REFLECTORIZED LICENSE PLATES: DO THEY REDUCE NIGHTTIME REAR-END COLLISIONS?

by

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ABSTRACT

The Commonwealth of Virginia randomly distributed 100,000 sets of experimental reflectorized and 100,000 sets of control nonreflective 1971 license plates. Each Division of Motor Vehicles distribution point in the state received and sold a pro rata number of each type. Plates were distributed evenly throughout each day of the distribution period.

Accident data for the vehicles using experimental and control plates were collected for a 12-month period. These data were specifically coded and stored for retrieval by the Department of State Police. The reporting format distinguished between the striking vehicle and the vehicle struck. Reflectorized/control comparisons involved statewide data concerning nighttime and daytime accidents. The age of the driver, his driving experience, the age of the vehicle, and the weather conditions at the time of the crash were analyzed, as were data on fatal, personal injury, property damage, and total accidents.

It was concluded that there was no statistically significant difference between the number of nighttime rear-end collisions of vehicles equipped with reflectorized license plates and that of vehicles equipped with control nonreflective license plates.

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INTRODUCTION

The issue of reflective material being used on license plates has been of interest to manufacturers, researchers, and highway safety enthusiasts, both in the United States and abroad, at least since 1950. The Virginia Highway Research Council has conducted previous studies on the use of reflectorized license plates. One of these, by C. B. Stoke and C. H. Simpson,(1) dealt with the legibility and visibility aspects. Field experiments were carried out on an unopened section of interstate highway and the plates were attached to the rear of an automobile. The results were similar to those from previous studies.(2, 3, 4)

Legislation regarding the use of reflectorized license plates has been introduced on several occasions in the Virginia General Assembly, and the 1970 session authorized the issuance of experimental reflectorized plates. [Virginia Code Annotated § 46.1-103.1 (1970)]. Pursuant to this statute the Division of Motor Vehicles was directed to issue 100,000 sets of reflectorized tags and 100,000 sets of specifically designated nonreflectorized tags to serve as a control group for the purposes of research. All tags had black numbers on a white background.

The main question to be answered prior to the adoption of reflectorized license plates is whether or not they offer safety benefits as shown through decreased nighttime rear-end collisions. Several studies have purportedly demonstrated crash reductions attributable to reflectorized plates. A 1959 study conducted in Polk County, Iowa(5) divided resident vehicle owners into two groups: one group (60.1% of the total) was provided reflectorized plates while the other group (39.9% of the total) was given regular steel and enamel plates. The study found that the distributions of night rear-end collisions involving parked cars differed markedly between the two groups of plates; 76.7% of the struck cars did not have reflectorized plates.

The Polk County study was deficient in its sampling design in that the experimental plates were put on sale first and sold until the supply was exhausted. The possibility exists that persons who purchased their plates early differed in social, psychological, and other demographic characteristics from the later group of purchasers. This study did not take into account the number of accidents which occurred in daylight hours or vehicle conditions other than parked. It also did not determine if the accident differences between the two groups were statistically significant.

Reflectorized tags were adopted in North Carolina in 1967 with the requirement that they be evaluated for their crash reduction effectiveness. A study on the safety benefits of reflectorized tags was conducted by the Highway Safety Research Center of the University of North Carolina. Researchers studied the rates of involvement in rear-end collisions for cars bearing reflectorized plates and those having nonreflectorized plates during a six-week grace period when old tags were being replaced. This approach avoided the difficulties inherent in "before and after" studies but the design was suspect because a distribution method similar to that of the Polk County study was used and persons purchasing tags early might have differed in some characteristics from those purchasing late. The authors state, " circumstances of sample size and unavoidable limitations of study design preclude assertion that the effectiveness of reflectorized plates has been proved in an absolute sense."(6)

PURPOSE

The purpose of this study was to determine if the use of reflectorized license plates provides a safety feature through a reduction in nighttime rear-end collisions.

METHODOLOGY

The Virginia study followed a specific method for the distribution of control and experimental license plates for 1971. Data collection and analyses also occurred according to a predetermined format.

Distribution of Plates

The importance of the random distribution of the license plates should be emphasized. The purpose of random assignment is to sample the general population and its characteristics before experimental use of the plates, thus the experimental group differs in only one measurable respect, reflectorization, from the control group. Prior random selection permits the application of statistical logic to the assessment of obtained differences on the experimental variables (rear-end and parked collisions at night) after use of reflectorized plates. A failure to randomize opens the possiblity that the experimental and control groups do not represent the same driving population.

