THE EFFECTIVENESS OF HIGHWAY DELINEATORS ON ACCIDENT OCCURRENCE

Prepared by

MICHIGAN STATE HIGHWAY DEPARTMENT

CHARLES M. ZIEGLER, State Highway Commissioner

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Table of Contents

THE EFFECT OF HIGHWAY DELINEATORS
ON ACCIDENT OCCURRENCE

Index to Figures

THE EFFECT OF HIGHWAY DELINEATORS ON ACCIDENT OCCURRENCE

Highway engineers have long sought a means of eliminating or counteracting the effect of darkness on accident occurrence. Accident records have consistently shown that nighttime driving is more hazardous than daytime driving. On the basis of these records, the Planning and Traffic Division of the Michigan State Highway Department has found that night driving conditions are four and one-half times as hazardous as those encountered during the daylight hours. In other words, sixty percent of all fatal and injury accidents on trunkline highways occurred during the hours of darkness when these highways carried only 20 to 30 percent of their 24-hour traffic.

THE NATURE OF NIGHT HAZARDS

The reasons why darkness is specially hazardous are not hard to find, though they are somewhat difficult to define. In both daylight and darkness the motorist must contend with very similar problems of physical arrangement and movement. Although the number of vehicles with which he shares the roadway decreases, the dimensions, alignment, and surroundings of the roadway itself do not change when daylight fades. The motorist's perception of the roadway, however, is radically limited and sometimes distorted at night.

In the daytime the normal driver's vision extends far ahead and to a considerable distance on either side of the road. Sometime before he traverses a section of road the driver can clearly see inherent hazards such as those involved in: (1) Traffic and pedestrians on the road; (2) road alignment and grades; (3) width and condition of road surface and shoulders; (4) roadside developments as they divert attention or obscure vision of road ahead; and (5) roads and driveways from which traffic can enter, cross or leave the highway.

Although exposure to accidents is greater during the daytime concentrations of traffic, the driver can perceive the number, kind, speeds and direction of vehicles well in advance of passing them. Being fore-warned of these elements of his constantly changing driving problem, because the elements are all clearly and coincidentally visible, he ordinarily will have plenty of time to act properly to prevent serious mishaps.

Driver Reactions to Darkness

Darkness blanks practically all of these elements from the driver's sight, but not from his memory. His view of the road is limited to the short section of highway illuminated by his headlights. The rest of the picture is made up of what he knows about roads in general and what he can mentally visualize of the highway ahead through his interpretations of the lights of other cars, the dim outlines of surrounding objects, and glimpses of signs, signals and lane markings.

At night the driver attempts to discern the location of the road beyond the range of his headlights by watching telephone lines, fences, and lights in houses, but he is conscious of the vagueness of his perceptions, particularly those involving perspective. As a result he often becomes tense and over-wary, and is constantly oppressed by the feeling that he is driving into a darkened tunnel or that the road ends or turns abruptly just beyond range of his vision. When facing the glare of approaching headlights, he becomes uncertain of his car's position on the roadway and instinctively draws away from the pavement's right edge, often to the extent of encroaching on the lane of opposing traffic.

Attempts to Increase Visibility

The obvious way to eliminate the dangers of nighttime driving is to duplicate, as far as practicable, daytime visibility through the use of artificial light. Attempts to solve this problem with lights on the car it-

self have thus far proven only partially successful. Floodlight illumination of the highway has met with success on a few heavily traveled highways. However, the costs of constructing and operating such lighting installations have been so great as to prevent the lighting of any considerable mileage of highways.

The dangers of night driving have been offset somewhat by the use of large reflectorized signs to warn the driver of specific danger spots such as narrow bridges, etc. The use of these reflectorized signs has been standard practice in Michigan and other states for several years.

DELINEATION OF THE HIGHWAY

Recognition of the fact that something more than the warning of specific dangers was needed to protect night traffic led to the installation of the special markers or delineators to outline the highway. These delineators are the nearest approach to highway illumination without the use of expensive direct lighting that has yet been attained. Although the delineators give the impression of lights spaced at regular intervals along the road, they do not illuminate the road surface to any important extent. Their principle function is to delineate the highway clearly for a distance ahead of the car considerably greater than that actually illuminated by the headlights.

Delineators and Their Installation

Each delineator consists of three (3) reflector disks set in a vertical line in a metal holder mounted on a metal post. (See. Fig. 1) The disks, molded from a crystal clear synthetic resin that is nonshatterable, are lenses with many facets, each having high reflecting properties.

Considerable study was given to the proper arrangement of the delineators to obtain the greatest safe-driving benefit for motorists. It was found that the proper mounting height was 42 inches above the road surface. Uniformity in longitudinal spacing and offset distance from the edge

Fig. 1 A Delineator Unit Installed on US-16 Between Lansing and Detroit.

of the pavement were essential for accurate delineation of the roadway. Consequently, the Delineators were spaced at intervals of 100 feet, and offset eight (8) feet from the pavement edge in rural areas and four (4) feet in urban areas where the road surface was bordered by a curb.

At places where, by using this regular spacing, a delineator unit would have been placed in a side road or driveway, it was either moved not more than ten (10) feet or was omitted. Delineators were omitted at places where they would have interfered with traffic entering or leaving business places having broad entrance driveways. No contraction of the offset distance was permitted because of any hazard on the road shoulder between pavement and the line of delineators.

Value of Consistent Installation

These specifications for installation were adopted and rigidly adhered to on the theory that unvarying regularity of position would firmly establish in drivers' minds the position of their cars relative to the road and that omission of one or more delineator units would call attention to unusual conditions. It was expected that as motorists become oriented to driving by the delineators, many of the previous hazards of darkness would be eliminated. It was believed that the delineators would prove a simple but effective aid to safer night driving. (See Figure 2)

Public Reaction

Michigan drivers' experience with highway delineators began on April 6, 1938, when the installations on US-16 between Lansing and Detroit went into service. Soon after, questionnaires were sent out to obtain the public reaction. The response to these questionnaires indicated that the delineators were effective in easing the mind of the driver and were ap-

Fig. 2 Delineators Along the Highway Illuminated by the Headlights of Automobiles After Darkness.

parently increasing their perception distance. Motorists reported that they were more certain as to the position of their vehicle on the roadway, especially when meeting opposing vehicles.

The fact that the delineators met with such general public approval led to the second installation on US-24 between Toledo, Ohio and Pontiac, Michigan, which was inaugurated on January 6, 1939. Both US-16 and US-24 bear heavy traffic and were high accident producers.

THE ACCIDENT RECORD

Although public reaction to the use of delineators has been favorable, the true test is their effectiveness in reducing the number of accidents. Accident statistics have been compiled for a two year period before and after their installation on US-16 and US-24. Figure 3 shows the location of the delineated sections covered by this study.

Types of Accidents Studied

For this study only fatal and injury accidents have been used because it has been repeatedly demonstrated that the reporting of less serious accidents is not consistently complete.

The accidents were classified according to type of collision, and time of occurrence (day or night). It is believed that the types of accidents which may be effected by the delineators can be classified generally as "on the road" accidents that occur in the stream of traffic and are attributable to conditions arising on the surface of the pavement. Naturally, any effect which delineators may have on accident occurrence is limited to hours of darkness.

The accidents selected for study are described as follows:

1. Accidents caused by vehicles moving in opposite directions. This includes head-on collisions and side-swipes.

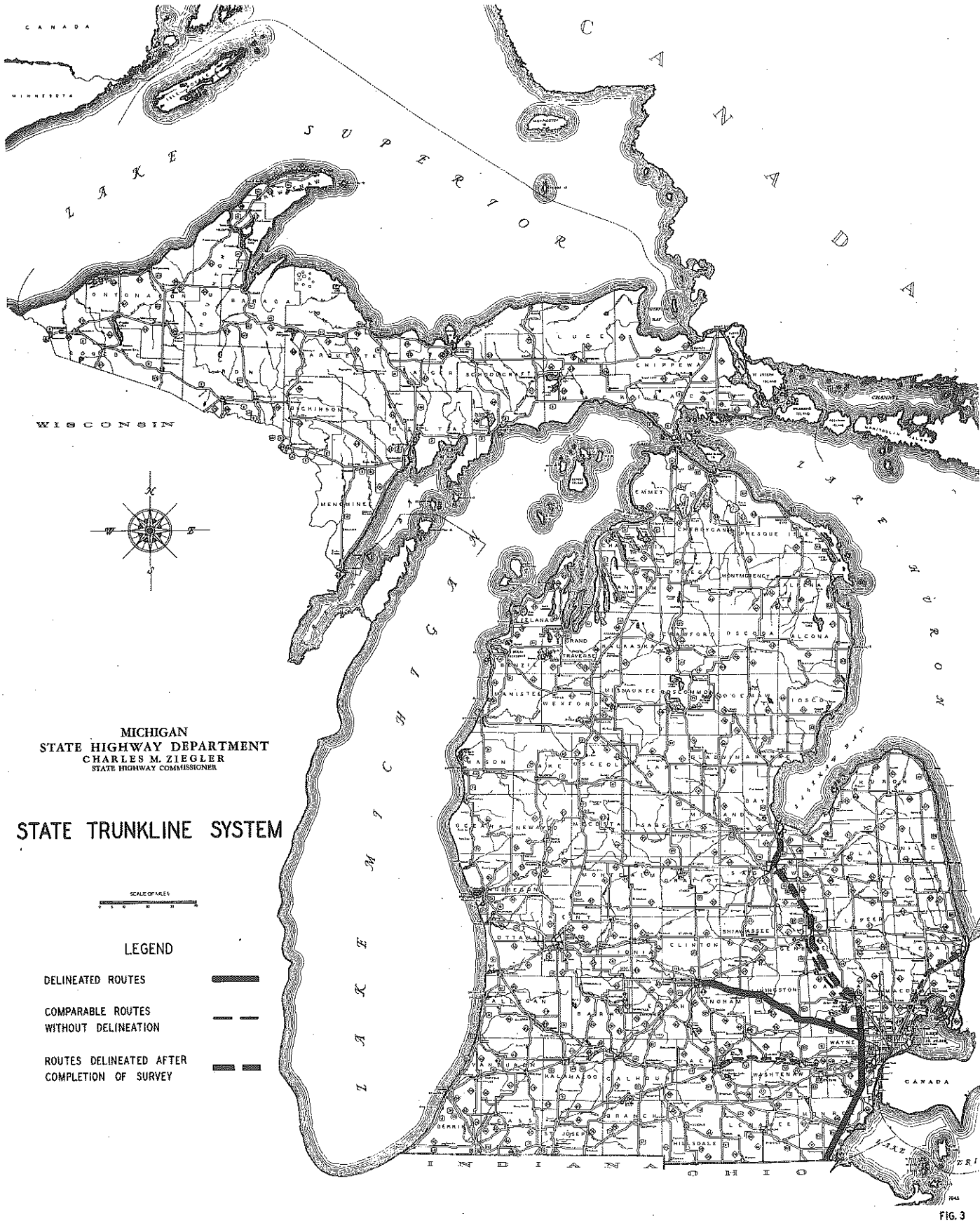

CANADA
MINNESOTA
LAKE SUPERIOR
CANADA
WISCONSIN
LAKE MICHIGAN
LAKE HURON
INDIANA
OHIO
CANADA
MICHIGAN
STATE HIGHWAY DEPARTMENT
CHARLES M. ZIEGLER
STATE HIGHWAY COMMISSIONER
STATE TRUNKLINE SYSTEM
SCALE OF MILES
LEGEND
DELINEATED ROUTES
COMPARABLE ROUTES WITHOUT DELINEATION
ROUTES DELINEATED AFTER COMPLETION OF SURVEY

FIG. 3

2. Accidents caused by vehicles moving in the same direction but at different speeds. They are accidents involved in attempts to pass the preceding vehicle and are due, either to not allowing sufficient clearance before cutting back to the outside lane or to misjudging the distance of an approaching vehicle and at the last minute being forced back into the slower traffic stream. They are also accidents due to the inability to see a preceding vehicle until too late to avoid a rear-end collision.

3. Accidents resulting in collision with fixed objects, along the roadway, overturning, and other non-collision types. They include fixed object and non-collision accidents which may be attributed to avoiding head-on side-swipes and rear-end collisions or other causes that result in leaving the road.

Pedestrian accidents, railroad crossing accidents and intersection accidents are omitted as being irrelevant.

Ratio of Accidents to Traffic

Any conclusion concerning the safety effect of delineators must be based on the occurrence of accidents of these three significant types. But it is impossible to properly evaluate accident statistics except in relation to the amount of traffic on the various roadways where the accidents occur. They are, therefore, presented as accidents per million vehicle miles.

When reduced to this basis, accident statistics can be used to directly compare the hazards on any number of routes having like physical and traffic characteristics or to determine the relative hazards on the same route at different times. For this purpose, the number of accidents occurring at night were divided by the millions of vehicle miles of night travel to obtain an index of night accident occurrence. The index for day accident occurrence was obtained by a similar process.

The Night Hazard Ratio

The ratio of these two indices revealed the hazard of night driving as compared to that of day driving. If this ratio could be brought to unity, conditions of highway travel would be as safe at night as by day. If, following the installation of the delineators, this ratio is found to be re-

COMPARISON of ACCIDENT EXPERIENCE on U.S. 16 and U.S. 24 BEFORE and AFTER INSTALLATION of DELINEATORS

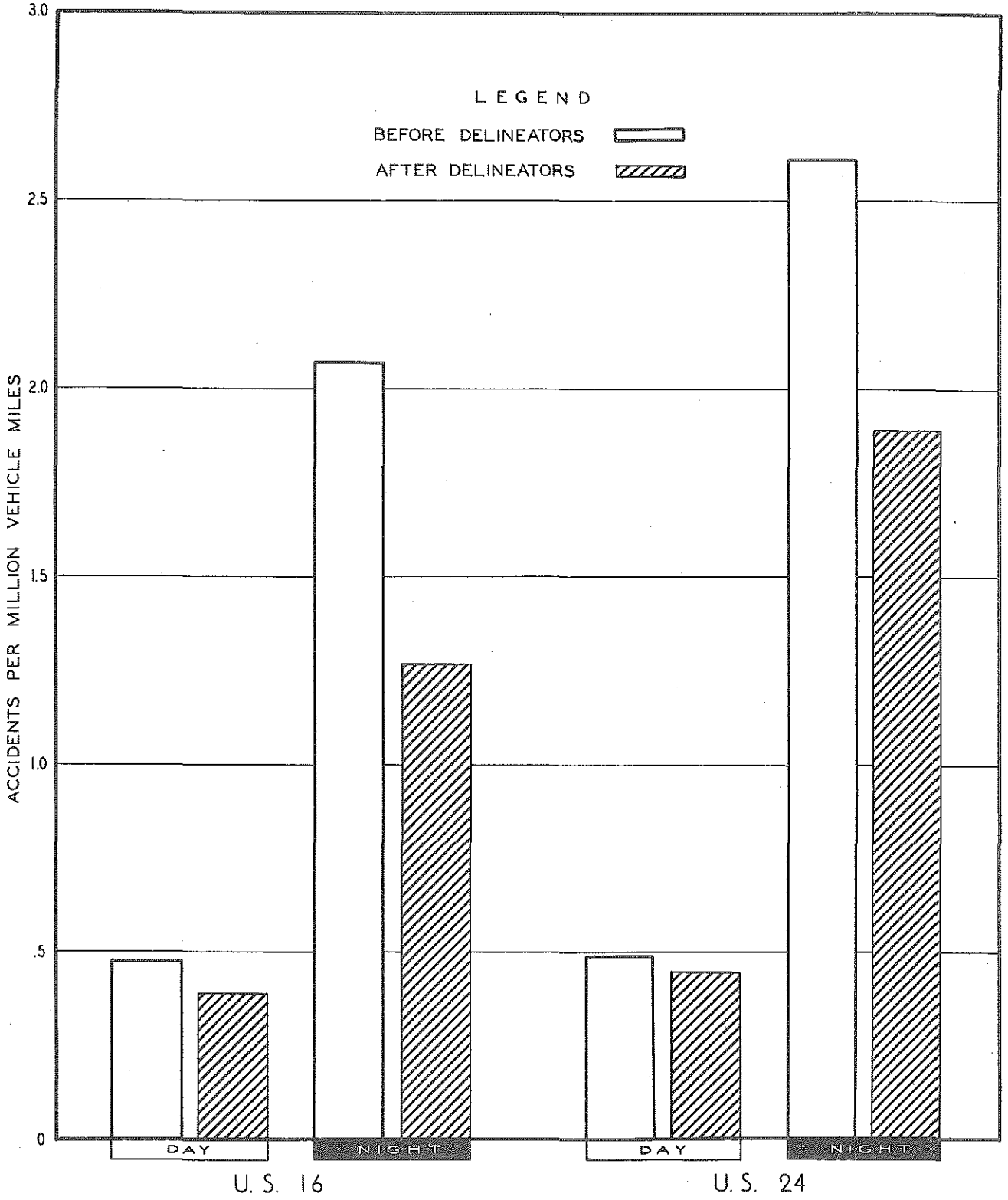


FIG. 4

duced, it will be assumed that the delineators have effected safer driving conditions.

