

During October and November 1966, tires on 1746 four-tired vehicles were examined in the parking areas of the five service centers shown in Figure 1. This was to obtain a sample of condition of tires in use on the Tollway.

Drivers were persuaded to cooperate; they could not be compelled. Surveys were conducted 16 hours per day 7 days per week. More than 90 percent of those "invited" to have tires examined consented.

Pressure in each tire was measured and correction made to give equivalent cold pressure. Depth of each groove was measured where exposed. Load on each tire was weighed and tire was examined on visible tread and sidewalls for cracks and blisters.

Distribution of the 6984 tires examined according to amount of tread groove remaining in each is shown in Figure 5. Groove depths are represented by the tapering black bar across the bottom of the chart. The smaller percents of tires with great groove depth, shown at the left, result from the fact that few new tires have grooves deeper than \( \frac{5}{32} \) in. The area under the curve represents the 6984 tires examined. The area under the curve in the shaded part represents tires that do not meet the inspection standard requiring more than \( \frac{5}{32} \) in. of tread groove remaining. This is 4\( \frac{3}{4} \) percent of the total number of tires.

Load on each tire was compared to the rated or permissible load for that tire with the air pressure in it. Pressures measured were corrected to give equivalent cold
pressure. Modal load was about 80 percent of rated load. The shaded area in Figure 6 under the curve at the right represents 5.9 percent of tires that were overloaded for the pressure in them but not exceeding the maximum allowable pressure. Although 5.9 percent of the tires were overloaded, only 1.8 percent carried more than a 10 percent overload.

The percent of tires that should have attention for various reasons is shown in Figure 7. Overload and worn treads, which were shown in Figures 4 and 5, are most common. Together they account for half of all tire deficiencies. Overloaded tires would not be discovered by usual inspection procedures, first because load is not weighed and second because loaded vehicles are rarely presented for inspection. Note in Figure 7 that more than half the tires with overload and almost all of the tires with too much pressure (usually more than 32 psi) could be corrected simply by adding or releasing air. The inflation condition of the tires may be summarized as follows: satisfactory for load 92.2 percent, underinflated (needs more air)—3.5 percent, overinflated (needs less air)—1.8 percent, and overloaded (needs less load or larger tires)—2.5 percent. The overloaded tires could not be corrected by air pressure change. The load on the wheel should be reduced or a larger tire should be provided.

The distribution of station-wagon tires by percent of permissible load for actual air pressure was quite similar to that for all cars (including wagons) shown in Figure 6. For cars excluding wagons, the average actual load was 80.1 percent of permissible load at existing pressure, and for wagons alone the average was 80.4 percent. Therefore, in general, station-wagon tires were loaded about the same as those on other vehicles. Slightly fewer station-wagon tires (5.8 percent) had too much load for pressure in them than tires on other cars (6.0 percent). The difference is too small to be significant.
A total of 1117 tire ailments was observed (not including uneven wear) on 1022 tires. In other words, few tires had more than one ailment. The 1022 tires with ailments represent 14.7 percent of all 6984 tires inspected.

These 1022 deficient tires were on 607 vehicles. This is an average of 1.68 ailing tires on the cars that had any deficient tires. If 607 cars have 1022 ailing tires among them, nearly 415 would have more than one deficient tire. Thus, approximately 2 out of 3 cars had more than one ailing tire.

Among 1746 cars surveyed, there were 1022 ailing tires. This would average 0.59 ailing tire per car. Among these cars, 607 (34.7 percent) had one or more tires about which something should be done. Thus, about 1 tire in 7 should have attention but 1 driver in 3 should do something about 1 or more tires.

TIRE STUDY 3: TIRE DISABLEMENTS NOT RESULTING IN ACCIDENTS

For the 12 months of the study, patrolmen on the Tollway were requested to make a special report when they encountered a car stopped on the roadside with a disabled tire. The report included the same data collected in the use-and-condition survey, except that the load on tires and air pressure in the disabled tire could not be measured. However, data were collected on the damage to the tire and the circumstances of its disablement.