The method used by the state of Virginia to distribute 100,000 sets of reflectorized and 100,000 sets of control group 1971 license plates provided a sampling mechanism which lent itself to statistical analysis. The numbers of reflectorized and control plates sold at each of the distribution points throughout the state were calculated on the basis of the numbers of plates sold during the preceding year. The 100,000 sets of each type were pro rated for each distribution point according to the percentage of plates sold in 1970 to the total issue for the state. For example, a distribution point which had issued 5% of the total passenger car license plates during the preceding renewal period received 5% of both the reflectorized and control plates. During the distribution period from March 15 to April 15 reflectorized and control license plates were sold on a prearranged basis. Neither type was available upon request by the purchaser. Equal

numbers of both types were sold each day of the renewal period. This method was used to assure geographical coverage of the entire state, to prevent all the experimental plates from being sold at once, and to assure all groups an equal opportunity to obtain such plates.

Data Collection

In order to determine if a distinct safety advantage accrues to the user of reflectorized license plates, it was necessary to compare the 1971 accident data of the group which used reflectorized plates with those of the group which used control nonreflective plates on their vehicles. Rear-end and parked collisions were considered for the safety benefit analysis, because it is in the reduction of these types of accidents that reflectorized license plates are supposed to have their most important benefits.

In determining collision reduction, multi-vehicle crashes were considered and the reporting scheme distinguished between the striking vehicle and the vehicle struck. Data on the age of the driver, experience of the driver, the age of the motor vehicle, and the weather conditions were obtained, as were data for fatal, personal injury, and property damage accidents in both urban and rural locations. These factors were analyzed to determine what role they played in accidents involving automobiles with reflectorized or control license plates.

The Department of State Police furnished computer tapes of the accident records to the Highway Research Council. Sufficient time was allowed for the complete reporting of accidents by individuals and investigating officers, and for the information from the accident report forms to be processed by the Division of Motor Vehicles and the Department of State Police.

Control and experimental group accident data were obtained to determine if a distinct safety advantage resulted from the use of reflectorized automobile license plates during the hours from 6:00 p.m. to 6:00 a.m. (nighttime) during the months of October through March, and 9:00 p.m. to 6:00 a.m. from April through September.

Collision data were obtained from nine State Police accident report categories. Table 1 lists these categories and describes the conditions.

TABLE 1

DIRECTIONAL ANALYSIS

(From Crash Facts, Virginia Department of State Police, Richmond, Virginia.)

INTERSECTION ACCIDENTS — REAR-END COLLISIONS

Item 15 Both vehicles in same direction — both going straight

Item 16 Same — one right turn, other straight

Item 17 Same — one left turn, other straight

Item 18 Same — one stopped

Item 19 Same — all others

NONINTERSECTION ACCIDENTS — REAR-END COLLISIONS

Item 22 Both vehicles in same direction — both going straight

Item 25 One car parked — proper location

Item 26 One car parked — improper location

Item 27 One car stopped in traffic

Data Analyses

There were two basic questions to be answered by analyses of the data. First, were the reflectorized and control license plate samples comparable groups? Although considerable effort was expended to randomly distribute the plates, and therefore have similar groups (R vs. C), the data were tested to determine if in fact the groups were similar. The question was resolved through the use of statistical tests applied to the following catagories of daytime accidents: (1) Crashes* by type; (2) collisions by type; (3) the ages of the drivers involved in the accidents; (4) the driving experience of these operators; (5) the ages of the vehicles involved; and (6) the weather conditions at the time the accidents occurred. Also used were nighttime crashes and collisions (excluding the experimental variables) by type. Data for these analyses were obtained from the Virginia Department of State Police.

The 50% Probability Test is used to compare any two things expected to differ from one another only by chance. It is an extended version of the Binomial Test for cases in which the known or expected average is 50%. The test is designed for comparing two samples of isolated occurrences, e.g. accidents, if the expected number of occurrences in each sample is the same. This is the case when both samples have the same duration and are drawn from parent groups of the same size. This test was used to determine if differences in the number of rear-end collisions of passenger cars with reflectorized license plates and that of passenger cars with control nonreflective license plates occurred due to chance. Individual data cells were compared and the computed values are included in the appendixes.

The conventional way of comparing two samples of isolated occurrences is to use the two cell Chi-Square Test with Yates' correction, but the 50% Probability Test gives identical answers with large samples, and more accurate answers with small samples. (7)

*The term "crash" is herein defined as any reportable traffic accident. The term "collision" is defined as two or more motor vehicles involved in a crash.

