Effectiveness of Sign Background Reflectorization

LAWRENCE D. POWERS
Highway Research Engineer, Traffic Systems Division, Office of Research and Development, Bureau of Public Roads

•PRESENT standards for directional signs on Interstate highways call for white legend on a green background. Where the sign is not self-illuminated the standards require that the legend be reflectorized; however, for roadside signs and illuminated overhead signs, reflectorization of the background is optional. There has been some question as to the degree of background brightness that is necessary and consequently the degree of reflectorization. The results of previous studies by the U. S. Bureau of Public Roads (1) have indicated little practical difference in legibility of signs with different degrees of background reflectorization, including no reflectorization. It is possible, however, that the degree of background brightness affects other sign-effectiveness factors such as detectability or reading time.

As an initial attack on this question, signs with different degrees of background reflectorization were compared by analyzing their effect on the ability of drivers to follow a test route to a given destination on controlled-access highways in a suburban area.

DESCRIPTION OF STUDY

Test subjects drove over a fictitious route which included highways and parkways of the Pentagon network and other controlled-access highways in the Virginia suburbs of Washington, D. C. Changes in the direction of the route were marked by test guide signs in advance of the exits. An observer riding in the car with the test subject noted missed turns, and directed the test subjects back onto the route in case of a missed turn. In order to conceal the true nature of the experiment, subjects were informed that this was a study of "night driving characteristics" and they were being asked to use the same route so as to have a consistent basis for comparison.

The test route (Fig. 1) was approximately 25 miles long, and its controlled-access design was of the World War II era with fairly curvilinear alignment. All test turns were right-hand exits. Each turn was marked by a single test guide sign (Fig. 2) placed 400 ft or more in advance of the exit. All portions of the route on approaches to and in the vicinity of test signs and turn exits were on controlled-access divided highways with two or three lanes in each direction. Some exit ramps led to streets or highways of lesser design, but the route always led back to an access-controlled divided highway usually one-half mile or more in advance of a test sign location. Posted speed limits on the route ranged from 35 to 55 mph, but were predominantly 35 or 40 mph. Prevailing speeds on the same highways ranged, for the most part, from 35 to 45 mph. There were 18 test turns on the route, all of which were marked with green test signs having reflectorized white legends.

Three degrees of reflectorization were used for the test sign backgrounds: (I) a nonreflectorized green background; (II) a moderately bright reflectorized green background; and (III) a relatively high-brightness reflectorized green background (standard reflectorized sheeting). Specific luminance curves for divergence angles up to one degree at an incidence angle of $\frac{1}{3}$ deg for these materials, and for the material used for the white legend, are shown in Figure 3. For comparison, the specific luminance of unity of a theoretical perfect white diffuse surface is included. Figure 4 shows the appearance of the different materials at one location. Because of the limited range of brightness that can be depicted by photographic process, the views are only approximate representations.

Paper sponsored by Special Committee on Night Visibility and presented at the 44th Annual Meeting.