COMPARISON OF RESULTS

A comparison of the day and night accident ratio for periods before and after the installation of the delineators is shown in Fig. 4 for both US-16 and US-24. There was very little change in the accident rates for daytime driving for either route. However, there was a marked reduction in the accident ratio for nighttime driving after the delineators had been installed. The day and night accident rates and the night hazard ratio are shown in the table below:

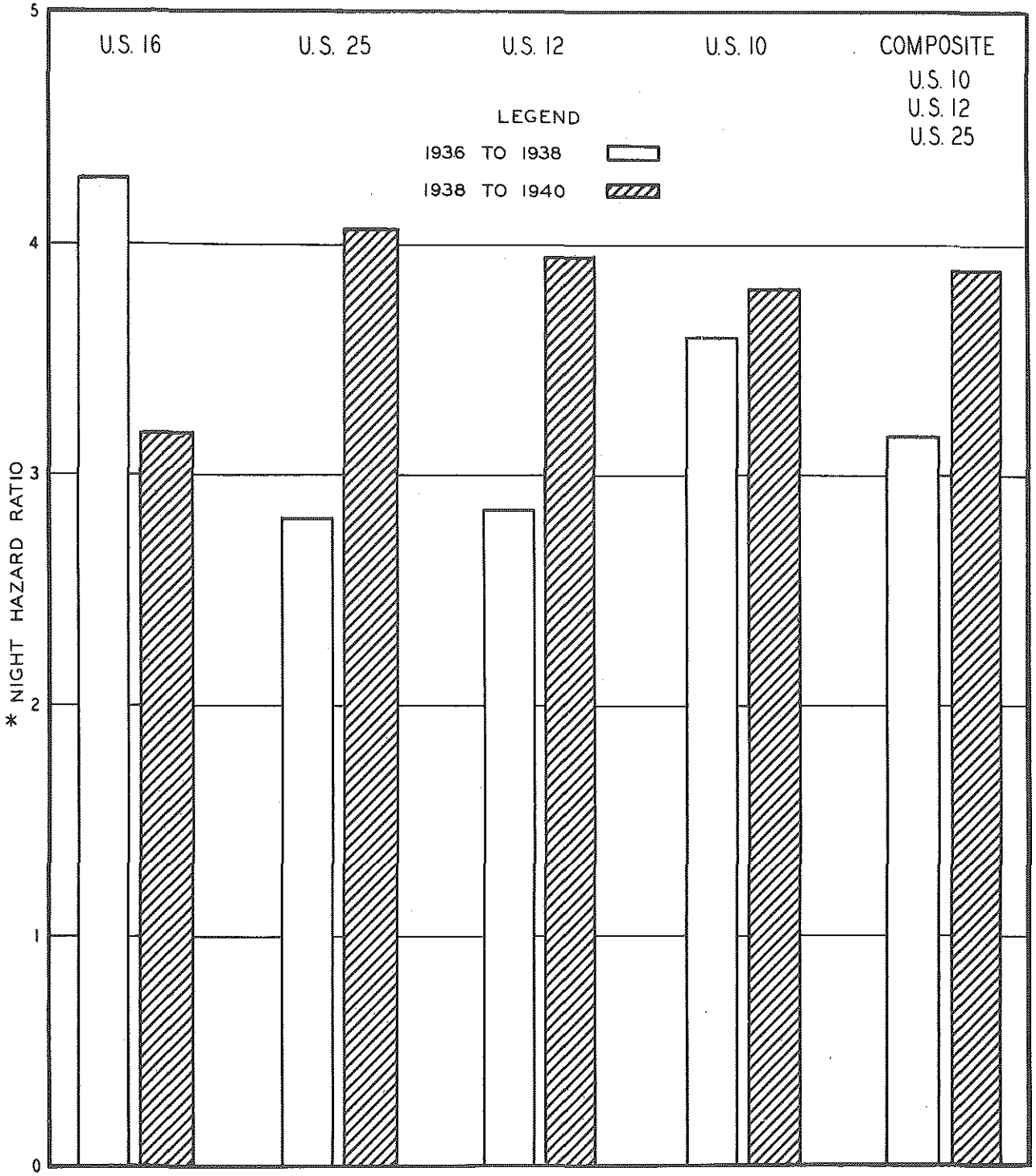
	US-16		US-24	
	Before	After	Before	After
Day Accident Rate	.483	.397	.494	.448
Night Accident Rate	2.071	1.270	2.618	1.892
Night Hazard Ratio	4.288	3.199	5.300	4.223
Percent Improvement		25%		20%

From the above table it appears that delineators were beneficial in reducing the danger of nighttime driving and reducing the night hazard ratio from 20 to 25 percent. To substantiate these results, comparisons were also made of accident experience on other routes with similar physical and traffic characteristics but without benefit of delineators.

Comparison with Non-delineated Routes

The routes selected for comparison were US-10--Pontiac to Flint, US-12--Ann Arbor to Jackson, and US-25--Mt. Clemens to Port Huron. In the two following tables and in Figs. 5 and 6, the accident data for these undelineated trunkline sections are compared, first, with the section of US-16 on which delineators were installed, and second, with the similarly equipped section of US-24. Because the installation of delineators was completed on the latter highway nine months after that on US-16, the before and after periods are different in the two tables.

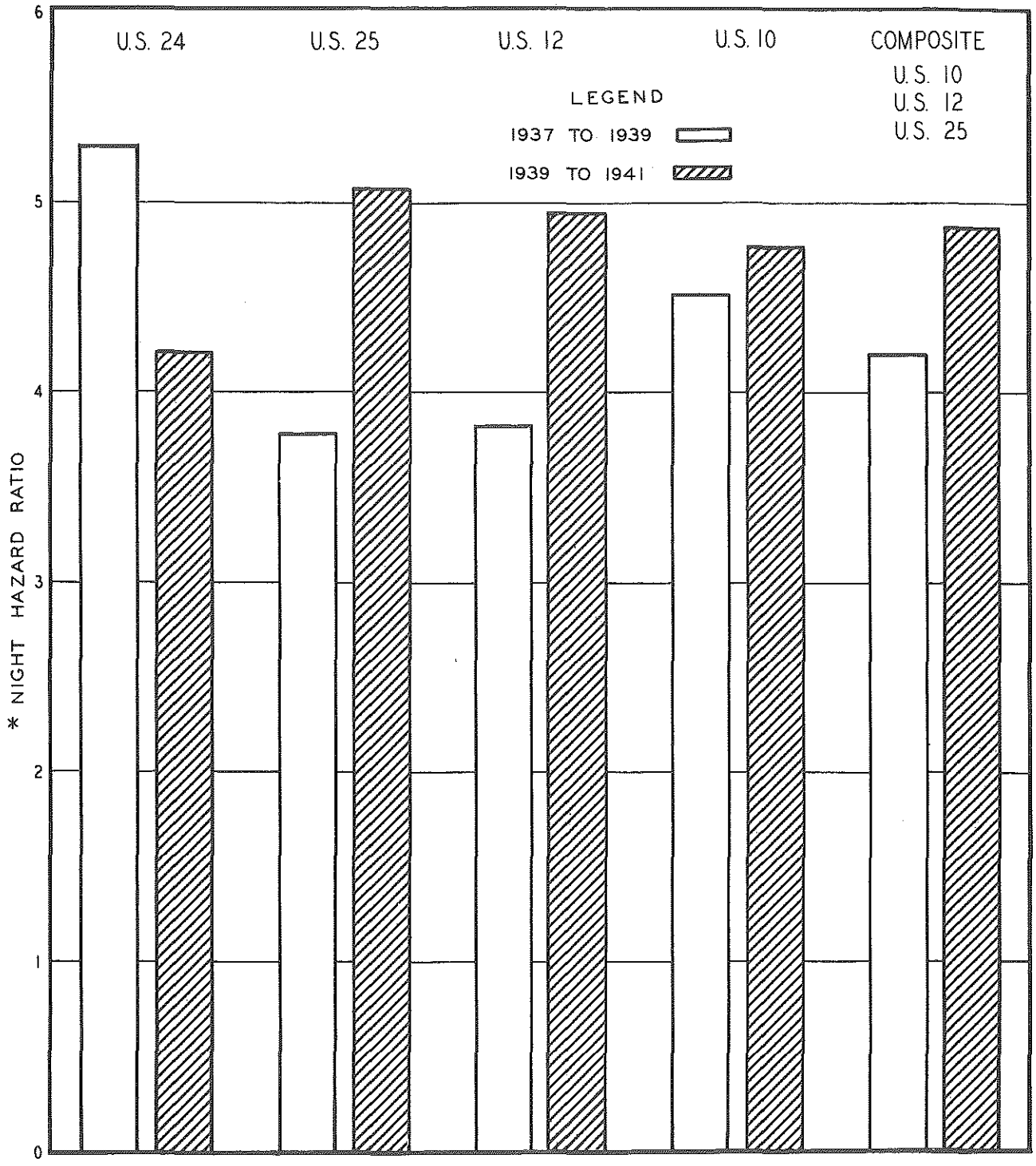
COMPARISON of ACCIDENT EXPERIENCE on U.S. 16 BEFORE and AFTER INSTALLATION of DELINEATORS with OTHER ROUTES without DELINEATORS for THE SAME PERIOD