The relationship of car age to tire disablements can be examined by comparing the percent of new, medium, and old cars in the general travel population with cars experiencing disablements. The comparison may be represented by "risk indexes" in which the risk of disablement of the average car is 1.00. Groups of cars with less than average risk will have indexes lower than 1.00; those with more than average risk greater than 1.00. Table 2 gives risk indexes by size of car for two comparisons: the cars with and without disablement in Tire Study 1 and all cars in Tire Studies 2 and 3. These show that old cars in Tire Study 1 were nearly three times as likely to experience disablements as new cars. In Tire Study 1 data were obtained for both disablements and nondisabilities at the same time and place. Other indexes were computed from data
TABLE 2

<table>
<thead>
<tr>
<th>Age of Cars (yr)</th>
<th>Tire Study 1</th>
<th>Tire Study 2 and 3</th>
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<tbody>
<tr>
<td>1 and 2</td>
<td>0.6</td>
<td>0.5</td>
</tr>
<tr>
<td>3 through 8</td>
<td>1.2</td>
<td>2.1</td>
</tr>
<tr>
<td>9 or more</td>
<td>1.7</td>
<td>3.0</td>
</tr>
<tr>
<td>Average all cars</td>
<td>1.0</td>
<td>1.0</td>
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Comparisons were made of a number of other circumstances of tire disablements. From these, the following circumstances seemed to have no effect on the likelihood of disablement: age of driver, sex of driver, 4-ply or 2-ply with 4-ply rating, power steering, and state of registration.

Comparing tread wear of disabled tires (Tire Study 3) with those in general use (Tire Study 2) permits calculation of disablement indexes for various remaining tread depths. Applying the disablement rates and mileage figures obtained in Tire Study 1 gives approximate disablements per 100,000 car miles for various degrees of tread wear. These are shown in Figure 8.

Note that the disablement rate curve rises sharply after wear reduces groove depth to less than $2/32$ in. This fact supports $2/32$ in. as an inspection standard requirement. Bald tires appear to be about 45 times as susceptible to disablement as new tires.

TIRE STUDY 4: TIRE DISABLEMENTS FOLLOWED BY ACCIDENTS

For this part of the program, police were asked to make a supplementary 4-page tire report whenever any tire on a 4-tired vehicle was disabled after an accident for any reason whatsoever. When applicable, the same form was used for disablements not followed by accidents and the use-and-condition survey. It was hoped to obtain the collected— for example, comparing Tire Study 1 and Tire Study 2. These gave greater range of risk indexes. It is logical that old cars would have old tires that would be more likely to give out.

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special reports on all such events, but it was realized that this would be impossible in practice. To estimate the number missed by police, all accident reports were examined to determine how many additional accident reports mentioned tire disablement in describing damage or explaining the accident. Then telephone calls were made to a random sample of drivers involved to inquire whether there had been unmentioned tire disablements. These resulted in the following 235 estimates of the number of accidents to 4-tired vehicles accompanied by tire disablements: supplementary police reports, tires obtained—39; supplementary police reports, tires not obtained—41; stated or inferred from official accident report—30; actually reported in phone survey—2; and estimated additional on basis of phone survey—123. This estimate is, if anything, high.

During 12 months there were 1566 motor-vehicle accidents (18 fatal to 21 people) reported on the Tollway involving 2582 vehicles, of which 2196 were four-tired. Of these, 112 (5.1 percent) were known to have had disabled tires afterward and there may have been as many as 235 (10.7 percent). Some cars had more than one disabled tire after the accident.

An Institute staff member tried to obtain for examination each disabled tire reported by police. Altogether 39 such tires were obtained.

Figure 9. Disablements followed by accidents.

Figure 10. Opinions about disablements followed by accidents.
Circumstances of the accident, the supplementary tire report, and the tire (when available) were studied separately by at least two staff people independently to try to determine whether the tire was disabled before or as a result of the accident. The result was: unquestionably disabled before accident—5.5 percent, doubtful cases—9.8 percent, and unquestionably disabled by the accident—84.7 percent.

Equally good and complete data were not available for all accidents after which a tire was disabled. With the "best" data, the questionable cases were few; with "better" data questionable cases were much more numerous (Fig. 9). The minimum number of disablements preceding accidents is shown by the black areas in Figure 9; the maximum number by the shaded area plus the black area. The total area of all three bars represents 235 four-tired vehicles that had flat tires for any reason after the accident. This is 10.7 percent of all 4-tired vehicles in accidents on the Tollway during 12 months.

In 12 months, there were altogether 1486 accidents involving 2196 four-tired vehicles. Thirteen definitely and an additional 23 possibly had disablements before the accident. Thus, at least 0.9 but not more than 2.4 percent of all such accidents could be counted as contributed to by tire disablement. That would mean that 1 disablement
in at least 4600 but not more than 1 in 1700 was followed by an accident. You might say that at least 99.94 percent of drivers successfully coped with tire disablements.