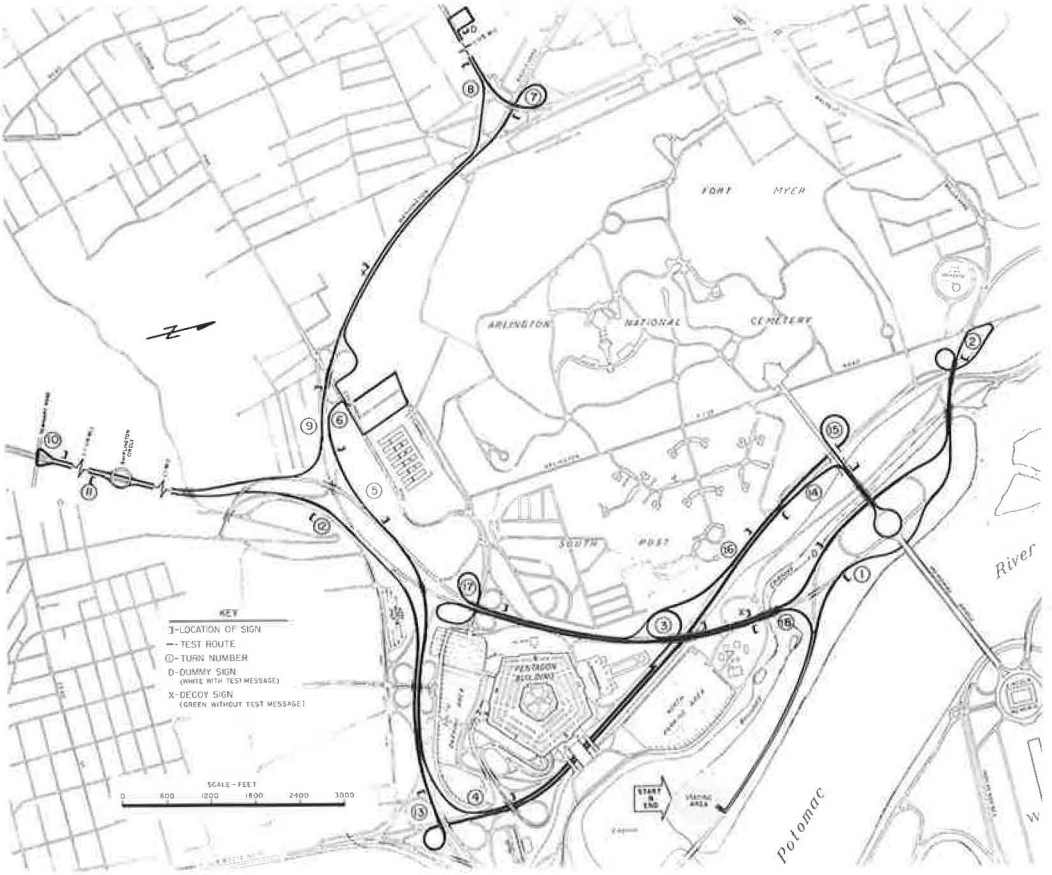

Figure 1. Map of test route.

Figure 2. Daytime view of typical test guide sign.

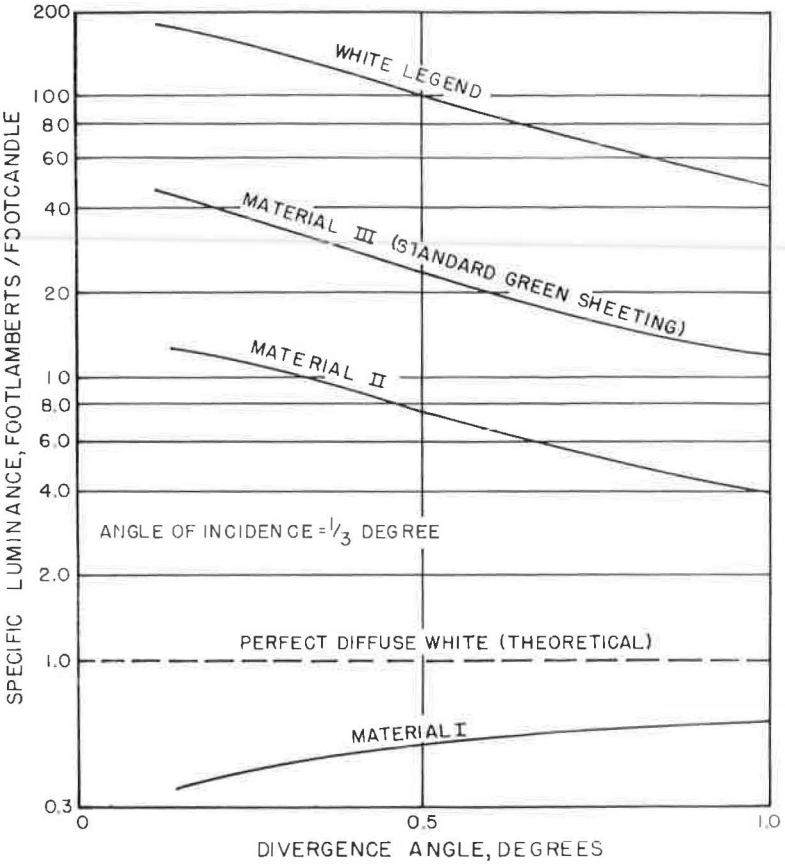

Figure 3. Specific luminances of the materials used on the test signs.

