EFFECTS OF HIGHWAY LIGHTING ON DRIVER BEHAVIOR

W P Walker

Assistant Highway Engineer-Economist, Public Roads Administration

SYNOPSIS

Limited data indicate that the behavior of drivers operating under artificial light may conform very nearly to their behavior in the daytime, but that the behavior of nighttime drivers without overhead lights may differ measurably from their behavior in the daytime In these observations differences between the behaviors of drivers during daylight and darkness were most apparent in the frequency of passing and in the transverse positions of vehicles on the pavement There is inconclusive evidence that speed may also be affected

During daytime the drivers utilized 57 7 percent of the available opportunities for passing as compared to 55 6 percent during nighttime with the highway lighted At night with the highway unlighted the drivers utilized only 38 5 percent of the available opportunities for passing

The frequency distributions of transverse positions were almost identical for conditions of daytime and nighttime with the highway lighted, but there is a marked difference in these distributions for conditions of daytime and nighttime with the highway unlighted The average position of the right wheel of passenger cars moving freely was 3 3 ft from the edge of a 20-ft pavement during both daytime and nighttime with the highway lighted With the highway unlighted, this average position was one-half foot nearer the center of the roadway

Accident records have consistently shown that nighttime driving is more hazardous than daytime driving. During recent years illumination engineers have done considerable research on highway lighting with the objective of reducing the ratio of nighttime to daytime accidents per vehicle-mile of travel Several hundred miles of rural highway are now lighted, many of these being temporary installations for purposes of demonstration and experimentation One such installation is a 1-mile section on U S Route 422 near Chagrin Falls, Ohio Excessive grade and curvature at this location result in its being considered highly hazardous, and for this reason was selected by the Nela Park Engineering Department of the General Electric Company for study of methods of illumination and measurement of factors affecting visibility on lighted roads

In the fall of 1939, the Public Roads Administration and the Ohio Department of Highways conducted studies at this location in an effort to determine the effect of lighting on driver behavior. These studies were made over a 5-day period and three types of equipment were employed, each designed to obtain different information regarding driver behavior With this equipment, comprehensive data were collected on passing practices, transverse positions of vehicles, and vehicle speeds and spacings The primary objective was to determine to what extent driver behavior varied in daytime, in nighttime with road lighted, and in nighttime with road unlighted. Inclement weather during the observations increased the number of variables to include conditions of wet and dry pavement

The highway approaches the section on a tangent with a slightly undulating grade About one quarter mile from the first light and within the lighted section, the road rises slightly, then drops sharply on a grade of about 10 percent for a distance of approximately one half mile. There are two horizontal curves on this grade, one of them being very sharp The lower one quarter mile of the section is approximately level tangent. Figure 1 is a sketch of the plan and profile showing the operating positions of the study equipment.

The surface is portland cement concrete pavement in fairly good condition, having a width of 20 ft. except on and below the hill where it is 27 ft. wide. The shoulders on the 20-ft. section are 10 ft. wide and consist of 2 ft. of clay-gravel and 8 ft. covered with grass and in good condition. The section 27 ft. wide has a 6-in. curb on each side. Lighting is by means of incandescent lamps in specially designed reflectors mounted 25 ft high, 125 ft. apart, and extending 5 ft. out over the pavement. The lights are along only one side of the road.

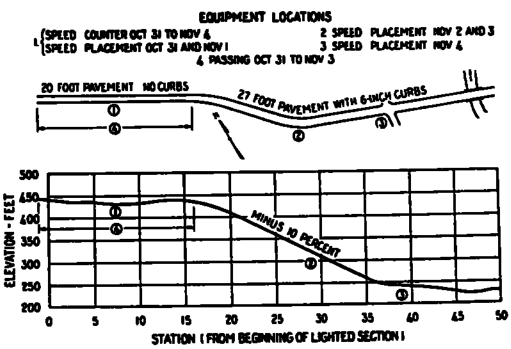

Figure 1. Plan and profile of one-mile section of lighted highway on U. S. Route 422 near Chagrin Falls, Ohio.

In evaluating the effects of highway lighting from a safety standpoint the accident record itself would be the most desirable index, but, since the number of accidents per mile of highway is relatively small, to obtain reliable data for a 1-mile section of highway would require years. Moreover, no accident records were available for this particular section of road. As a substitute for accident records it is possible, by a critical examination of driver behavior under the various conditions, to judge the probable effects of these conditions. From the results of driver behavior studies, it is possible to find instances where a driver on an unlighted highway was unquestionably driving too fast or in an otherwise reckless manner, but there is no way of proving that the particular driver might not drive just as recklessly during daylight or on a lighted highway. However, the chances are that on an average there will be just as many reckless drivers using the highway at night when it is not lighted as when it is lighted.