Accidents following tire disablements were compared to those with a number of other contributing circumstances. During the 12 months not more than 36 accidents followed tire disablements. However, in the same time, at least 75 accidents involved large animals, mainly deer. Remember that this is a well-fenced and mainly urban road.

Careful study of all available data showed that of an estimated 235 tires flat after accidents, not more than 18 percent were positively or possibly disabled before (Fig. 10, right column). But drivers (Fig. 10, left column) reported more than twice as many (37 percent) flat before. It appears to be easy to blame a flat tire for an accident. Police (Fig. 10, middle column) reported 27 percent. Note also that drivers are least in doubt and that the experts with the most complete data most in doubt.

Position of tires disabled before accidents for which special reports were available is as follows: left front–8, right front–6, left rear–10, and right rear–7. There are too few cases to make these differences very significant.

Most cars with a disabled left rear tire are supposed to veer in the same direction, but this is not necessarily so (Fig. 11). Therefore, we may infer that driver response to tire disablement, possibly overreaction, is usually also a contributing factor in these accidents.

The percent of Tollway drivers who were women is indicated by data from Tire Study 2. These were not involved in disablements or accidents. The percent of drivers experiencing disablements is indicated by data from Tire Study 1. Women in this study experienced disablements but not accidents. Tire Study 3 also gives the percent of drivers experiencing disablements but not accidents who were women. But Tire Study 4 gives the percentage of drivers who had accidents following disablements who were women (Table 3). The difference between Study 1 and Study 2 in percent of women drivers suggests that women are a little more likely to experience disablements but it is too small to be very significant. Theoretically the percent of women drivers experiencing disablements should be the same for Studies 1 and 3. The fact that the percent of women in Study 3 was nearly three times as great as in Study 1 may be explained by a circumstance of data collection: fewer women change tires than men, and women who do are likely to be delayed more than men. Women would then be much more likely to be encountered by a passing patrolman who would record data on a disablement not followed by an accident. Therefore, we cannot conclude that women are more likely than men to experience disablements.

But the fact that 42 percent of the drivers experiencing accidents after disablements were women cannot be overlooked and cannot be explained by an artifact of data collection.

By comparing data for the general driving population (Tire Study 2) with those for drivers having accidents after tire disablements (Tire Study 4), risk indexes were computed by age and sex for accidents following disablements (Fig. 12). The average driver would have an index of 1. Girls less than 20 years old had an index of about 22,
which means that they were about 22 times as likely as the average driver to have an accident after a tire disablement. All women and boys had indexes greater than 1.0. Although the number of cases is small (33), the difference between the average and all drivers less than 20 years old and all women drivers was so great that it is statistically significant at the 0.01 level.

**APPLICABILITY OF RESULTS**

People who pay to use a toll road are likely to afford better tires than other car owners. This suggests that toll road disablements and resulting accidents might be less than such events elsewhere.

On the other hand, high speeds are more likely to cause disablements and make coping with them more difficult. This suggests that toll road disablements and resulting accidents may be more prevalent than elsewhere.

To what extent these opposing considerations may offset one another would be difficult to guess. Hence, how much these data for a toll road apply to all traffic in the U. S. would be difficult to assess.

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**Discussion**

M. PETER JURKAT, Stevens Institute of Technology—The authors have gone about finding the relationship between automobile accidents and a particular factor, tire disablements, in the correct manner. First they determined the role that tire disablements play in the accidents that occurred during the time and place of their investigations. They did this by intensive case studies. Second, they determined as best they could all the occurrences of tire disablements in which no accidents resulted. A step of this nature has not been given enough emphasis in previous accident research. It is only after completion of both of these steps for many factors thought to cause accidents that proper weights can be assigned to each factor in the total accident picture.

In several places the paper speculates that the tires used by cars that travel on toll roads are in better condition with regards to disablements and tread remaining than
those in general use. The data collected during a tire-use study conducted by Stevens during the summer of 1967—east of the Mississippi River—confirm these speculations. This latter study was conducted at service stations on all kinds of roads—limited access, urban streets and rural highways. Concerning disabling, we found the rate to be 113 per MVM as opposed to the 46 per MVM as reported in the paper for tollway-like roads. I expect the figure reported in the paper to be more precise than the one found in our study since ours depended on driver memory concerning tire failures and annual mileage, and on sampling across many kinds of roads. However, I think it can be concluded that the general vehicle has more tire failures than the toll road vehicle.