* RATIO OF NIGHT ACCIDENT RATES TO DAY ACCIDENT RATES

FIG. 5

COMPARISON of ACCIDENT EXPERIENCE on U.S. 24 BEFORE and AFTER INSTALLATION of DELINEATORS with OTHER ROUTES without DELINEATORS for THE SAME PERIOD



* RATIO OF NIGHT ACCIDENT RATES TO DAY ACCIDENT RATES

FIG. 6

COMPARATIVE ACCIDENT DATA

Periods
April 6, 1936 to April 5, 1938
and
April 6, 1938 to April 5, 1940

	WITH DELINEATORS US-16		WITHOUT DELINEATORS BEFORE AND AFTER APRIL 6, 1938							
			US-10		US-12		US-25		Composite	
	Before	After	Before	After	Before	After	Before	After	Before	After
Day Accident Rate	.483	.397	.585	.313	.445	.419	.238	.168	.470	.311
Night Accident Rate	2.071	1.270	2.413	1.260	1.656	1.862	1.131	.786	1.917	1.327
Night Hazard Ratio	4.288	3.199	4.118	4.026	3.721	4.444	4.752	4.679	4.079	4.267
Change in Ratio		-25%		-2%		+19%		-2%		+5%

Periods
January 6, 1937 to January 5, 1939
and
January 6, 1939 to January 5, 1941

	WITH DELINEATORS US-24		WITHOUT DELINEATORS BEFORE AND AFTER JANUARY 6, 1939							
			US-10		US-12		US-25		Composite	
	Before	After	Before	After	Before	After	Before	After	Before	After
Day Accident Rate	.494	.448	.482	.360	.430	.350	.288	.174	.425	.316
Night Accident Rate	2.618	1.892	2.182	1.724	1.648	1.735	1.093	.886	1.792	1.543
Night Hazard Ratio	5.300	4.223	4.527	4.789	3.833	4.957	3.795	5.092	4.216	4.883
Change in Ratio		-20%		+6%		+29%		+34%		+16%

In considering the data presented in these two tables, it is useful to keep in mind certain conditions of traffic which existed during the periods covered by this study.

For the most part of the periods succeeding the installation of delineators on both US-16 and US-24, traffic was increasing quite sharply. Ordinarily such upswings of highway travel are accompanied by rising rates of accident occurrence. Yet it will be observed that in every instance the day accident rate declined on all these highway sections and that the highest accident rate rose only in the case of US-12. It is possible that this desirable over-all trend was due to the increased stringency of enforcement during the past three years.

However, for this study of the effect of delineators on accident occurrence, the important facts are the best reduction of the night hazard ratio on the sections where these devices were installed and the contrasting increase of this ratio on all except one of the sections which are not so equipped. The exception, US-25, was the subject of intense enforcement and control activity during part of the period.

The night hazard ratios on the delineated sections of US-16 and US-24 show a reduction of 25 percent and 20 percent, respectively. The ratios for the composites of the three non-delineated routes show an increase in relative night hazard of 5 percent in one case and of 16 percent in the other.

While there are many and complex factors which enter into and vary the rate of accident occurrence, it is possible and not unreasonable to interpret the data presented above as indicating that the delineators installed on US-16 and US-24 produced safer night driving conditions on these highways.

RESULTS BY TYPES OF ACCIDENTS

A further and more detailed investigation was made of the ac-

cidents on the equipped sections of US-16 and US-24 to determine the results as regards each of the three types of accidents whose occurrence might be affected by the use of delineators. As previously explained, these types are:

1. Head-on and side-swipe collisions with vehicles in the opposing traffic stream;

2. Rear-end and side-swipe collisions with vehicles in the same traffic stream;

3. Collisions with parked cars, trees, etc., and non-collision accidents where vehicles run off the roadway on curves or when approaching other vehicles.

Effects of Delineators by Accident Type

The results of this study are presented in the following tables and in Figs. 7 and 8 which show the night hazard ratios on the two highway sections for each of these three types of accidents before and after delineator installation. Finally, they show the percentage of reduction in the ratio.

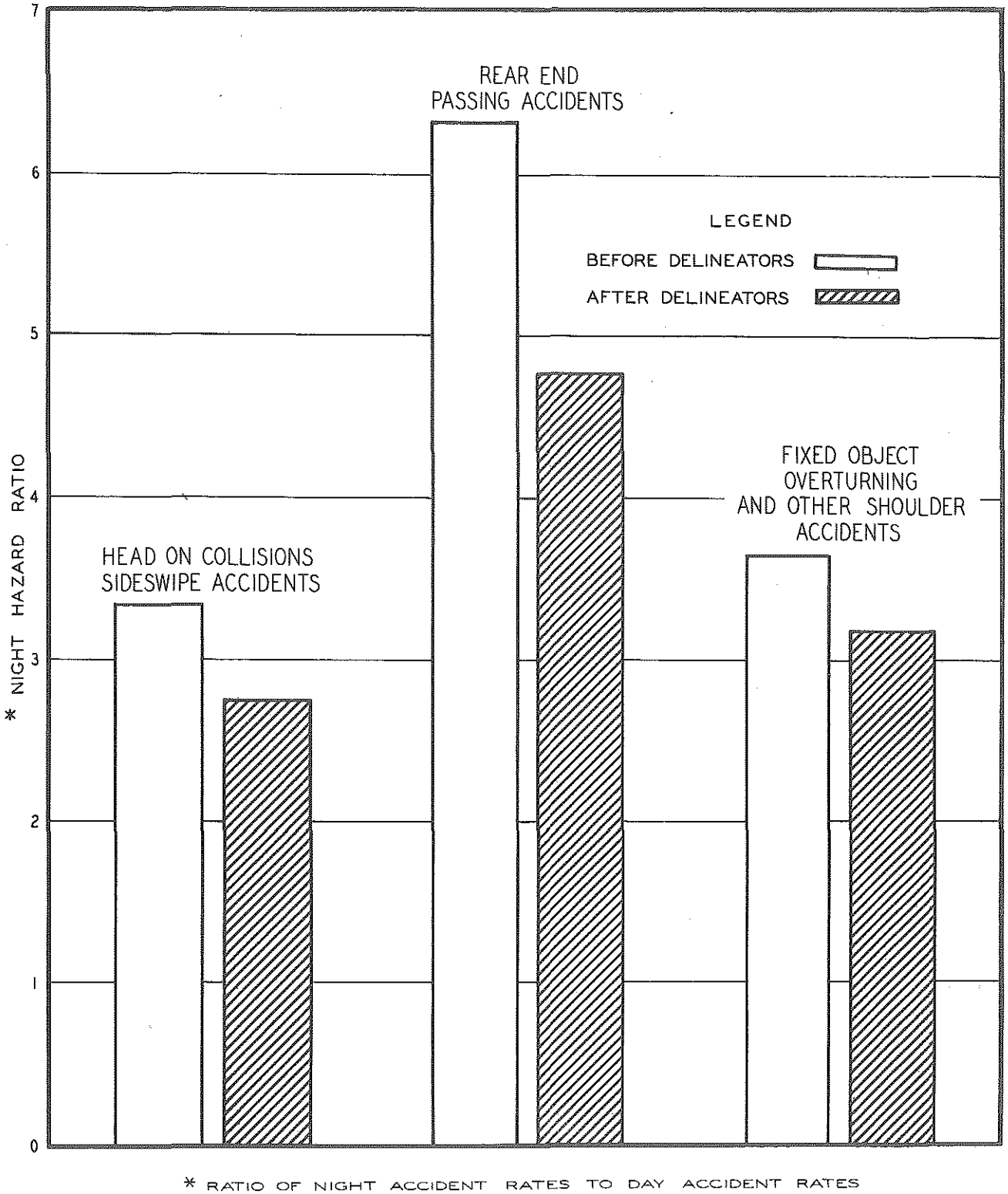
	NIGHT HAZARD RATIOS				REDUCTION	
	Before		After		In Per Cent	
TYPE OF ACCIDENT	US-16	US-24	US-16	US-24	US-16	US-24
Head-on, sideswipe	3.483	3.916	2.748	3.399	21	13
Rear-end, passing	6.379	8.292	4.792	5.678	25	32
Fixed Object, non-collision	3.643	4.277	2.512	3.655	31	15
Total	4.288	5.300	3.199	4.233	25	20

These indicate that the special hazards of night driving relative to day driving were reduced in the cases of these significant types of accidents by from 13 to 32 percent. It is encouraging to note that head-on, rear-end, side-swipe, and passing accidents, which seem to be the most characteristically hazardous at night, experienced the most marked reductions.