A differentiation between safe and unsafe driving practices under any set of driving conditions is difficult to make. Undoubtedly, the safest driving conditions exist during hours of daylight with a dry pavement, and the average driver under these conditions might be expected to perform in a somewhat different manner with respect to speed, distance from car ahead, and transverse position on the pavement than he would on the same highway after dark. If the drivers perform on a lighted highway at night in the same manner they perform on the highway in daylight, it is safe to assume that the vehicles are moving with greater safety and facility than they would on an unlighted highway. The degree to which driver performance on the lighted highway at night approaches that for daylight hours should be a measure of the effectiveness of the light in bringing about safer driving conditions.

Equipment for determining the passing practices of motor-vehicle drivers has been developed and its use described.[1,2] The equipment permits determination of the speed and time spacing of each vehicle at any point within a half-mile section, and shows whether the vehicle was in its own or the opposing lane of traffic or was straddling the center-

[1] Procedure Employed in Analyzing Passing Practices of Motor Vehicles, by E. H Holmes, Public Roads, vol. 19, No. 11, January 1939.

[2] Progress in Study of Motor-Vehicle Passing Practices, by O K. Normann, Public Roads, vol. 20, No. 12, February 1940.

line of the road It does not permit a determination of the pavement edge clearances of vehicles

Because of topographic conditions on the section of road studied, it was practicable to install only two-thirds of the detector tubes, the location selected being on the tangent at the top of the hill On a portion of this study section passing was restricted by inadequate sight distance. Because of this and the low traffic volumes prevailing, the number of passing maneuvers recorded was not great. The equipment was operated during afternoons and evenings until about 10 p.m. for four days The lights were off on alternate evenings.

TABLE 1

RESULTS OF STUDIES USING PASSING EQUIPMENT

Condition	Net hours studied	Vehicles recorded	Passings recorded
Daylight	1.85	448	41
Night—Lights on	3.77	496	20
Night—Lights off	4.48	616	20
Twilight	1 50	462	26
Total	11 60	2,022	107

Table 1 shows the operating time of the recorders, the number of vehicles and the number of passing maneuvers recorded under the various conditions studied. Of the 107 passing maneuvers recorded, a complete record was obtained of only 53, the other 54 having been started before entering or completed after leaving the study section. In all 107 cases, however, the passed and passing vehicles were recorded while abreast of each other so that data were obtained on at least half of each maneuver.

Conclusive results obviously cannot be drawn from such a small and varied sample. It is of interest, however, to examine a few of the passing maneuvers that were made under what might be considered hazardous conditions. Since no passing maneuver was made when an oncoming vehicle was so near as to constitute a hazard, this sample includes only passing maneuvers that were made where the driver could see less than 400 ft. of road surface ahead of him. This figure is used because it represents the sight distance at the point of beginning of a double white line center marking. The remainder of the passing study section had no centerline marking except the black center joint.

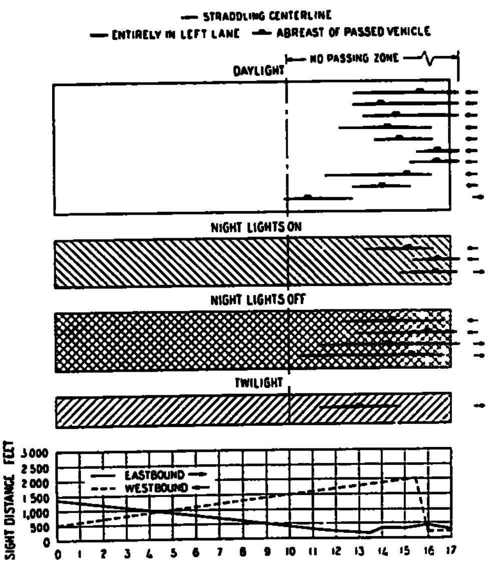

Figure 2. Passing Maneuvers Made in Violation of Center-Striped No-Passing Zone

Eighteen vehicles started to pass where the sight distance was 400 ft. or less and these maneuvers are shown graphically in Figure 2. These data are presented merely as a matter of general interest, since any comparison in numbers would be inconclusive and the similarity of the passing maneuvers permits of little differentiation for various conditions. It will be noted that, under all four conditions of light, there are cases where the passed and the passing vehicles were abreast of one another at points where the sight distance was only 200 ft. The speeds of these passing vehicles varied between 25 and 50 miles per hour. Had an oncoming vehicle made its appearance during one of these maneuvers, either the passing or oncoming vehicle would almost certainly have been required to take refuge on the shoulder to avoid a collison. In these 18 passing maneuvers, 11 of the passed vehicles were trucks, busses or tractor-semitrailer combinations moving relatively slowly.