Concerning tread depth, the paper reported that 4.25 percent of the tires measured on the toll roads had less than \( \frac{3}{8} \) inch of tread left, whereas we found that more than twice as many, 11.8 percent, fell into this category. Our entire distribution of tread depth was more skewed toward the lower tread depth than that found by the authors. On the Tollway, only \( \frac{3}{4} \) of 1 percent of the tires were found to be retreads; we found nearly 5 percent. The load condition of these tires was almost identical: on the Tollway, 5.9 percent of the tires were overloaded for the pressure in them; the Stevens study found 6.2 percent.

I think the point is clear. Automobiles on toll roads, and by extrapolation, on divided, limited-access roads, exhibit better tires than those on all vehicles.

Concerning the curve presented in the paper showing the relationship between disablement rate and tread depth, the paper points out that the usual minimum tread depth allowed by inspection stations, namely \( \frac{3}{8} \) in., occurs at the point in that curve where the disablement rate begins to increase very rapidly. The curve shows that on tires with \( \frac{3}{8} \) in. of tread depth about 150 disablements per MVM will occur, and that for tread depth less than that standard, a rapidly increasing disablement rate will occur. Therefore, the first prerequisite for a standard, namely that conditions that break it are concomitant with undesirable results, is met by the \( \frac{3}{8} \)-in. standard. Another prerequisite for standards concerns hardships felt by the population affected by the standard. The overall average for disablements found in this study, 46/MVM, and the one found by the Stevens study, 113/MVM, are well below the 150/MVM shown for tires with \( \frac{3}{8} \) in. driven on toll roads. This indicates that the public maintains its tires in sufficiently good condition so that the disablement rate is below that for tires, which are driven at high speeds for long distances, with \( \frac{3}{8} \) in. of tread. One aspect of maintaining this condition is keeping more than \( \frac{3}{8} \) in. of tread. A minimum of \( \frac{3}{8} \) in. of tread would then seem to be a good standard to avoid tire disablements.

HOWARD DUGOFF, University of Michigan—The current paper is a summary of the findings of four separate studies that have been described in greater detail elsewhere (1, 2, 3, 4). This discussion is based on a reading of not only the summary paper but also of the four source reports.

Tire Study 1 was an attempt to ascertain the frequency of tire disablement; i.e., disablements per mile of travel, under the driving conditions studied. From the standpoint of the highway safety researcher, the principal reason for seeking this information was to permit its utilization, in conjunction with independent data on the incidence of accident/disablement combinations, to estimate the probability that an accident will occur in the event of a tire disablement. Taken alone, however, the disablement rate data certainly constitute an impressive testament to the durability of the modern automotive tire. They also permit the authors to speculate as to some possible cause/effect relationships underlying various descriptive statistics, which they develop. The limitations of this approach are well known. They may be illustrated by discussing a particular example.

Trips averaging 18 miles had 1.57 times as many disablements per MVM as trips averaging 64 miles. The authors attribute this discrepancy to the fact that a greater percentage of the vehicles employed for the short trips were old; i.e., "that worn tires
used on short trips rather than trip length accounts for the lower disablement rate for longer trips."

This certainly seems to be a reasonable explanation. It seems equally reasonable, however, that aside from those tire failures that are directly attributable to so-called road hazards, the likelihood of disablement in the first few miles of high-speed operation is much greater than in subsequent miles. This could also be the reason for the observed discrepancy between the "short trip rate" and the "long trip rate." This is not to say that it necessarily is, merely that the explanation hypothesized by the authors may not be either. Other possible explanations of the fact that the "short trip" and "long trip" data correspond to different road sections can also be readily hypothesized.

The objective of Tire Study 2 was to investigate the condition and use of tires in a particular vehicle population. The Office of Vehicle Systems Research of the National Bureau of Standards has supported extensive studies by Southwest Research Institute and Stevens Institute of Technology to make virtually identical measurements for other, more general, vehicle samples. It will certainly be of great interest to compare the results of the three large surveys when all are available. Taken in aggregate, they should provide a rich data base for (a) the vehicle dynamicist, who wishes to estimate variations in tire mechanical properties and, in turn, vehicle response characteristics associated with realistic ranges of tire service conditions; (b) the safety researcher, who needs control data for use in connection with data on the characteristics of vehicles involved in accidents; and (c) the standards setter, who wants to know under what ranges of conditions it is appropriate to try to protect the public.