TABLE 1

SCHEDULE OF SIGN BACKGROUNDS BY NIGHTS AND TURNS

Turn Number	Sign Background Designations[1]		
	First Night	Second Night	Third Night
1	I	II	III
2	I	III	II
3	III	I	II
4	III	II	I
5	I	II	III
6	II	I	III
7	III	I	II
8	I	III	II
9	I	II	III
10	II	III	I
11	II	III	I
12	II	I	III
13	III	II	I
14	III	I	II
15	I	II	III
16	II	III	I
17	II	III	I
18	III	I	II

[1] Roman numerals refer to degree of reflectorization as follows: I, nonreflectorized green background; II, moderately bright reflectorized green background; and III, relatively high-brightness reflectorized green background (standard reflectorized sheeting).

The type of background at each turn was assigned randomly each night. The only limitation on the random assignment was that the sign marking each turn had to have a different background each night, and that each night the signs at one-third of the turns had to have each of the background treatments. Therefore, there were six turns each night marked with signs of each of the background treatments. On successive nights, the sign background was changed at each test turn. Each of the 18 turns on the route was therefore marked by a sign with each of the background types on successive nights. Three nights of testing (or multiples of three) were needed to balance the experimental design by background treatments and turns. A schedule of backgrounds by nights and turns is given in Table 1.

To facilitate changing the sign backgrounds on successive nights, three signs were fabricated for each test turn, which were identical in legend and legend spacing