Several of the passing maneuvers of west-bound vehicles (Fig 2) were accomplished without creating any traffic hazard, the reason being that the sight distance increased to about 2,000 ft. before

TABLE 2

RELATIONSHIP BETWEEN THE ACTUAL AND POTENTIAL NUMBER OF PASSINGS UNDER VARIOUS CONDITIONS

Condition	Number of passings			Percentage that potential is of total
	Actual	Potential	Total	
Daylight	41	30	71	42 3
Night—Lights on.	20	16	36	44 4
Night—Lights off.	20	32	52	61 5
Twilight	26	25	51	49 0

the passing vehicle was completely in the left lane. These were violations of the center striping that would not be so classified had the marking been of the directional type which permits passing in one direction while prohibiting it in the opposite direction. The number of vehicles that could have passed but were discouraged from doing so by reason of the center striping cannot be determined.

Table 2 shows the relationship between the number of passing maneuvers recorded and the number that could have been accomplished under favorable conditions. Classified as "potential" passings are those cases where a vehicle was following another vehicle at a spacing of 1½ sec. or less at a point where no restriction was offered to passing by an oncoming vehicle within 1,500 ft or by a sight distance less than 1,200 ft. The percentage that these potential passings are of the total is shown in the last column. These figures show that 42.3 percent of these drivers were reluctant to pass during daylight as compared to 61.5 percent at night when the highway was unlighted When the highway was lighted, however, only 44.4 percent of the drivers preferred to follow the vehicle ahead rather than pass it. This compares favorably with the data for daylight conditions It might be concluded from this that the drivers using the highway while it was unlighted were more cautious than those using the highway while it was lighted, but the important fact shown here is that the driving practices observed while the lights were on conformed much more nearly to those for daylight conditions than did the driving practices on the unlighted highway

The passing study equipment is well adapted to studying the variations in speed of vehicles over a length of highway. Such an investigation is of interest here to determine what effect the combination of a large diamond shaped "Hill" sign and a flashing danger signal, both located near the crest of the rise just preceding the steep descent, had upon the speeds of vehicles under various conditions. In Figure 3, the average speeds of vehicles as maintained throughout the section are plotted. The warning signs were located opposite station 14, facing the east-bound traffic.

The speed curves for east-bound vehicles vary considerably for the three conditions shown The average speed of the vehicles on the lighted highway showed a slight increase for the first 850 ft., whereas with the lights off, the average speed began to decrease almost immediately after entering the section. A number of explanations of this difference in behavior suggest themselves but none has any plausible basis. For each condition of lighting, the average speed showed a noticeable decrease upon approaching the warning signs, the amount of decrease varying from 5 miles per hour when the highway was lighted to 8 miles per hour during daylight. Without these warning signs, drivers unfamiliar with the road would be unaware of approaching any danger since the terrain visible from this point did not reveal the hill.

The ordinate at the right of Figure 3 for west-bound vehicles represents their average speeds as they ascended the

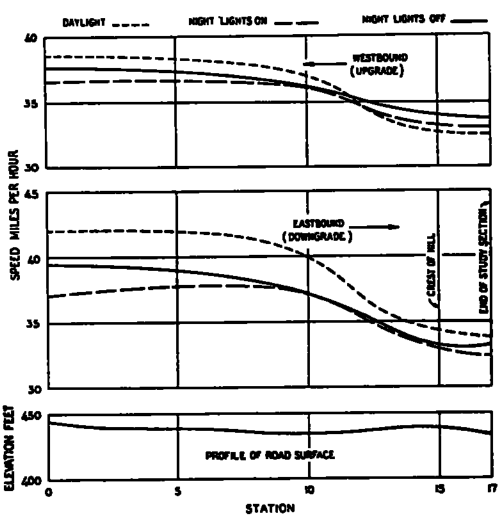

Figure 3. Average Speeds of All Vehicles as Recorded by Passing Equipment

grade. The normal speed of these vehicles was somewhat lower than for the east-bound traffic.

The results of the passing study show that there are certain drivers whose hazardous driving habits cannot be corrected by means of artificial lighting, since such drivers are present under all conditions of light and darkness.