ANALYSIS OF RESULTS

Although there is still a serious difference between the rate of

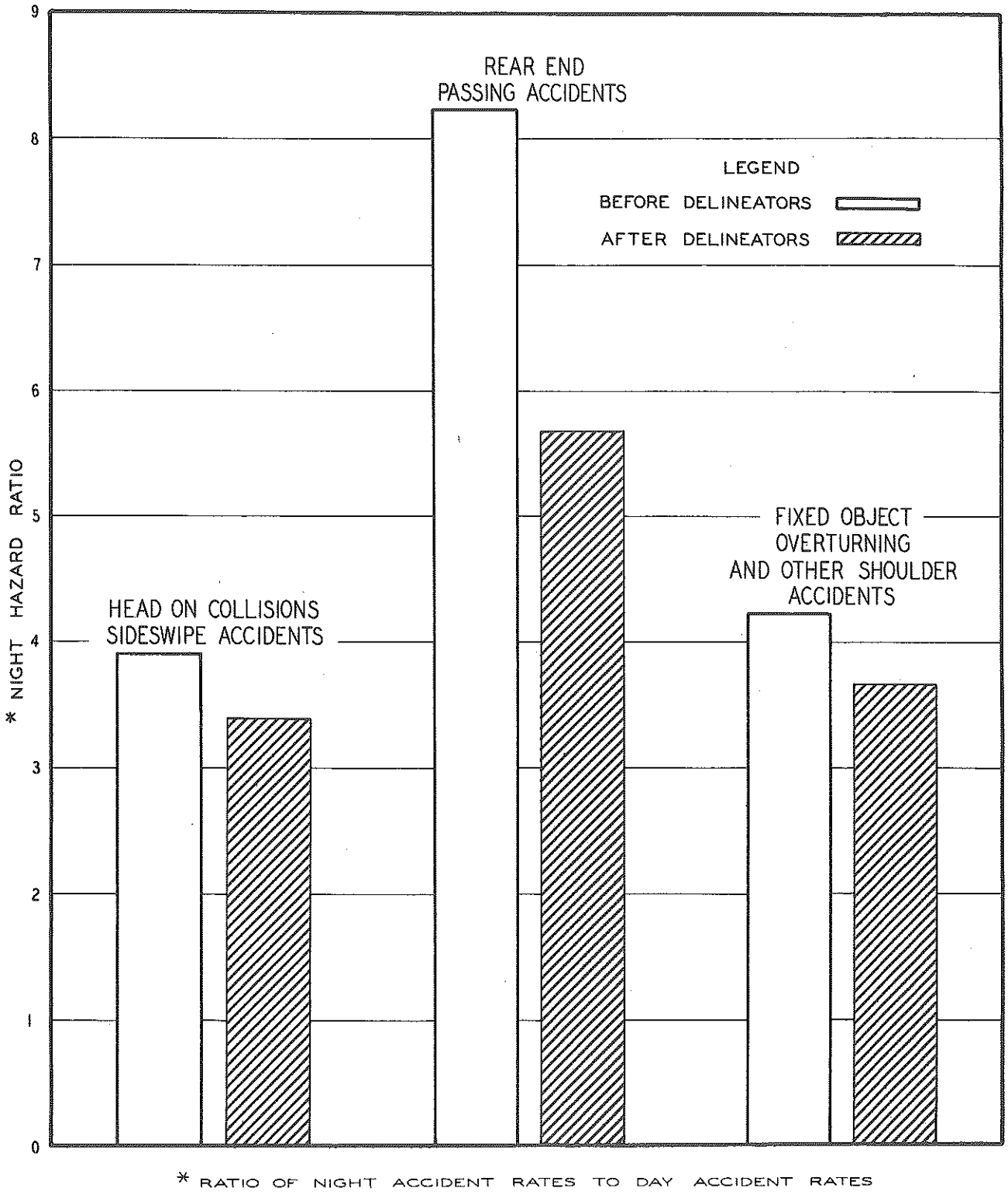
ACCIDENT EXPERIENCE on U.S. 16 BEFORE and AFTER INSTALLATION of DELINEATORS CLASSIFIED by TYPES of ACCIDENTS



* RATIO OF NIGHT ACCIDENT RATES TO DAY ACCIDENT RATES

FIG. 7

ACCIDENT EXPERIENCE on U.S. 24
BEFORE and AFTER INSTALLATION of DELINEATORS
CLASSIFIED by TYPES of ACCIDENTS



* RATIO OF NIGHT ACCIDENT RATES TO DAY ACCIDENT RATES

FIG. 8

occurrence of all these kinds of accidents in daytime and night, it appears that there is a considerable lessening of this difference on the two delineated sections.

It is possible to translate these comparative accident rates and night hazard ratios into terms of the number of accidents which changed driving condition have prevented. It is important to present the results in this form because that is the kind of improvement which has the most direct meaning for the average motorist.

In the case of US-16 it has been shown that the ratio of night to day accident rates was 25 percent lower after the delineators had been installed than it had been before. On the other hand the composite record of the three undelineated trunkline sections showed this significant ratio to be 5 percent higher in the last of the two periods compared.

On the assumption that, except for delineators night accident occurrence in relation to the day rate would have been the same on US-16, as on the three unequipped sections, the ratio for US-16, had it not been delineated, would have been 4.479 instead of 3.199. On the basis of this estimated ratio and the known day accident rate on this section during the later period, its night accident rate would have been 1,788.

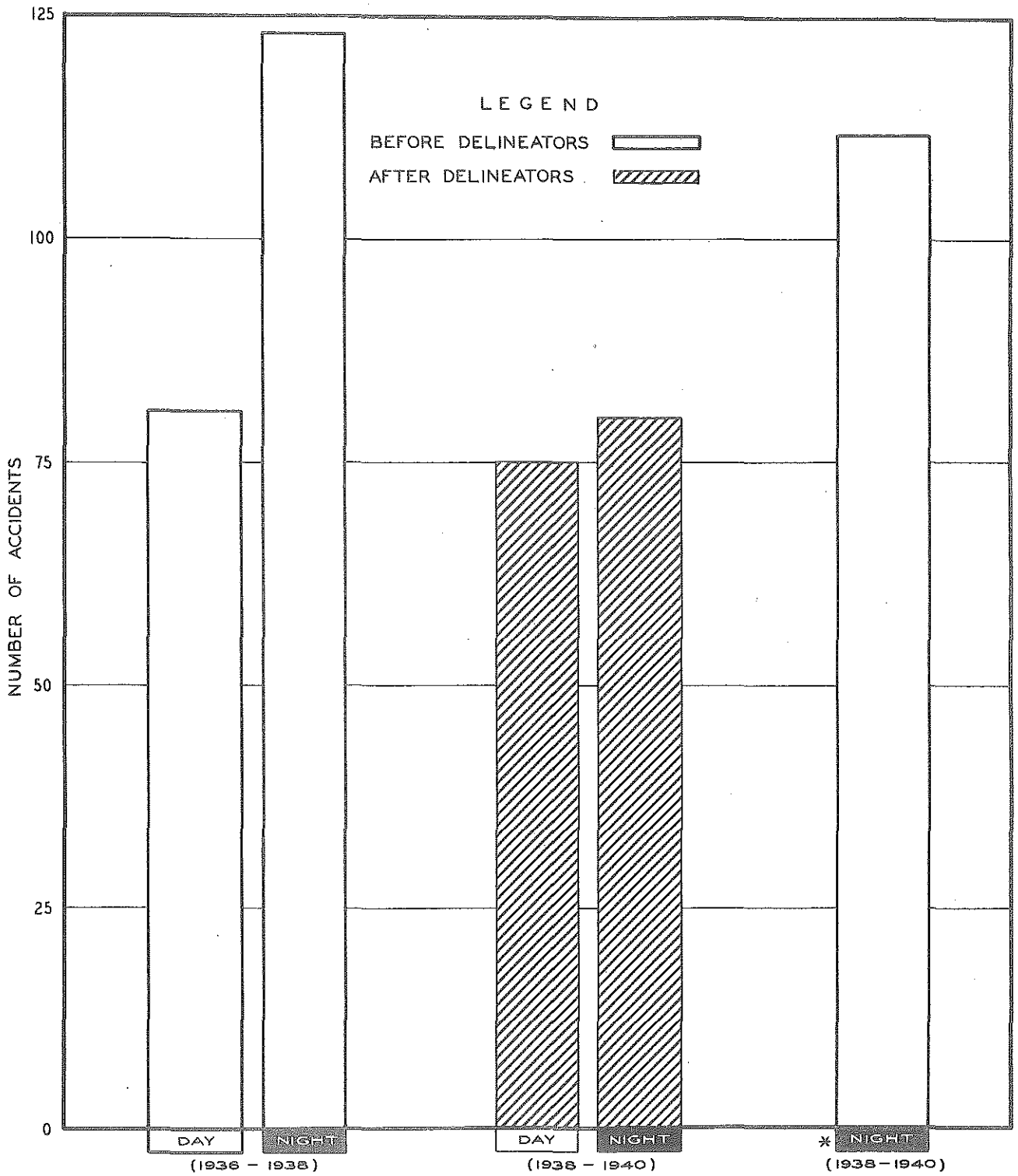
This rate is 1.4 times the rate that actually existed with delineators installed. Applying this ratio to the 80 night accidents during the period gives an estimated 112 as the number of accidents which would have occurred had there been no delineators. This is 32 accidents more than actually were produced.