The data required for the 50% Probability Test are:

x = Number of occurrences in smaller sample

y = Number of occurrences in larger sample

x + y = Number of occurrences in both samples

To calculate the value X^2, the following formula was used:

$$X^2 = \frac{(|x - y| - 1)^2}{x + y}$$

The critical values of X^2 for this test are 3.84 for $P < 0.05$ and 6.63 for $P < 0.01$.

If the control nonreflective license group is not statistically different from the experimental reflective license plate group, one can proceed to the second question. Is the nighttime collision experience of vehicles equipped with experimental license plates significantly less than the nighttime collision experience of vehicles equipped with control license plates? To resolve this question, data on night comparisons by (1) collision type, (2) directional analysis, (3) fatal, personal injury (PI), property damage (PD) accidents, and (4) weather conditions (WC), driver experience (DX), driver age (DA), and vehicle age (VA) were used. The analyses proceeded along the following schematic format in making statistical comparisons.

Crashes → Collisions → Rear-end Collisions →
1. Directional Analysis
2. Fatal, PI, PD
3. WC, DX, DA, VA

The standard Chi-Square Test for distributions of data and the 50% Probability Test for sets of data were used in determining if the collision distributions and individual data sets of the two groups differed significantly with respect to accident occurrence or if the differences could be ascribed to chance. The data for these analyses were furnished by the Virginia Department of State Police. These tapes contained crash facts for the 1971 license plate year rather than for the 1971 calendar year and were specifically developed for this study.

RESULTS OF ANALYSES

Analyses of the data occur in two stages. First, it is necessary to determine if the two study groups had similar accident experience in cases where reflectorization would not be an influencing factor. Second, if the groups are similar in these cases, what is the nighttime rear-end and parked collision experience of the two groups?

Are The Experimental And Control Groups Comparable?

In determining the comparability of the two study groups, factors which represent the influence of the vehicle, the roadway, and the driver on crashes were analyzed. In addition, comparisons were carried out for day crashes and collisions and for night crashes and collisions (excluding the experimental variables).

The data presented in Tables 2, 3, 4, and 5 include every accident involved vehicle from the two study samples. The data presented in the remainder of this section include only the vehicles involved in the primary collision. The inclusion of all crashes more adequately represents the true picture of vehicle crash involvement. The use of only the primary rear-end and parked car collisions controls for those factors where neither plate type nor other driver, vehicle, or roadway characteristics influence vehicle collision involvement.

The statistical comparison presented in Table 2 shows that the number and distribution of daytime crashes of vehicles equipped with reflectorized license plates were not different from those of the vehicles equipped with control nonreflective license plates.

TABLE 2

DAY COMPARISON BY CRASH TYPE

Crash Type	Reflectorized	Control
With Another Motor Vehicle	5447	5401
Other Noncollision	13	16
With Fixed Object	80	70
Overturned in Roadway	14	16
Ran Off Roadway	464	478
All Other and Not Stated	124	122
TOTAL	6142	6103
Chi-Square = 1.727 (Not Significant at the 0.05 level)		

Table 3 presents the nighttime crash comparisons. The criterion variables rear-end and parked have been subtracted from the category with another motor vehicle, thus permitting an analysis of crash differences at night. The reflectorized and control nonreflective groups did not have statistically different crash experiences with respect to the remaining variables.

Table 4 presents data on the comparisons of daytime collisions. Note specifically the category of Parked. The reflectorized and the control license plate groups did not have a statistically different experience for the total number and the distribution of these collisions.

TABLE 3

NIGHT COMPARISON BY CRASH TYPE

Crash Type	Reflectorized	Control
With Another Motor Vehicle (Minus Rear-end and Parked)	864	881
Other Noncollision	7	5
With Fixed Object	68	75
Overturned in Roadway	16	24
Ran Off Roadway	521	473
All Other and Not Stated	101	83
TOTAL	1577	1541
Chi-Square = 6.106 (Not Significant at the 0.05 level)		

TABLE 4

DAY COMPARISON BY COLLISION TYPE

Collision Type	Reflectorized	Control
Sideswipe	1620	1616
Head-On	591	617
Rear-end	1620	1510
Parked	645	645
Not Stated and All Other	971	1013
TOTAL	5447	5401
Chi-Square = 5.113 (Not Significant at the 0.05 level)		

Table 5 presents data on the comparisons of nighttime collisions other than for the experimental variables of parked and rear-end. The two groups did not have a statistically different experience for the total number and distribution of these collisions.