The results further show that there is a marked difference between the normal behavior of drivers during daylight and darkness, and that the behavior of drivers under artificial light conforms more nearly to their behavior during daylight than it does to their behavior during darkness.

ANALYSIS OF TRANSVERSE POSITION

The effect of weather conditions on driver behavior was more noticeable in the results of the speed-placement study than in the passing study For this reason the results for various lighting conditions have been further classified to show variations caused by wet pavement. The passing equipment and placement equipment are two distinct sets of apparatus and are operated independently of each other. Speed and time-spacing data for all vehicles are an incidental part of the passing study records, and are available for any point within the study section. These data are also obtained by the speed-placement recorders but at only one point. In addition, the latter equipment records the positions of vehicle wheels with respect to the edge of the pavement.

TABLE 3

NET HOURS OF OPERATION AND VEHICLES RECORDED IN SPEED-PLACEMENT STUDY

Condition	Speed-placement equipment	
	Hours studied	Vehicles recorded
Daylight:		
Wet pavement	2 00	441
Dry pavement	10 13	2,388
Night—Lights on.		
Wet pavement	3 72	547
Dry pavement	5 92	1,131
Night—Lights off:		
Wet pavement		
Dry pavement	6 92	1,027
Twilight	3 80	1,225
Total	32 49	6,759

Table 3 shows how the 32 49-hour net operating time of the speed-placement equipment was distributed with respect to weather and lighting conditions. This was the total time of study at three locations: One on the level tangent at the top of the hill, one on the sharp curve about midway of the steep grade, and one on the level tangent at the foot of the hill.

The frequency distribution of time spacings was investigated as a possible index of driving habits under various

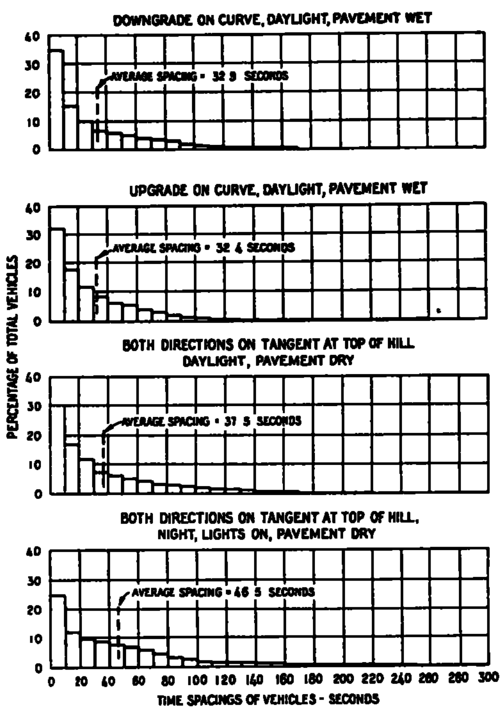

Figure 4. Frequency Distributions of Time Spacings

conditions of lighting and alinement. It is interesting that the time-spacing patterns varied only slightly from patterns found in previous studies, confirming the results of nearly all earlier studies. Under all conditions the percentage of vehicles traveling at or below the average time spacing was between 63 and 67. Earlier studies had showed invariably that approximately two-thirds of the vehicles traveled at or less than the average time spacing.

In Figure 4, the frequency distributions of time spacings are shown for four conditions. Distributions for other conditions could also be shown but the similarity is so pronounced that further illustration is unnecessary. The fact that the frequency distribution of time spacings is a definite function of the average spacing and hence of the traffic volume, is more apparent in Figure 5, where the distribution is based on the percentage of the average spacing. Here the distribution of spacings for one condition is superimposed on that for another up to twice the average spacing. These two conditions represent the extremes

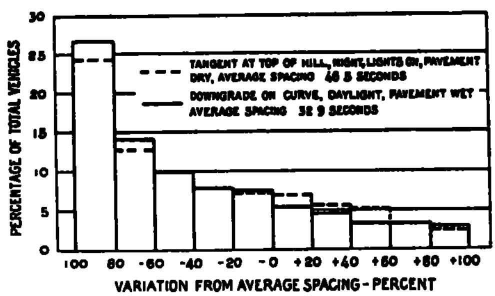

Figure 5. Frequency distribution of variations in time spacings from the average spacing.

in traffic volumes studied. These results show that for the traffic volumes studied the time spacing of vehicles is independent of alinement, weather, and light conditions.