A similar computation for US-24 results in an estimate of 220 night accidents during the period following installation had there been no delineators. This is 68 more than actually occurred.

Thus, it is estimated that during the two-year periods, delineators prevented 32 fatal or injury accidents on US-16 and 68 such accidents

on US-24 or a total of 100 accidents. Figures 9 and 10 present the quantities and comparisons resulting from this estimate. It represents the practical benefits of the delineators as revealed by this investigation of the number of accidents and the accident rates before and after delineator installations.

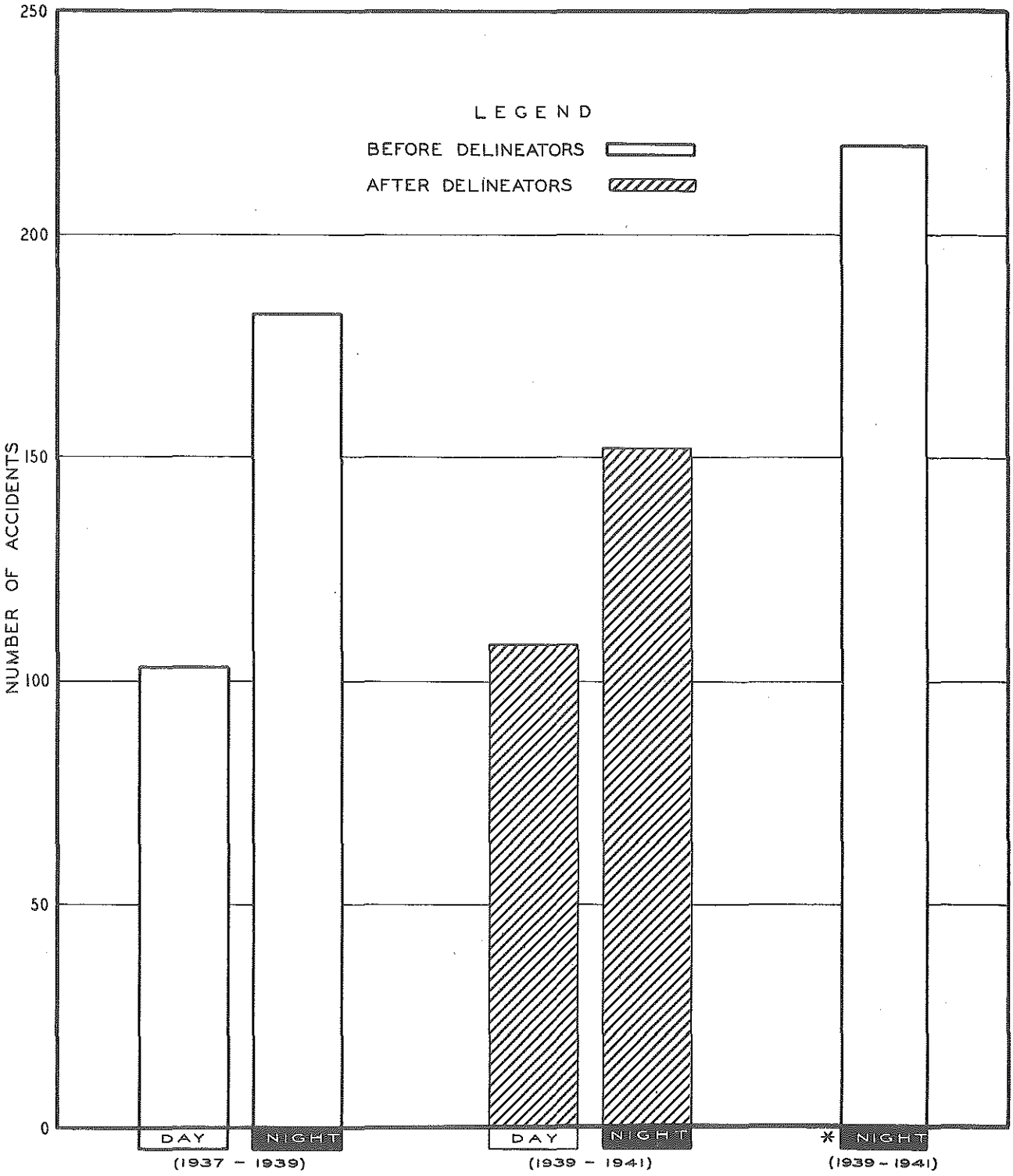
NUMBER of FATAL and INJURY ACCIDENTS BEFORE and AFTER INSTALLATION of DELINEATORS on U.S. 16



* ESTIMATED NIGHT ACCIDENTS BASED ON AMOUNT OF TRAVEL AND ACCIDENT CHARACTERISTICS ON U.S. 16 AND OTHER COMPARABLE ROUTES

FIG. 9

NUMBER of FATAL and INJURY ACCIDENTS BEFORE and AFTER INSTALLATION of DELINEATORS on U.S. 24



* ESTIMATED NIGHT ACCIDENTS BASED ON AMOUNT OF TRAVEL AND ACCIDENT CHARACTERISTICS ON U.S. 24 AND OTHER COMPARABLE ROUTES

FIG. 10

SUMMARY

Accident experience on US-16 and US-24 indicates that the special hazards of nighttime driving were reduced from 20 to 25 percent after the installation of delineators. Comparisons of accident experience on the delineated highways with other highways which were not delineated but that had the same physical and traffic characteristics, further illustrates the beneficial effect of delineators. Accident experience on these comparable highways shows that the night hazard rates remains approximately the same for the two periods, while on US-16 and US-24 there was a marked reduction in this ratio after the highways had been delineated.

The results of this study indicate that delineators were beneficial in reducing nighttime accidents resulting from head-on collisions, sidewiping of vehicles in opposite or same directions, rear-end collisions, fixed object and non-collision accidents.

After delineation there was a reduction in the nighttime accidents caused by these frictions on both US-16 and US-24. This appears to be due to the driver's increased ability to perceive well in advance the elements which are responsible for accidents, and to act properly to prevent serious mishaps.

Effect of Delineators

On the basis of the charts and supporting data in this report, it is believed that delineators have been effective in eliminating accidents during the hours of darkness so that nighttime driving conditions approach daytime driving conditions for the following reasons;

1. The delineators so clearly define the limits of the pavement that the motorist is able to perceive the roadway for a considerable distance ahead, often as much as a mile where alignment and grades are favorable. Changes in grade and alignment are readily noted thus reducing the possibility of the driver running off the road.

2. Because the delineators are uniformly spaced and have the appearance of lights, they enable the driver to obtain a much more accurate sense of perspective and distance than he can get from the lights of approaching cars. This enables the driver to judge whether or not he has sufficient time to "make a pass", thus reducing the frequency of head-on collisions or sideswipes.

3. The presence of the delineators reduces the blinding effect of undimmed headlights on approaching vehicles. The delineators aid the driver in determining his distance from the edge of the pavement and consequently he is less apt to drive off the road or cause a head-on collision by veering into the approaching vehicle because of fear that he is getting too near the edge of the pavement.

4. Hazardous objects that are present between the vehicle and the delineators are frequently discerned by the blanking out of one or more of the delineators. Vehicles parked on the shoulder as well as moving vehicles without rear lights are detected in this manner, thus reducing the frequency of rear-end and fixed-object accidents.

5. As a result of the foregoing, the driver is more at ease and is confident of his position on the highway. The hazards of night driving have been greatly reduced and nighttime driving conditions are more nearly like those encountered during the daylight hours.

CONCLUSION

The results of this study indicate that delineators are an aid to nighttime driving. They appear to have reduced the special hazards of night driving by from 20 to 25 percent. Cost of installation is low when compared to the number of accidents which are estimated to have been prevented by delineator use.

It is recommended that all highways should be investigated to determine the hazard conditions of nighttime driving and that those routes with high traffic density and a high night hazard ratio should be given first consideration in plans for extending this type of traffic safety improvement.