Pending the release of the NBS data, a smaller, more limited sample of independent results is available for comparison purposes. These are values of tire tread depth measured on 1222 cars selected at random at gasoline stations in Ann Arbor, Michigan, that were collected as control data in connection with a study at the Highway Safety Research Institute.

The HSRI data are plotted, together with corresponding results of the authors, in Figure 13. It will be noted that there is a substantial discrepancy. In light of the
earlier discussion, it does not seem appropriate to attempt an after-the-fact explanation. The vehicle sample considered by the authors (i.e., cars people use on toll road trips) is one that "probably represents tires in better than usual condition," whereas the HSRI data were generated locally in Ann Arbor, an area characterized by a large population of students and professors—a group that might be expected to have tires in worse than usual condition.

Tire Study 3 was an investigation of the circumstances surrounding tire disablements. Its main result concerns the variation of disablement rate (flat tires per vehicle-mile) with tread depth. This result appears to provide one basis for an objective criterion for a tread/depth inspection standard; as such, it is virtually uniquely valuable.

Of the four studies summarized in the paper, the results of Tire Study 4 are potentially of the greatest relevance from the standpoint of the safety researcher. Here the authors have attempted to draw broad conclusions concerning the relationship between tire disablement and accident causation. Unfortunately, some of the conclusions reached appear to be founded on somewhat less than solid ground.

Of the total vehicle population studied, only 13 cases are considered by the authors to represent "definite" instances where an accident actually followed a disablement. Of these 13 definite instances, data on tire condition were available to the authors for 10. Data were also available for 7 other cases in which it was "questionable" whether or not the disablement preceded the accident. All of the conclusions reached by the authors concerning the condition of tires whose disablement preceded an accident are based on analysis of this sample of 17, 7 of which the authors qualify by the statement, "it is likely that most of these 7 were not actually disabled before the collision (4)."

The conclusions drawn concerning the characteristics of drivers involved in accidents following disablements are based on analysis of 33 cases in which the disablement either "definitely" or "possibly" preceded the accident. By the authors' classification, the probability that any particular case in this sample represents an instance where a disablement definitely preceded an accident is just about 1 in 3. In light of this, it appears clear that the various risk indexes presented in the paper should be interpreted with a considerable degree of discretion.

Since so many of the authors' results in Tire Study 4 depend on the evaluations that were made to determine exactly how many disablements occurred just prior to accidents, and since these evaluations contrasted so markedly with driver and police reports, it is of great interest to examine the methods used by the authors to make their evaluations. These are not described in the paper. However, they are discussed in the source report (4). Although the techniques are (inevitably) arbitrary and subjective, they do appear to provide a much better basis for making an accurate after-the-fact judgment than either the police or driver reports. On the other hand, it seems clear that such an authoritative statement as "at least 99.94 percent of the drivers are apparently able successfully to cope with a tire disablement," is not warranted by the accuracy of the analysis techniques employed.

The authors are to be commended and thanked for a complete and painstaking job of data collection. Although some criticism has been directed at certain interpretations and extrapolations of the statistical results, the results themselves must be recognized as having potentially great value to the highway safety research community. The authors have asserted a need for research directed to basic fact-finding on which safety program judgments can be more solidly based. Their findings certainly represent a significant step in that direction.

References


J. STANNARD BAKER, Closure—It is gratifying to an author when discussants point out no important deficiencies in his work.

The small number of solid examples of accidents following disablements collected in a year is conceded to be a disappointing base for conclusions about how and why they occur. But until more prolonged studies give more cases, they must be considered at least as suggestive. The fact remains that tire disablements are not so great or inevitable a contributor to accidents as unsupported rumors might have one believe.

The data on condition of tires not in use on a toll road confirm the authors' suspicions that tires in the study were in better condition than normal, but it does not help solve the problem as to applicability of data from Tire Study 4 in estimating nationwide contribution of tires to auto accidents.

The two additional hypotheses offered by Dugoff for higher rates of short-trip toll road users had been considered but were not believed to be as cogent as the one offered. Roadway differences for the longer trips are scarcely noticeable on a toll facility. That tires might be more likely to fail during the first few miles of toll road driving is a possibility. It could be that if heating were to disable the tire, temperature would rise enough in the shorter trips to do the damage; and if it did not, the tire would continue to function on a longer trip. Or it could be that puncturing objects picked up on less clean roads would be likely to give trouble soon after entering the toll road. But the fact that car age was less (50.0 percent new) for long trips than short ones (35.8 percent new) suggests that short-trip tires were more worn and therefore more likely to give out.