Data on the average placement of all vehicles with respect to the edge of the pavement are useful in comparing driver behavior under various conditions. In order to eliminate insofar as possible all extraneous factors, however, the most significant placement data are those for vehicles whose drivers were uninfluenced by the presence of a preceding or an opposing vehicle. The edge clearances of such "freely" moving passenger cars on the tangent at the top of the hill, Figure 6, show frequency distributions for conditions of daylight that are very similar to those at night with the highway lighted. In both cases the average edge clearance was 3.3 ft.

The distribution of edge clearances at night with the highway lights off, however, follows a noticeably different pattern and the average placement is ½ ft. nearer the center of the road. With the highway lights on, 75 percent of the drivers followed a path not more than 2 ft. wider than the car, the right wheel always being between 2 and 4 ft. from the pavement edge. When the highway lights were off, the same percentage of drivers had a 3-ft. variance in their path, the position of the right wheel being between 2 and 5 ft. from the pavement edge On the tangent at the foot of the grade the similarity between the placements during daylight and at night with the highway lights on is almost as striking (Fig. 7). The difference in the average placement for these two conditions is only 0.1 ft. No record was obtained at this location at night with the highway unlighted.

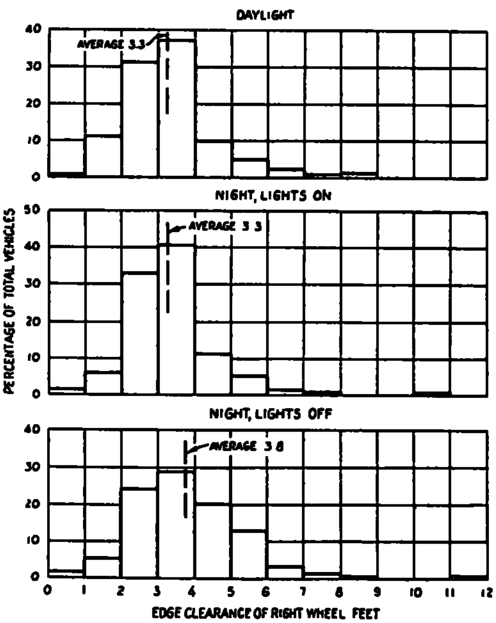

Figure 6. Edge clearances of passenger cars moving freely on tangent at top of hill, pavement dry.

Because of differences in weather conditions no direct comparison can be made of placement data recorded on the curve. The pavement was wet when studied with the highway lights on, and dry when studied with the lights off. Furthermore, the paths of vehicles traveling upgrade were restricted by the natural tendency of drivers to hug the inside of the curve regardless of weather or lighting conditions. For the drivers traveling downgrade there is greater freedom in selecting the path which the driver feels is consistent with safety and comfort. Figure 8 shows that, for vehicles traveling downgrade, there was a slight difference between the placement distributions at night with the highway lights on and in the daytime under similar weather conditions. However, when the highway lights were off there was a marked differ-

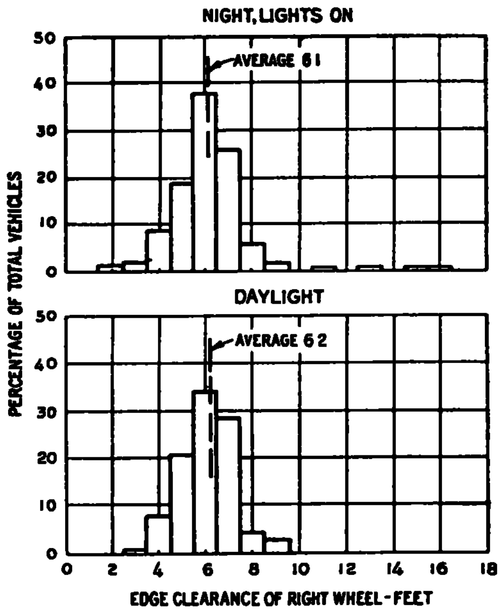

Figure 7. Edge clearances of passenger cars moving freely. Tangent at foot of hill, pavement dry.

ence in the distribution when compared to that for daylight with dry pavement.