INDEX OF DELINEATOR TABLES

TABLE I

Fatal & Injury Accident Rates Per Million Vehicle Miles

US-16 Detroit to Lansing

Before and After Delineation

April 6, 1936—April 5, 1938 Compared to April 6, 1938—April 5, 1940

Types of Accidents	Day Accident Rates			Night Accident Rates			Ratio of Night to Day Accident Rates		
	Before	After	Per Cent Changes	Before	After	Per Cent Changes	Before	After	Per Cent Change
Head-On, Sideswipe Opposite Direction	.174	.127	-27	.606	.349	-42	3.483	2.748	-21
Rear-End, Sideswipe in Same Direction	.124	.106	-15	.791	.508	-36	6.379	4.792	-25
Fixed Object, and Other Non-Collision Accidents	.185	.164	-11	.674	.412	-39	3.643	2.512	-31
Total	.483	.397	-18	2.071	1.270	-39	4.288	3.199	-25

TABLE II

Fatal & Injury Accidents

US-16—Detroit to Lansing

Before and After Installation of Delineators

April 6, 1936—April 5, 1938 Compared to April 6, 1938—April 5, 1940

Types of Accidents	Day Accident Rates			Night Accident Rates			Ratio of Night to Day Accident Rates		
	Before	After	Per Cent Change	Before	After	Per Cent Change	Before	After	Per Cent Change
Head-On, Sideswipe Opposite Direction	31	24	-23	36	22	-39	1.161	.916	-21
Rear-End, Sideswipe in Same Direction	22	20	- 9	47	32	-32	2.138	1.600	-25
Fixed Object, and Other Non-Collision Accidents	33	31	- 6	40	26	-35	1.212	.839	-31
Total	86	75	-13	123	80	-35	1.430	1.067	-25

TABLE III

FATAL & INJURY ACCIDENT RATES PER MILLION VEHICLE MILES

US-10 - Pontiac to Flint

Before and After Delineation of US-16

April 6, 1936—April 5, 1938 Compared to April 6, 1938—April 5, 1940

Types of Accidents	Day Accident Rates			Night Accident Rates			Ratio of Night to Day Accident Rates		
Head-On, Sideswipe Opposite Direction	.254	.123	-52	.813	.420	-48	3.200	3.415	+ 3
Rear-End, Sideswipe in Same Direction	.183	.132	-28	.944	.593	-37	5.158	4.492	-13
Fixed Object, and Other Non-Collision Accidents	.148	.058	-61	.656	.247	-62	4.432	4.259	- 4
Total	.585	.313	-47	2.413	1.260	-48	4.125	4.026	- 2

TABLE IV

Fatal & Injury Accidents

US-10—Pontiac to Flint

Before and After Installation of Delineators on US-16

April 6, 1936—April 5, 1938 Compared to April 6, 1938—April 5, 1940

Types of Accidents	Day Accidents			Night Accidents			Ratio of Night to Day Accidents		
	Before	After	Per Cent Change	Before	After	Per Cent Change	Before	After	Per Cent Change
Head-On, Sideswipe Opposite Direction	29	15	-48	31	17	-45	1.069	1.133	+ 6
Rear-End, Sideswipe in Same Direction	21	16	-34	36	24	-33	1.715	1.500	-13
Fixed Object, and Other Non-Collision Accidents	17	7	-59	25	10	-60	1.471	1.429	- 3
Total	67	38	-43	92	51	-45	1.373	1.342	- 2

TABLE V

FATAL & INJURY ACCIDENT RATES PER MILLION VEHICLE MILES

US-12—Jackson to Ann Arbor

Before and After Delineation on US-16

April 6, 1936—April 5, 1938 Compared to April 6, 1938—April 5, 1940

Types of Accidents	Day Accident Rates			Night Accident Rates			Ratio of Night to Day Accident Rates		
	Before	After	Per Cent Change	Before	After	Per Cent Change	Before	After	Per Cent Change
Head-On, Sideswipe Opposite Direction	.154	.145	- 6	.966	.737	-24	6.273	5.083	-19
Rear-End, Sideswipe in Same Direction	.138	.173	+25	.460	.520	+13	3.333	3.006	-10
Fixed Object, and Other Non-Collision Accidents	.153	.101	-10	.230	.607	+164	1.503	6.010	+300
Total	.445	.419	- 6	1.656	1.862	+12	3.721	4.444	+19

TABLE VI

FATAL & INJURY ACCIDENTS

US-12—Jackson to Ann Arbor

Before and After Installation of Delineators on US-16

April 6, 1936—April 5, 1938 Compared to April 6, 1938—April 5, 1940

Types of Accidents	Day Accidents			Night Accidents			Ratio of Night to Day Accidents		
	Before	After	Per Cent Change	Before	After	Per Cent Change	Before	After	Per Cent Change
Head-On, Sideswipe Opposite Direction	10	10	0	21	17	-19	2.100	1.700	-19
Rear-End, Sideswipe in Same Direction	9	12	+34	10	12	+20	1.111	1.000	-10
Fixed Object, and Other Non-Collision Accidents	10	7	-30	5	14	+180	.500	2.000	+300
Total	29	29	0	36	43	+19	1.241	1.483	+20

TABLE VII

FATAL & INJURY ACCIDENT RATES PER MILLION VEHICLE MILES

US-25 - Mt. Clemens to Port Huron

Before and After Delineation on US-16

April 6, 1936—April 5, 1938 Compared to April 6, 1938—April 5, 1940

Types of Accidents	Day Accident Rates			Night Accident Rates			Ratio of Night to Day Accident Rates		
	Before	After	Per Cent Change	Before	After	Per Cent Change	Before	After	Per Cent Change
Head-On, Sideswipe Opposite Direction	.119	.112	- 6	.293	.337	+13	2.504	3.009	+20
Rear-End, Sideswipe in Same Direction	.080	.019	-76	.774	.393	-49	9.675	20.684	+114
Fixed Object, and Other Non-Collision Accidents	.040	.037	- 7	.060	.056	- 7	1.500	1.514	+ 1
Total	.238	.168	-29	1.131	.786	-31	4.752	4.679	- 2

TABLE VIII

FATAL & INJURY ACCIDENTS

US-25 - Mt. Clemens to Port Huron

Before and After Installation of Delineators on US-16

April 6, 1936—April 5, 1938 Compared to April 6, 1938—April 5, 1940

Types of Accidents	Day Accidents			Night Accidents			Ratio of Night to Day Accidents		
	Before	After	Per Cent Change	Before	After	Per Cent Change	Before	After	Per Cent Change
Head-On, Sideswipe Opposite Direction	6	6	0	5	6	+20	.833	1.000	+ 20
Rear-End, Sideswipe in Same Direction	4	1	-25	13	7	-49	3.250	7.000	+116
Fixed Object, and Other Non-Collision Accidents	2	2	0	1	1	0	.500	.500	0
Total	12	9	-25	19	14	-26	1.583	1.556	- 2

TABLE IX

FATAL & INJURY ACCIDENT RATES PER MILLION VEHICLE MILES

Composite of US-10, US-12, & US-25

Before and After Delineation on US-16

April 6, 1936—April 5, 1938 Compared to April 6, 1938—April 5, 1940

Types of Accidents	Day Accident Rates			Night Accident Rates			Ratio of Night to Day Accident Rates		
	Before	After	Per Cent Change	Before	After	Per Cent Change	Before	After	Per Cent Change
Head-On, Sideswipe Opposite Direction	.195	.127	-35	.744	.492	-34	3.815	3.874	+ 2
Rear-End, Sideswipe in Same Direction	.148	.119	-20	.730	.528	-28	4.932	4.437	-10
Fixed Object, and Other Non-Collision Accidents	.126	.065	-48	.405	.307	-24	3.214	4.723	+47
Total	.470	.311	-34	1.917	1.327	-31	4.079	4.267	+ 5

TABLE X

FATAL & INJURY ACCIDENTS

Composite of US-10, US-12 & US-25

Before and After Installation of Delineators on US-16

April 6, 1936—April 5, 1938 Compared to April 6, 1938— April 5, 1940

Types of Accidents	Day Accidents			Night Accidents			Ratio of Night to Day Accidents		
	Before	After	Per Cent Change	Before	After	Per Cent Change	Before	After	Per Cent Change
Head-On, Sideswipe Opposite Direction	45	31	-31	57	40	-30	1.267	1.290	+ 2
Rear-End, Sideswipe in Same Direction	34	29	-15	56	43	-23	1.648	1.472	-10
Fixed Object, and Other Non-Collision Accidents	29	16	-45	31	25	-19	1.069	1.563	+46
Total	108	76	-30	147	108	-27	1.361	1.421	+ 4