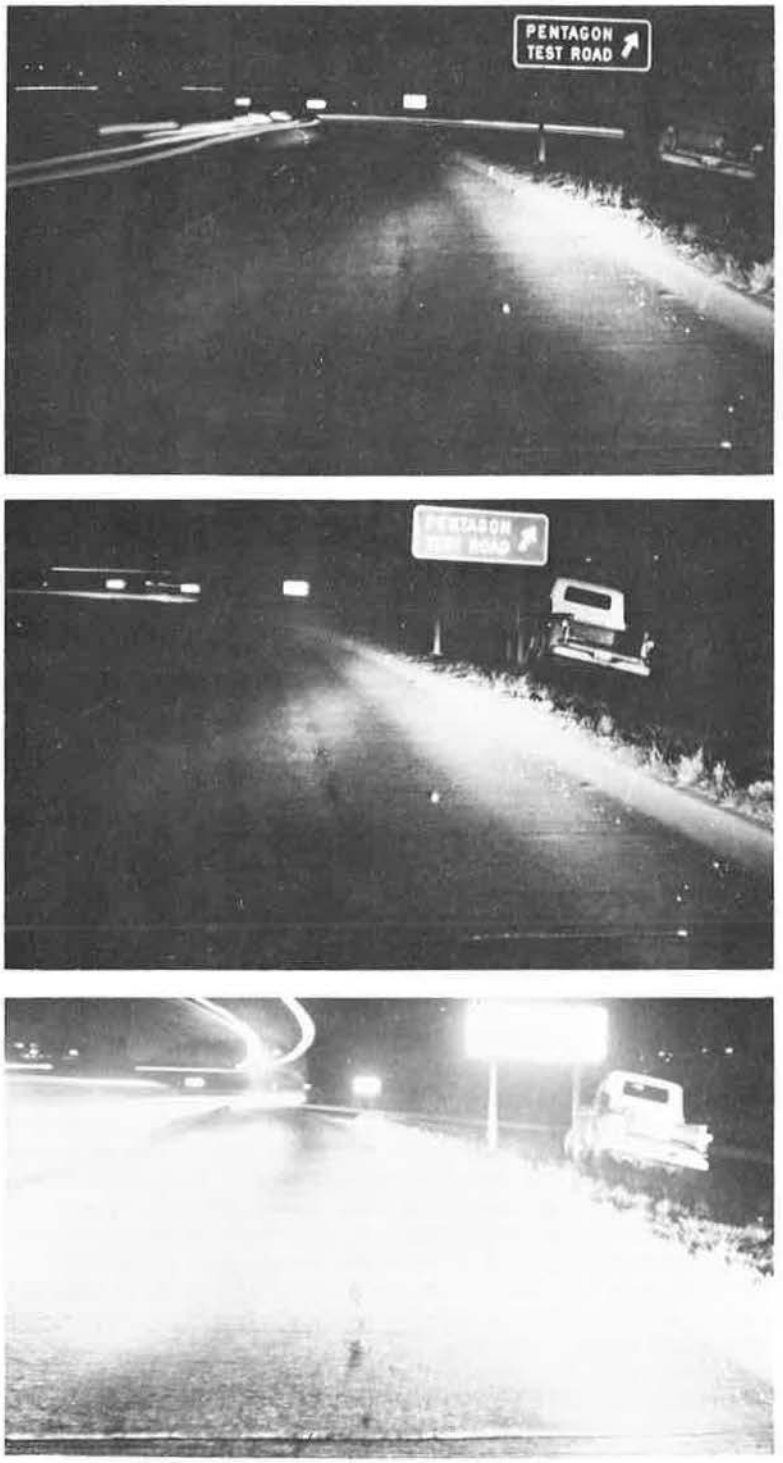

Figure 4. Night views of signs with different background materials at same location.

and differed only in background treatment. Legends and borders consisted of white reflectorized sheeting. Eight-inch series D letters were used. The test sign carried two lines of copy and appropriate arrows: the first line gave a legitimate destination on the route, e. g., PENTAGON; and the second line, in all cases, read TEST ROAD. All test signs measured 96 by 32 in.

The test signs were designed so as not to appear conspicuously different in size and legend style (letters and arrows) from the permanent directional signs along the route, most of which had either black legend on a white reflectorized background or white reflectorized legend on a nonreflectorized background. None of the test signs gave directions which conflicted with, or appeared to duplicate, the existing signing. In a few cases, a test sign replaced an existing sign.

Even with these precautions, it was felt that the subjects would have learned to associate, either consciously or subconsciously, the test message with signs having green backgrounds. This would have biased the results in favor of reflectorized backgrounds. Furthermore, subjects might also have learned to associate the test message with the test-sign shape (a low, wide rectangle) or design (two lines of legend, and arrows). In order to further camouflage the differences between the test signs and the existing signs, two dummy signs (Fig. 5) displaying the test message which more nearly resembled the existing signs in dimension and color combination (black legend on a white reflectorized background), were placed along the route; two other signs were placed which resembled the test signs in shape, design, and color combination, but with the test message omitted (Fig. 6). The latter signs termed "decoys," supplemented by the few existing green background signs along the route, were intended to prevent the subjects from associating green backgrounds with the test message. Small 24- by 30-in. auxiliary signs used for directions on ramps and other connections on the route had black legends on white reflectorized backgrounds (Fig. 7).

Test signs were mounted in horizontal channels on posts to facilitate changing them each night. The signs were mounted at a height 5 ft from the bottom of the sign to the pavement, and laterally at a minimum distance of 2 ft beyond an unmountable curb or edge of shoulder. They were mounted at approximately right angles to the roadway, but the angle with the roadway always exceeded 90 deg in order to minimize specular reflections.

Test subjects were volunteers from organizations such as local Junior Chambers of Commerce, a local sports car club, the Bureau of Public Roads (other than the Traffic Systems Division), and other agencies of the Department of Commerce. Subjects were scheduled in advance for specific nights and times of arrival at the staging area.

PROCEDURE

The test procedure was essentially the same as that used in a previous study of route turn markers (2). On arrival at the staging area, subjects received a printed sheet containing explanations and instructions. They were asked to complete a questionnaire on driving experience and to undergo a vision test on a Keystone Visual Safety Tester for acuity, stereopsis, and far-point fusion. Color vision also was tested. The questionnaire and vision test were included as part of the facade of a general study of night driving characteristics, and in addition, tests served to screen subjects for visual defects. The questionnaire and visual acuity data are summarized for the different groups of subjects taking part in the study every night (Table 2).

Subjects were told only that the aim of the study was to observe typical night driving characteristics and that, in order to have a consistent basis of comparison, they were to drive over the same route. The subjects were instructed to drive normally, and were told that the accompanying observer would not judge their driving but only observe their normal night driving characteristics. In order to retain anonymity, subjects were identified by code number. It was explained that the observer would usually be too busy to give directions, and that the subjects were expected to follow the course which was marked by signs with the message TEST ROAD. Subjects were not specifically informed that the observer would guide them if they missed a turn. Furthermore, a missed turn was not called to their attention; the observer merely began giving cor-

Figure 5. Dummy sign—test message with black legend on reflectorized white background.