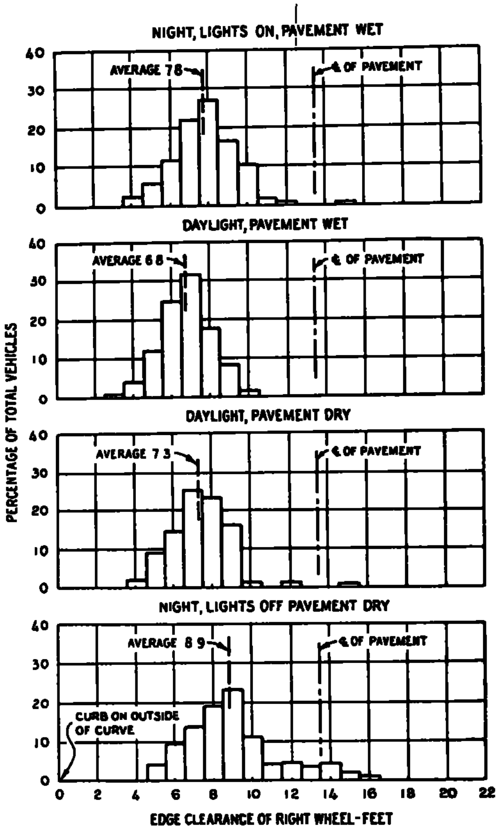

Figure 8. Edge clearances of passenger cars Moving Freely Down Grade on Curve

ANALYSIS OF SPEED DISTRIBUTION

As mentioned previously, the speeds of all vehicles were obtained as an incidental feature of the passing study at the top of the hill, and at three points with the speedmeter The top of the hill, below the hill, and on the grade at the curve.

From the results of the passing study, Figure 3, it appears that the speeds of vehicles, particularly of those just entering the lighted section, may not be representative of normal driving practice on lighted highways. This may be caused by the fact that the passing section was located at one end of the lighted portion of the highway, and drivers entering the section had had no opportunity to adjust their driving to the changed condition. This assumption appears reasonable since the speeds of westbound vehicles were fairly uniform, as shown in Figure 3

At the first location of the speedmeter, 700 ft. from the end of the lighted section, this same effect could be expected to influence the speed distribution. In addition, during study at this station too small a sample was obtained under each condition to indicate reliably the effect of illumination on speed distribution

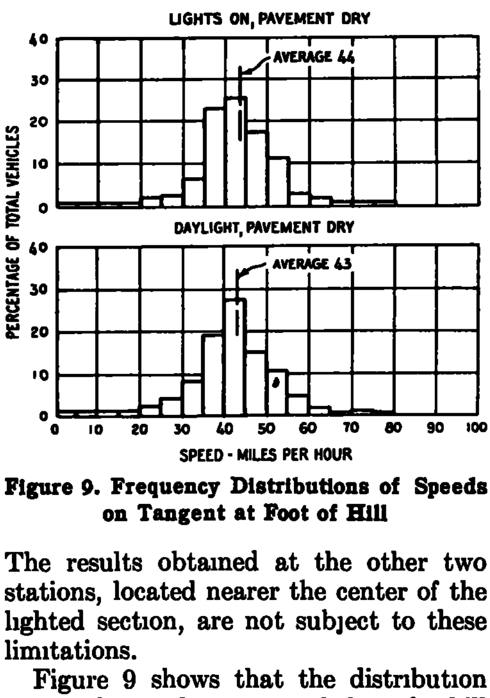

Figure 9. Frequency Distributions of Speeds on Tangent at Foot of Hill

The results obtained at the other two stations, located nearer the center of the lighted section, are not subject to these limitations.

Figure 9 shows that the distribution of speeds on the tangent below the hill was about the same under illumination as during daylight. The average speeds were 43 and 44 miles per hour respectively. The posted speed limit on this road was 35 miles per hour, but these speed distributions show that 82 percent of the vehicles traveled in excess of this speed, both during daylight and night with the highway lighted. Under both conditions 20 percent of the vehicles traveled in excess of 50 miles per hour.

On the curve, speed distributions were more varied in character, as shown in Figure 10 For vehicles going downgrade the greatest similarity in speeds seems to exist between daylight with wet pavement and night without lights but with dry pavement. The speed distribution for vehicles on lighted wet pavement seems to be in a class by itself, the average speed of 26 miles per hour

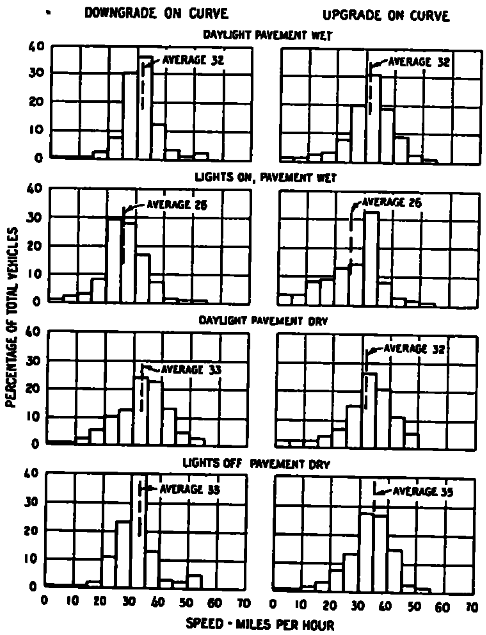

Figure 10. Frequency Distributions of Speeds of All Vehicles

being 6 miles per hour less than for daylight under similar weather conditions. For vehicles going upgrade, there are no marked differences in the patterns of speed distribution for the various conditions, but it is of interest that the average speeds of vehicles going upgrade under the various conditions are almost identical with the speeds of vehicles going downgrade under those same conditions.