TABLE 5

NIGHT COMPARISON BY COLLISION TYPE

Collision Type	Reflectorized	Control
Sideswipe	392	411
Head-On	249	245
Not Stated and All Other	223	225
TOTAL	864	881
Chi-Square = 0.337 (Not Significant at the 0.05 level)		

Table 6 is a summary of chi-square values obtained when the test was applied to the daytime rear-end categories of data. The distribution of daytime rear-end collisions of vehicles equipped with reflectorized plates, as influenced by weather, driver, and vehicle variables, was not different from the distribution of daytime rear-end collisions of vehicles equipped with control nonreflective license plates. In only one category, Day Intersection Collisions by Vehicle Age, are the differences beyond chance expectations.

TABLE 6

CHI-SQUARE VALUES OF DAYTIME COLLISIONS

Weather Conditions	Chi-Square	Degrees of Freedom
Total Day	7.406	6
Day Intersection	5.634	5
Day Nonintersection	3.206	5
Driver Experience		
Total Day	2.792	4
Day Intersection	1.406	4
Day Nonintersectior	5.770	4
Driver Age		
Total Day	0.729	9
Day Intersection	2.561	9
Day Nonintersection	6.447	8
Vehicle Age		
Total Day	9.896	8
Day Intersection	17.545*	8
Day Nonintersection	14.854	8

* Significant at 0.05 level

Table 7 is a summation of the results of the 50% Probability Test, presented in Appendixes A-D, applied to the daytime weather, driver and vehicle categories. These are comparisons of individual data sets within each of the distributions of daytime rear-end collisions. Of the total data sets analyzed, 98 daytime sets were not statistically different and seven daytime sets were found to be different at the 5% level, and the majority of those are in the Day Collision by Vehicle Age category.

TABLE 7

SUMMARY OF 50% PROBABILITY RESULTS FOR DAYTIME COLLISIONS

Category	Weather Conditions	Driver Experience	Driver Age	Vehicle Age
Number of Statistically Different Day Categories	2	1	0	4
Number of Day Categories with no Statistical Difference	25	17	33	23
Total Possible Categories Compared	27	18	33	27

Appendix A presents the 50% Probability values for rear-end collisions which occurred during various weather conditions. The 50% Probability values in Appendix B present information for determining the influence of driver experience and license plate type on rear-end collisions. Appendix C presents the 50% Probability values

with regard to driver age and license plate type. The 50% Probability values for the vehicle age variable are presented in Appendix D.

Collision frequency for the 100,000 vehicles with control nonreflective license plates was not different from the collision frequency for the 100,000 vehicles with reflectorized license plates when weather, driver, and vehicle variables were considered.

The overwhelming similarity of data presented in this section — i.e. day crashes and collisions; night crashes and collisions (excluding the experimental variables); and the influence of weather conditions, driver experience, driver age, and vehicle age on the accident experience of automobiles using reflectorized and control nonreflective license plates — led to the conclusion that the two groups were similar. Having determined this, one could determine if reflectorization reduced nighttime rear-end collisions.

Are Rear-end Collision Results Comparable?

Table 8 presents the results of the 50% Probability calculations for total nighttime rear-end collisions by accident type. Fatal, personal injury, property damage, and total accidents are shown for both study groups. Also included is a calculated number of control nonreflective collisions necessary for the computations to be statistically significant at the 5% level when the number of reflectorized collisions is held constant. It is evident that although there were numerical differences between the two study groups, these differences were not greater than could be expected due to chance. Therefore, for these categories of night-rear-end collisions, it was concluded that automobiles with reflectorized license plates did not have a significantly different collision experience when compared with automobiles with control nonreflective license plates.

TABLE 8

REAR-END COLLISIONS AT NIGHT

Category	Reflectorized	Control	50% Test	Calculated*
Fatal	0	1	—	6
Personal Injury	88	98	0.44	116
Property Damage	387	398	0.13	443
TOTAL	475	497	0.45	538

* The number of control collisions necessary for a significant difference at the 0.05 level.

The 50% Probability values by accident type for directional analysis are presented in Appendix E. In every nighttime category, whether fatal, personal injury, or property damage, no statistical difference between the two study groups was evident. The nighttime accident experience of vehicles equipped with the reflective license plates was not statistically different from that for vehicles equipped with the control nonreflective license plates.