Figure 6. Decoy sign, similar in design and color to test signs, not carrying test message.

Figure 7. Auxiliary sign used for directions on ramps and other connections.

TABLE 2

CHARACTERISTICS OF TEST SUBJECTS

Characteristic	Number of Test Drivers		
	First Night	Second Night	Third Night
Organization[a]:			
Bureau of Public Roads	20	20	20
Sports car club	23	19	31
Jaycees	9	9	7
Others	12	15	6
Sex of driver[b]:			
Male	47	45	43
Female	3	5	7
Age of driver (years)[b]:			
Under 20	2	1	0
20 - 29	18	13	20
30 - 39	14	10	15
40 - 49	7	16	6
50 - 59	8	7	6
60 and over	1	3	3
Visual acuity:			
Below 20/40	50	49	49
Above 20/40	0	1	1
Familiarity with area[c]:			
Very familiar	10	11	8
Moderately familiar	24	28	25
Unfamiliar	16	11	17
Avg. age	35.1	39.3	35.9
Median age	33	40	33

[a]Estimated from mail return and schedule of volunteers—since subjects were identified by code number at the site, there is no way of identifying the 50 subjects who participated each night by organization.
[b]Taken from first questionnaire.
[c]Taken from second questionnaire; subjects queried after completing course.

rective directions. In the case of a choice of roadways, subjects were further instructed to stay on the main road except when directed otherwise by signs or by the observer. It was hoped that the foregoing explanation would somewhat satisfy the understandable curiosity which would have arisen by giving the subjects a plausible reason for following the signs, and minimize emphasis on the signs themselves being the object of the study. To obtain further consistency, subjects were instructed to keep their headlights on low-beam during the study. Subjects drove the route only once during the test, with 5-min intervals between the dispatching of each subject to prevent overtaking.

In order to reduce public exposure to the signs, they were put in place at approximately 6:00 p.m. and taken down after the last subject had traversed the route.

At the beginning of the test, the observer directed the subject to drive to the exit of the staging area parking lot where one of the small auxiliary signs reading TEST ROAD was placed. From this point on, the subject was on the test route. The observer noted turns made correctly or missed. Whenever an error was made the subject was directed back onto the route in such a way that he would not encounter any of the remaining test signs out of sequence.

After returning to the staging area, a second questionnaire was completed dealing with such items as the subject's familiarity with the area of the route and problems in following the route.

REFLECTIVE PROPERTIES OF SIGN MATERIALS

The specific luminance curves (Fig. 3) were derived from outdoor measurements on 24-in. square plaques identical to the materials used for the test sign. Similar measurements made on a sample basis of the actual test signs were compared with those on the plaques and were found to be essentially the same. The curves as plotted were derived from the measurements on the plaques. Because of the limited number of measurements on these materials, the curves shown should be considered as representative of the relatively specific luminances of the materials rather than the absolute specific luminances.

The values for the non-reflectorized background materials appear somewhat high. This is probably because the material was a smooth sheeting and exhibited some specular reflection. However, the material when used on the test signs would have exhibited the same characteristics.

Figure 8 shows how the brightness of the sign materials varied with distance from the sign for each turn. These data represent actual field measurements of the plaques mounted on the sign supports and illuminated by the low beams of a single vehicle. With the vehicle stationary at a measured distance from the sign, brightness measurements were made by a Pritchard photometer mounted at the driver's head position. The plotted numerals represent the turn at which the brightness values were obtained for the standard sheeting sign background material at the indicated distances from the sign. A curve has been drawn through the median brightness for all turns at each distance (the median value for the 700-ft distance is based only on those signs which were