It would appear from the speed distributions that the effect of highway lighting at this hazardous location was a reduction in the average speed when the pavement was wet. However, concrete pavement has a tendency to appear slippery at night when wet, whether the light is from an overhead source or from the headlights of vehicles Such accentuation of the appearance of slipperiness may account for this marked reduction in speed, but it is impossible from the results obtained to determine to what extent, if any, the overhead lights influenced vehicle speeds.

The speed counter was operated continuously for 96 hours at a position on the tangent at the top of the hill. This counter merely classified the vehicles by their speeds into 20 groups, and the total number of vehicles in each group was manually recorded at the end of each hour Despite the fact that speeds at night under lights at this position may not be representative of normal behavior, this phase of the study is of particular interest because it represents perhaps the longest continuous record of vehicle speeds ever collected.

Table 4 shows the average speed of vehicles, and the distribution of speeds in 10 groups. As might be expected, the average speed during daylight, 38 5 miles per hour, is faster than the average speed at night. The average speed with the lights on, 35 0 miles per hour, is less than the average of 36.8 miles per hour found with the lights off Wet pavement resulted in a decrease of speed in daytime, but a slight increase at night with the highway illuminated, a change that is inexplicable. It is significant that where a reduction of average speed occurs (Table 4) it results from a general lowering of speeds in all ranges rather than because of a marked decrease in the number of vehicles in the higher speed groups. Under all conditions, some vehicles moved at 60 miles per hour or faster despite the 35-mile speed limit.

Figure 11 shows graphically the variation in average speed and traffic volume by hours. The consistency of the records is shown very clearly in this figure, for in no daylight hour was the average speed on wet pavement as great as that on dry pavement. This condition was reversed

TABLE 4

PERCENTAGE OF VEHICLES TRAVELING IN VARIOUS SPEED GROUPS DURING DAYTIME AND NIGHTTIME WHILE PAVEMENT WAS DRY AND WHILE PAVEMENT WAS WET[1]

Speed group, miles per hour	Daylight hours—7 a.m. to 5 p.m		Night hours—6 p.m. to 6 a.m.		
	Dry pavement	Wet pavement	Pavement dry		Pavement wet
			Lights off	Lights on	Lights on
	Per-cent	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*
Below 19.1	2.8	3.6	2.6	5.2	2.4
19.1–25.0	3.2	5.6	4.6	6.4	4.5
25.1–29.7	7.5	10.0	9.8	11.1	11.8
29.8–35.1	19.1	22.4	24.6	25.4	29.5
35.2–41.4	30.1	32.7	31.4	25.9	31.9
41.5–45.4	17.0	13.6	14.0	13.6	11.5
45.5–50.3	12.6	8.0	7.6	8.4	5.8
50.4–56.3	5.7	3.1	3.4	2.8	2.1
56.4–59.5	1.1	5	.9	5	2
Over 59.5	9	5	1.1	7	.3
Average speed ..	38.5	36.5	36.8	35.0	35.8
Vehicles per hour	197	174	84	82	73
No. vehicles studied..	5,886	1,722	1,989	966	874

[1]Data for 8 hours of study between 6–7 A.M., and between 5–6 P.M., and for 1 hour at night with pavement wet, lights off, are not included in this table.

when the highway was lighted, as in the early evening and thereafter throughout the night the average speed on wet pavement remained consistently higher than that when the pavement was dry.

In interpreting the significance of the results of this investigation, several factors should be borne in mind.

1. The traffic volumes were relatively low, and the effect of lights on the speed of traffic as shown here may be entirely different from that for greater traffic volumes.

2. The alinement and grade of the short length of road studied may have prevented drivers from driving normally under any one condition.

3. The novelty of the lights being off for the first time in several years may well have had an influence on drivers accustomed to using the road.