Table 9 presents data and the statistical test for the comparison of nighttime collisions of the vehicles equipped with reflectorized license plates and vehicles equipped with control nonreflective license plates. One data set, Parked, is especially noteworthy. This is the one situation where the struck vehicle is most likely to be unlighted. The rear-end collisions for the two study groups are similar for vehicles which are parked. Differences for each data set and the distribution of collisions are not greater than could be expected due to chance. Automobiles with reflectorized and control nonreflective license plates did not have a different collision experience for these two categories of data.

TABLE 9

NIGHT COMPARISONS BY COLLISION TYPE

Type	Reflectorized	Control
Rear-end	472	477
Parked	416	413
TOTAL	888	890
Chi-Square = 0.036 (Not Significant at the 0.05 level)		

Table 10 is a summary of chi-square values obtained for the nighttime rear-end data categories. There were no statistical differences due to the influences of weather, driver, or vehicle factors on nighttime rear-end collisions. The number of nighttime rear-end collisions of vehicles equipped with reflectorized license plates was not different from the number of nighttime rear-end collisions of vehicles equipped with control nonreflective license plates.

Table 11 is a summary of Appendixes F through I, the 50% Probability values for nighttime collisions with regard to weather, driver and vehicle factors. Vehicles with reflectorized license plates did not have a significantly different nighttime rear-end collision experience than vehicles with control nonreflective license plates when these factors were considered.

TABLE 10

CHI-SQUARE VALUES OF NIGHTTIME COLLISIONS

Weather Conditions	Chi-Square	Degrees of Freedom
Total Night	3.269	5
Night Intersection	3.626	3
Night Nonintersection	1.568	3
Driver Experience		
Total Night	0.261	4
Night Intersection	2.318	4
Night Nonintersection	3.393	3
Driver Age		
Total Night	4.585	7
Night Intersection	3.441	7
Night Nonintersection	5.746	6
Vehicle Age		
Total Night	5.260	8
Night Intersection	7.647	7
Night Nonintersection	14.477	8

TABLE 11

SUMMARY OF 50% PROBABILITY RESULTS FOR NIGHTTIME COLLISIONS

Category	Weather Conditions	Driver Experience	Driver Age	Vehicle Age
Number of Statistically Different Night Categories	0	0	0	2
Number of Night Categories with no Statistical Difference	27	18	33	25
Total Possible Categories Compared	27	18	33	27

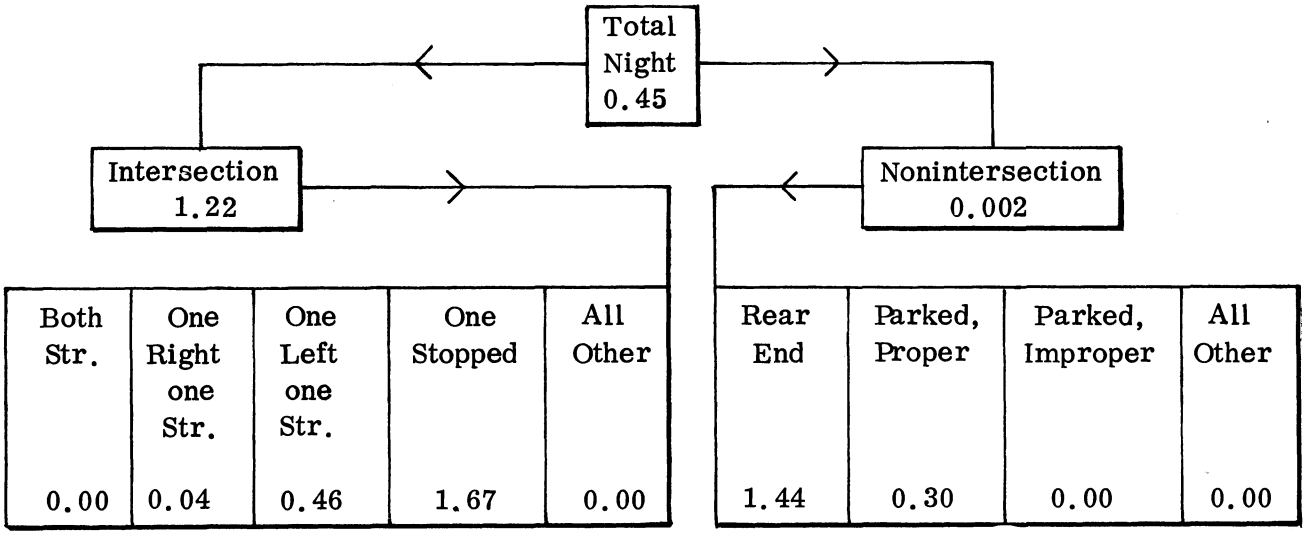
Table 12 is a computation of the 50% Probability values by directional analysis of the nighttime rear-end collision experience of the two study groups. Vehicles equipped with reflectorized license plates and those with control nonreflective license plates did not have a statistically different rear-end collision experience.