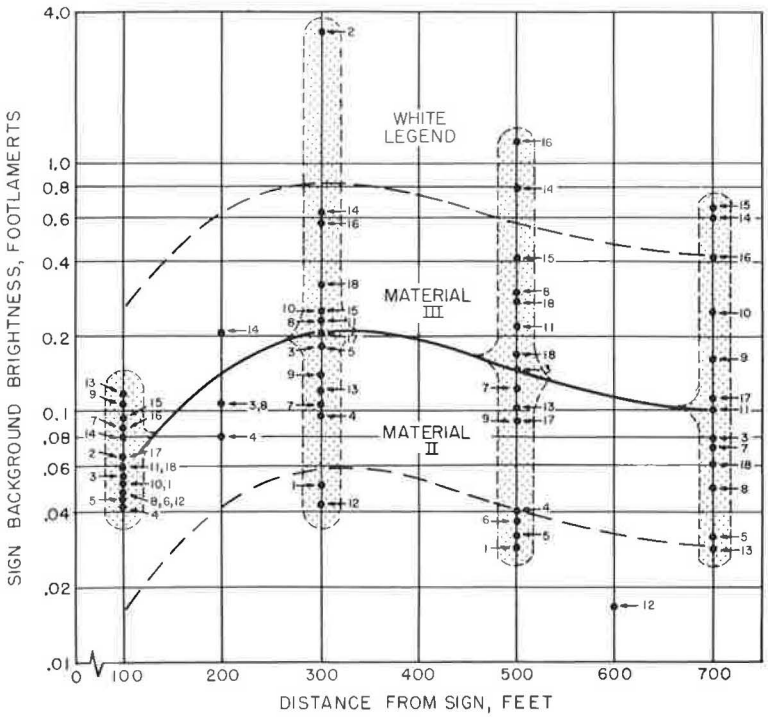

Figure 8. Brightness of the sign materials in place by distance from the signs for two-lamp low beam illumination. (The plotted points are all for material III, the standard green sheeting, shown here as the solid curve; numbers next to the points refer to the turns at which the measurements were made; and the dashed curves represent the median brightnesses for material II and the white legend material.)

not obscured at that distance). The median curves for the intermediate sheeting and the white legend material are shown by broken lines below and above the curve for the standard sheeting, respectively.

The wide range in brightness is caused by the variations in horizontal and vertical curvature on the approaches to the signs at the individual sign locations, which resulted in differences in incidence angles and in the amount of head-lamp illumination incident on the signs. To a lesser extent, variations in the approaches also resulted in differences in divergence angles. For each sign location and distance, the incident illumination and incidence and divergence angles were the same for each material, and thus the brightnesses were in the same ratio as the specific luminances. Although there is considerable overlap in the brightness ranges for the three materials at different locations, the brightnesses of individual materials at the same location were in the same ratio. The median curves are therefore parallel, and the individual measured points for the other two materials, if shown, would have fallen as far from the corresponding turn points indicated for the standard sheeting as the distances between the medial curves for the other two materials.

These brightness values were obtained under low-beam illumination by a single vehicle and are therefore minimum values. The brightnesses of the signs during the tests could have been higher as a result of illumination contributed by other vehicles on the highway.

TEST SUBJECTS

The number of test subjects was limited by the need to run the study for a period consisting of multiples of three nights in order that the three background treatments

could be balanced by turns. It was not considered feasible to extend the test to six or more nights because of increased field crew requirements and possible publicity of the test project.

Test runs began after 6:30 p.m., when the evening traffic peak had ended, and were terminated shortly after midnight, which was as late as volunteers would remain on week nights. Therefore the requirement of 5-min intervals between test subjects permitted about 60 subjects to be scheduled each night. Actually more than 60 subjects were tested on each of the three nights. However, because the last test sign on the route was inadvertently removed on the first night while some subjects were still on the route, these subjects were not completely exposed to the balanced experimental test design and their data were not used. In addition, a few erratic drivers missed almost all the turns and were hopelessly lost. Since there were complete data for 50 test subjects on the first night, data for only the first 50 subjects (after elimination of the erratic drivers) were used for the other two nights in order to maintain a balanced experimental design.

Several factors which may have acted to confound the results became apparent during the course of the field operations or on inspection of the data sheets.

Toward the middle of the second night's runs and, to a lesser extent, later in the evening of the third night, temperature-humidity conditions caused moisture condensation on many of the signs. This resulted in a lowering of the brightnesses of the reflective materials.