4. The number of vehicles for which the speeds were recorded at night was not great.

5. The final criterion of effectiveness of such lighting installation should be the

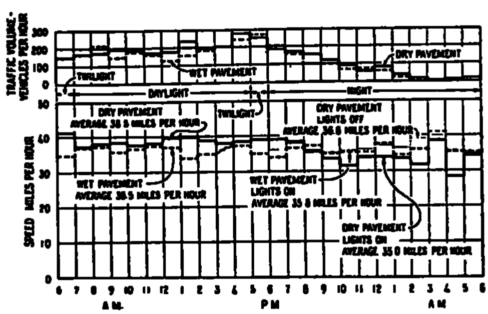

Figure 11. Traffic Volumes and Average Speeds by Hours

effect on safety as revealed by before-and-after accident records.

These considerations almost preclude comparison of the results obtained in this study with those obtained elsewhere. Results of the study, however, seem to permit the following conclusions:

1. There are measurable differences in the behavior of drivers during daylight and darkness. These differences are most apparent in the transverse position of vehicles and in the frequency of passing. There is evidence that speed is also affected, but in this study the evidence cannot be considered conclusive.

2. The behavior of drivers operating on a lighted highway conforms very

nearly to their behavior in daylight, but does not conform to their behavior on unlighted highways at night, insofar as transverse position and passing frequency are concerned.

3. Conditions of illumination, as well as alinement and weather conditions, have no apparent effect on the normal distribution of time spacings between vehicles

Other findings of general interest are

1. A posted speed limit, when unenforced, has little effect upon the speeds of vehicles Speeds as high as 82 miles per hour were recorded on the study section where the posted limit was 35 miles per hour, and hourly averages were seldom below this legal limit. This speed limit appears unreasonably low because the locality is distinctly rural in character although within corporate limits

2. There is a certain minority of drivers on the road at all times who are prone to take risks. This is brought out rather clearly in the passing study, in which drivers were found passing where sight distances were entirely too short for safety

MR. J A BUCHANAN, *Public Roads Administration:* Has consideration been given to the driving practices and particularly the accident records of unlighted highways adjacent to lighted highways,—the same situation as where the previously lighted highways were left unlighted? That is, does leaving a lighted section and going into an unlighted section materially affect driving practice? Especially does it tend to affect accidents due to lack of readjustment of the eyes?

MR. BURTON MARSH, *Chairman, Committee on Highway Lighting Research:* That logical question has been discussed by the Committee. We hope to secure further information concerning the matter Mr. Kirk Reid of our working committee has stated that such evidence as he has been able to collect indicates that there are no serious effects due to readjustment of eyes on leaving lighted sections of highways. Further support for this indication is found in the increasing number of hazardous locations—generally short stretches—which are being illuminated. The driver enters and leaves such lighted hazard zones in rather rapid succession, but no reports have come to our attention of accidents experienced in leaving such zones

In committee discussions on this subject, the question has been asked as to whether there was a change in the intensity of the highway lighting near the end of a lighted zone. Mr. Reid has informed the committee that there are generally no such changes in lighting intensity, and he has pointed out reasons why such changes are not considered to be warranted. However, further research on this whole subject is needed.

MR JOSEPH BARNETT, *Public Roads Administration:* Caution should be used in applying accident data gathered before and after lighting a highway. Lighting installations to date generally have been made in connection with improvement of the highway itself. It is the logical time to do so. A decided drop in accident experience after lighting a highway might result and it may not be due to the lighting at all. Suppose a pot hole in a road was the cause of numerous accidents. After lighting drivers would see that pot hole and avoid it, reducing the number of accidents. The same could be accomplished by filling the pot hole. That is a ridiculous extreme of course but the same principle applies to more subtle examples such as one of alignment and grade which result in frequent driver behavior of a dangerous character. A required reduction in speed for example may not be obvious to drivers resulting in vehicles frequently leaving the road Lighting that highway may improve driver behavior but realigning that particular highway may also do so. I have no doubt that the committee will think of these things. A reduction in accident experience probably always will result upon lighting a highway but it should be carefully examined against a possible alternative to lighting.

MR. MARSH: The committee is aware of the points which Mr. Barnett has appropriately made. Admittedly, lighting is not the only corrective, and it may not be the best, long-time answer to certain hazardous conditions. Furthermore, in seeking to ascertain the effects of highway lighting upon accidents, it is highly important to avoid being misled by effects of other changes. For example, upon lighting a highway, it is likely that there will be increased night use and that patrolling by police will be considerably increased. A statement concerning this project prepared last year by Mr. Roy Crum brings out the importance of isolating the particular factor . . . highway lighting . . . which we wish to study. It is hoped that we can make arrangements for the conduct of studies both before and after lighting, under pre-arranged conditions for keeping as many other factors unchanged as is practicable