TABLE XI

FATAL & INJURY ACCIDENT RATES PER MILLION VEHICLE MILES

US-24 - Ohio State Line to Pontiac

Before and After Delineation

January 6, 1937—January 5, 1939 Compared to January 6, 1939—January 5, 1941

Types of Accidents	Day Accident Rates			Night Accident Rates			Ratio of Night to Day Accident Rates		
	Before	After	Per Cent Change	Before	After	Per Cent	Before	After	Per Cent Change
Head-On, Sideswipe Opposite Direction	.202	.183	- 9	.791	.622	-21	3.916	3.399	-13
Rear-End, Sideswipe in Same Direction	.144	.149	+ 3	1.194	.846	-29	8.292	5.678	-32
Fixed Object, and Other Non-Collision Accidents	.148	.116	-22	.633	.424	-33	4.277	3.655	-15
Total	.494	.448	- 9	2.618	1.892	-28	5.300	4.223	-20

TABLE XII

FATAL & INJURY ACCIDENTS

US-24—Ohio State Line to Pontiac

Before and After Installation of Delineators on US-16

Jan. 6, 1937—Jan. 5, 1939 Compared to Jan. 6, 1939—Jan. 5, 1941

Types of Accidents	Day Accidents			Night Accidents			Ratio of Night to Day Accidents		
	Before	After	Per Cent Change	Before	After	Per Cent Change	Before	After	Per Cent Change
Head-On, Sideswipe Opposite Direction	42	44	+ 5	55	50	- 9	1.310	1.137	-13
Rear-End, Sideswipe in Same Direction	30	36	+20	83	68	-18	2.765	1.890	-32
Fixed Object, and Other Non-Collision Accidents	31	28	-10	44	34	-23	1.420	1.214	-15
Total	103	108	+ 5	182	152	-17	1.768	1.407	-20

TABLE XIII

FATAL & INJURY ACCIDENT RATES PER MILLION VEHICLE RATES

U. S. 10 Pontiac to Flint

Before and after Delineation on US-24

January 6, 1937 - January 5, 1939 Compared to January 6, 1939 - January 6, 1941

Types of Accidents	Day Accident Rates			Night Accident Rates			Ratio of Night to Day Accident Rates		
	Before	After	% Change	Before	After	% Change	Before	After	% Change
Head-On, Sideswipe Opposite Direction	.195	.153	-21	.710	.758	∕7	3.641	4.954	∕36
Rear-End, Sideswipe in Same Direction	.135	.153	∕31	.914	.644	-30	6.770	4.209	-38
Fixed Object, and Other Non-Collision Accidents	.152	.360	-36	.558	.322	-42	3.671	5.963	∕62
Total	.482	.360	-25	2.182	1.724	-21	4.527	4.789	∕6

TABLE XIV

FATAL & INJURY ACCIDENT RATES PER MILLION VEHICLE MILES

US-10 - Pontiac to Flint

Before and After Delineation on US-24

January 6, 1937 - January 5, 1939 Compared to January 6, 1939 - January 5, 1941

Types of Accidents	Day Accident Rates			Night Accident Rates			Ratio of Night to Day Accident Rates		
	Before	After	% Change	Before	After	% Change	Before	After	% Change
Head-On, Sideswipe Opposite Direction	23	20	-13	28	33	+18	1.217	1.650	+36
Rear-End, Sideswipe in Same Direction	16	20	+25	36	28	-22	2.250	1.400	-38
Fixed Object, and Other Non-Collision Accidents	18	7	-61	22	14	-36	1.222	2.000	+63
Total	57	47	-18	86	75	-13	1.509	1.596	+6

TABLE XV

FATAL & INJURY ACCIDENT RATES PER MILLION VEHICLE MILES

US-12 - Jackson to Ann Arbor

Before and After Delineation on US-24

January 6, 1937 - January 5, 1939 Compared to January 6, 1939 - January 5, 1941

Types of Accidents	Day Accident Rates			Night Accident Rates			Ratio of Night to Day Accident Rates		
	Before	After	% Change	Before	After	% Change	Before	After	% Change
Head-On Sideswipe Opposite Direction	.178	.175	-2	.802	.766	-4	4.506	4.377	-3
Rear-End, Sideswipe in Same Direction	.178	.067	-62	.490	.524	+8	2.753	7.821	+184
Fixed Object, and Other Non-Collision Accidents	.074	.108	+46	.356	.444	+25	4.811	4.111	-15
Total	.430	.350	-19	1.648	1.735	+5	3.833	4.957	+29

TABLE XVI

FATAL & INJURY ACCIDENT RATES PER MILLION VEHICLE MILES

US-12 - Jackson to Ann Arbor

Before and After Delineation on US-24

January 6, 1937 - January 5, 1939 Compared to January 6, 1939 - January 5, 1941

Types of Accidents	Day Accident Rates			Night Accident Rates			Ratio of Night to Day Accident Rates		
	Before	After	% Change	Before	After	% Change	Before	After	% Change
Head-On, Sideswipe Opposite Direction	12	13	⁄8	18	19	⁄5	1.500	1.462	-3
Rear-End, Sideswipe in Same Direction	12	5	-58	11	13	⁄18	.917	2.600	⁄184
Fixed Object, and Other Non-Collision Accidents	5	8	⁄60	8	11	⁄37	1.600	1.375	-14
Total	29	26	-10	37	43	⁄16	1.276	1.654	⁄30

TABLE XVII

FATAL & INJURY ACCIDENT RATES PER MILLION VEHICLE MILES

US-25 Mt. Clemens to Port Huron

Before and After Delineation on US-24

January 6, 1937- January 5, 1939 Compared to January 6, 1939 - January 5, 1941

Types of Accidents	Day Accident Rates			Night Accident Rates			Ratio of Night to Day Accident Rates		
	Before	After	% Change	Before	After	% Change	Before	After	% Change
Head-On, Sideswipe Opposite Direction	.134	.087	-35	.402	.364	-10	3.000	4.184	⁄39
Rear-End, Sideswipe in Same Direction	.096	.052	-46	.635	.261	-59	6.594	5.019	-24
Fixed Object, and Other Non-Collision Accidents	.058	.034	-40	.058	.261	⁄350	1.000	7.457	⁄746
Total	.288	.174	-40	1.093	.886	-19	3.795	5.092	⁄34

TABLE XVIII

FATAL & INJURY ACCIDENT RATES PER MILLION VEHICLE MILES

US-25 - Mt. Clemens to Port Huron

Before and After Delineation on US 24

January 6, 1937 - January 5, 1939 Compared to January 6, 1939 - January 5, 1941

Type of Accidents	Day Accident Rates			Night Accident Rates			Ratio of Night to Day Accident Rates		
	Before	After	% Change	Before	After	% Change	Before	After	% Change
Head-On, Sideswipe Opposite Direction	7	5	-29	7	7	0	1.000	1.400	+40
Rear-End Sideswipe in Same Direction	5	3	-40	11	5	-55	2.200	1.667	-24
Fixed Object, and Other Non-Collision Accidents	3	2	-33	1	5	+400	.333	2.500	+650
Total	15	10	-33	19	17	-11	1.267	1.700	+ 34

TABLE XIX

FATAL & INJURY ACCIDENT RATES PER MILLION VEHICLE MILES

COMPOSITE ROUTE (US-10, US-12, US-25)

Before and After Delineation on US-24

January 6, 1937—January 5, 1939 Compared to January 6, 1939—January 5, 1941

Types of Accidents	Day Accident Rates			Night Accident Rates			Ratio of Night to Day Accident Rates		
	Before	After	Per Cent Change	Before	After	Per Cent Change	Before	After	Per Cent Change
Head-On, Sideswipe Opposite Direction	.177	.144	-19	.669	.674	+ 1	3.780	4.681	+24
Rear-End, Sideswipe in Same Direction	.139	.107	-23	.732	.526	-28	5.266	4.916	- 7
Fixed Object, and Other Non-Collision Accidents	.109	.065	-40	.391	.343	-12	3.587	5.277	+47
Total	.425	.316	-26	1.792	1.543	-14	4.216	4.883	+16

TABLE XX

FATAL & INJURY ACCIDENT RATES PER MILLION VEHICLE MILES

COMPOSITE ROUTE (US-10, US-12, US-25)

Before and After Delineation on US-24

January 6, 1937—January 5, 1939 Compared to January 6, 1939—January 5, 1941

Type of Accidents	Day Accident Rates			Night Accident Rates			Ratio of Night to Day Accident Rates		
	Before	After	Per Cent Change	Before	After	Per Cent Change	Before	After	Per Cent Change
Head-On, Sideswipe Opposite Direction	42	38	- 9	53	59	+11	1.262	1.553	+23
Rear-End, Sideswipe in Same Direction	33	28	-15	58	46	-21	1.758	1.643	- 7
Fixed Object, and Other Non-Collision Accidents	26	17	-35	31	30	- 3	1.192	1.765	+48
Total	101	83	-18	142	135	- 5	1.406	1.627	+16