In determining whether reflectorized license plates reduce the incidence of nighttime rear-end collisions, four sets of data were compared. These involved differences in fatal, personal injury and property damage collisions; rear-end and parked collisions; directional analysis; and driver, vehicle, and weather factors. For all comparisons there were no significant differences between the number of accidents for the reflectorized group and that for the control nonreflective group.

It is concluded that the null hypothesis, which states that there is no difference between the reflectorized and control nonreflective groups, can not be rejected. It is further concluded that the use of reflectorized license plates does not provide a safety advantage through a statistically significant reduction in nighttime rear-end collisions.

TABLE 12

50% PROBABILITY VALUES BY DIRECTIONAL ANALYSIS



INCREASED COST OF REFLECTORIZATION

A recent estimate of the increased costs for reflectorizing license plates has been prepared by the Virginia Division of Motor Vehicles. For the 1974/75 biennium the increase in costs is nearly $1.9 million ($1,866,750). Virginia is using a multi-year license plate, and therefore the 1976/78 biennium estimate must be considered. The increase in costs is over 1\frac{3}{4}$ million ($1,751,750). The four year cost increase is over $3.6 million ($3,618,500), which represents nearly a 106% increase for reflectorizing license plates.

In view of the fact that the nighttime collision experience has not been reduced for vehicles with reflective plates, and the large increase in costs to reflectorize plates, a positive benefit/cost ratio does not exist.

SUMMARY AND CONCLUSIONS

This project was carried out in two steps. To make proper comparisons of the nighttime rear-end collisions between the two study groups, it was first necessary to determine the comparability of the groups which used each type of license plate. Data on weather conditions at the time of the accident, the age of the driver, his driving experience, vehicle age, day crashes and collisions, and night crashes and collisions (excluding the experimental variables) were analyzed for this determination.

The data and analysis presented in Tables 2 through 7 and Appendixes A through D show that the accident experiences of the two study groups are comparable in those cases where reflectorization would not play a role in accident reduction. It was concluded that the group of vehicles with reflectorized license plates and the group of vehicles with control nonreflective license plates were statistically similar on vehicle, roadway, and driver characteristics, and on the total number and distribution of day crashes, the total number and distribution of night crashes (excluding the experimental variables), the total number and distribution of day collisions, and on the total number and distribution of night collisions (excluding the experimental variables).

After the comparability of the two groups was established, analyses were performed to see if reflectorized license plates reduced the incidence of nighttime rear-end collisions. Accident type, collision type, directional analysis, and weather, driver, and vehicle factors were analyzed to determine if nighttime differences occurred. No significant differences were found to exist in the number of involvements of vehicles equipped with reflectorized license plates as compared with vehicles equipped with control non-reflective license plates. It was concluded that the use of reflectorized license plates did not produce a safety benefit through a statistically significant reduction in the incidence of rear-end collisions at night.

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APPENDIX A

50% PROBABILITY VALUES FOR REAR-END COLLISIONS BY DAYTIME WEATHER CONDITIONS

Weather Conditions								
Clear	Cloudy	Fog	Mist	Rain	Snow	Sleet	Smoke/Dust	Not Stated
Intersection Collisions								
6.93**	0.37	0.44	1.11	0.07	0.27	0.00	-	1.14
Nonintersection Collisions								
0.18	1.31	0.00	0.00	0.19	1.24	0.00	-	0.04
Total								
5.56*	1.55	0.63	0.70	0.28	1.84	0.00	-	0.20

* Significant at the 0.05 level
** Significant at the 0.01 level

APPENDIX B

50% PROBABILITY VALUES FOR REAR-END COLLISIONS BY DAYTIME DRIVER EXPERIENCE

Years of Experience					
Less 3 Months	3-12 Months	1-5 Yrs.	6-10 Yrs.	11 + Yrs.	Not Stated
Intersection Collisions					
2.29	0.32	0.70	0.88	3.46	0.01
Nonintersection Collisions					
0.00	0.00	0.16	3.57	0.84	0.52
Total					
0.75	0.26	0.08	0.05	4.34*	0.51

* Significant at the 0.05 level

APPENDIX C

50% PROBABILITY VALUES FOR REAR-END COLLISIONS BY DAYTIME DRIVER AGE

Driver Age										
Under 16	16-17	18-19	20-24	25-34	35-44	45-54	55-64	65-74	Over 75	Not Stated
Intersection Collisions										
0.00	0.12	0.04	2.80	1.63	1.08	0.14	0.14	0.68	0.19	0.31
Nonintersection Collisions										
-	0.00	0.13	1.70	0.14	0.00	1.12	0.61	0.83	0.00	0.22
Total										
0.00	0.01	0.20	0.39	0.71	0.69	0.95	0.67	0.01	0.04	0.02

APPENDIX D

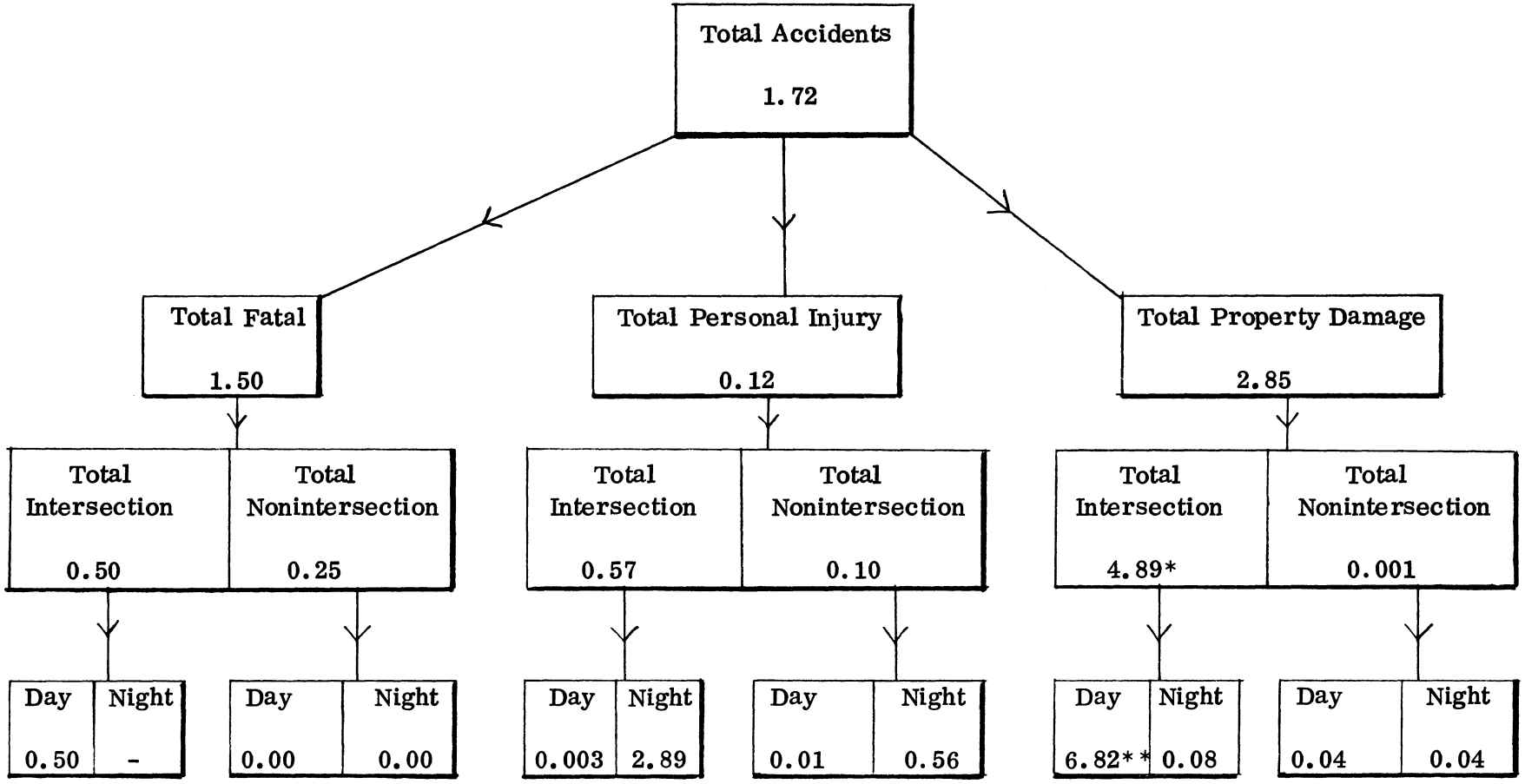
50% PROBABILITY VALUES FOR REAR-END COLLISIONS BY DAYTIME VEHICLE AGE

Vehicle Age								
Current Yr.	1 Yr.	2 Yrs.	3 Yrs.	4 Yrs.	5 Yrs.	6-10 Yrs.	Over 10	Not Stated
Intersection Collisions								
6.08*	2.37	0.10	0.38	9.58**	0.02	0.04	0.41	2.04
Nonintersection Collisions								
0.04	1.19	0.30	3.34	0.37	5.30*	2.82	0.00	0.10
Total								
3.07	0.26	0.41	0.35	4.13*	1.62	0.78	0.36	1.88

* Significant at the 0.05 level
** Significant at the 0.01 level

APPENDIX E

50% PROBABILITY VALUES BY ACCIDENT TYPE



* Significant at the 0.05 level
** Significant at the 0.01 level

Appendix E (Continued)

DAYTIME COLLISIONS

Both Str.	One Rt. One Str.	One Left One Str.	One Stopped	All Other	Rear End	Parked Proper	Parked Improper	One Stopped
FATAL								
0.50	-	-	-	-	0.50	-	-	0.00
PERSONAL INJURY								
0.00	0.05	1.07	0.01	1.64	0.08	0.00	0.00	0.00
PROPERTY DAMAGE								
0.00	3.81	0.41	0.15	8.47**	0.08	0.82	0.24	0.002

NIGHTTIME COLLISIONS

FATAL								
-	-	-	-	-	-	-	-	0.00
PERSONAL INJURY								
0.07	0.67	0.94	0.31	0.27	2.78	0.03	0.00	0.00
PROPERTY DAMAGE								
0.10	0.00	0.02	1.19	0.09	0.07	0.21	0.00	0.00

** Significant at the 0.01 level.

APPENDIX F

50% PROBABILITY VALUES FOR REAR-END COLLISIONS BY NIGHTTIME WEATHER CONDITIONS

Weather Conditions								
Clear	Cloudy	Fog	Mist	Rain	Snow	Sleet	Smoke/Dust	Not Stated
Intersection Collisions								
0.15	3.74	0.00	0.56	0.02	-	0.00	-	0.25
Nonintersection Collisions								
0.003	0.00	0.36	0.27	1.73	0.57	0.00	0.00	0.17
Total Collisions								
0.03	1.69	0.64	0.00	0.60	0.57	0.00	0.00	0.00

APPENDIX G

50% PROBABILITY VALUES FOR REAR-END COLLISIONS BY NIGHTTIME DRIVER EXPERIENCE

Years of Experience					
Less 3 Months	3-12 Months	1-5 Yrs.	6-10 Yrs.	11 + Yrs.	Not Stated
Intersection Collisions					
0.00	0.00	0.18	0.63	1.72	0.00
Nonintersection Collisions					
0.50	0.00	0.54	0.63	1.45	0.49
Total Collisions					
0.00	0.00	0.00	0.01	0.12	0.37

APPENDIX H

50% PROBABILITY VALUES FOR REAR-END COLLISIONS BY NIGHTTIME DRIVER AGE

Driver Age										
Under 16	16-17	18-19	20-24	25-34	35-44	45-54	55-64	65-74	Over 75	Not Stated
Intersection Collisions										
-	0.19	0.52	0.10	1.80	0.35	0.02	0.96	1.50	-	0.02
Nonintersection Collisions										
-	0.00	2.12	2.88	0.02	0.41	0.04	0.00	0.00	-	0.18
Total Collisions										
-	0.03	0.02	1.73	0.88	0.00	0.12	0.43	1.78	-	0.09

APPENDIX I

50% PROBABILITY VALUES FOR REAR-END COLLISIONS BY NIGHTTIME VEHICLE AGE

Vehicle Age								
Current Yr.	1 Yr.	2 Yrs.	3 Yrs.	4 Yrs.	5 Yrs.	6-10 Yrs.	Over 10	Not Stated
Intersection Collisions								
0.00	0.00	1.82	0.57	0.02	0.31	4.30*	0.13	0.00
Nonintersection Collisions								
0.00	0.61	4.21*	0.79	0.00	3.21	0.18	1.56	0.76
Total Collisions								
0.01	0.43	0.37	1.56	0.01	0.72	0.83	0.38	0.52

* Significant at the 0.05 level.