It became apparent also that some of the test subjects had not fully grasped the intent of the written instructions, which had of necessity emphasized the TEST ROAD message rather than the type of sign. Since the first sign carrying this message was the small auxiliary sign encountered at the exit from the staging area, a psychological set was apparently often formed; and for the first few turns, these subjects were looking only for the small white signs and ignoring all others. Some evidence for this is the fact that more than one-half of the total errors occurred at the first three turns. Furthermore, an analysis of consecutive turns missed showed that several subjects missed the first two or three turns before they realized that the test message appeared on types of signs other than the small auxiliary signs.

Finally, it became apparent during the study that some of the exit gores and throats were poorly defined. Since the study was conducted in the middle of winter, the pavement markings were somewhat obliterated and the melting of previous snowfalls had left debris and dust at the curbs and road edges. (At the time of the tests, however, there was no snow on the ground and the pavements were dry.) Often the observers commented on the data sheets that the subject called out when he saw the sign, or reduced speed and operated his turn signal but failed to make the turn. From these comments, it was concluded that many of the errors were due to missing the exit rather than to missing the sign. On the basis of the observer's comments, an attempt was made to cull out those errors which should not have been attributed to the signs. These errors were termed "doubtfuls."

Consequently, the data have been analyzed by nights and by backgrounds for several categories: total errors, for all turns, and for turns 4-18 only; and total errors with doubtfuls excluded, for all turns, and for turns 4-18.

RESULTS

Table 3 gives the number of errors by nights and by backgrounds for each turn on the route and for selected groups of turns. The results of chi-square tests performed on these frequencies of errors are given in Table 4. The probability shown is the probability of obtaining by chance alone a chi-square value as large as or larger than that observed; e.g., a chi-square value as large as or larger than 0.46 would be expected to arise almost 8 times out of 10 merely from chance.

The chi-square tests give no evidence of any significant differences between the numbers of errors for any of the breakdowns, either by nights or by background treatments (Table 4). Chi-square tests on the relative frequencies of errors by turns were generally significant at the 1 percent level or less, indicating that there were signifi-

TABLE 3

NUMBER OF ERRORS BY TURNS, NIGHTS, AND BACKGROUNDS

Turn Number	All Errors							All Errors Less Doubtfuls						
	First Night	Second Night	Third Night	Background I	Background II	Background III	Errors by Turns	First Night	Second Night	Third Night	Background I	Background II	Background III	Errors by Turns
1	16	19	19	16	19	19	54	13	15	18	13	15	18	46
2	11	7	13	11	13	7	31	10	5	11	10	11	5	26
3	16	8	13	8	13	16	37	14	3	11	3	11	14	28
4	3	4	4	4	4	3	11	2	4	4	4	4	2	10
5	4	8	4	4	8	4	16	4	6	4	4	6	4	14
6	1	2	3	2	1	3	6	1	2	2	2	1	2	5
7	1	2	2	2	2	1	5	1	2	2	2	2	1	5
8	1	1	2	1	2	1	4	1	1	2	1	2	1	4
9	5	1	0	5	1	0	6	4	1	0	4	1	0	5
10	2	2	2	2	2	2	6	2	2	2	2	2	2	6
11	1	4	5	5	1	4	10	1	3	4	4	1	3	8
12	10	7	9	7	10	9	26	5	6	4	6	5	4	15
13	1	1	0	0	1	1	2	1	1	0	0	1	1	2
14	1	0	0	0	0	1	1	1	0	0	0	0	1	1
15	1	0	0	1	0	0	1	1	0	0	1	0	0	1
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	1	4	2	2	1	4	7	1	2	1	1	1	2	4
18	0	1	1	1	1	0	2	0	1	1	1	1	0	2
Summary:														
Turns 1-18	75	71	79	71	79	75	225	62	54	66	58	64	60	182
Turns 1-3	43	34	45	35	45	42	122	37	23	40	26	37	37	100
Turns 4-18	32	37	34	36	34	33	103	25	31	26	32	27	23	82

TABLE 4

SUMMARY OF CHI-SQUARE TESTS

Item of Comparison	χ^2	Probability[1]
By nights:		
All errors:		
Turns 1-18	0.46	0.79
Turns 4-18	0.37	0.83
Doubtful errors omitted:		
Turns 1- 8	1.34	0.51
Turns 4-18	0.78	0.69
By background material:		
All errors:		
Turns 1-18	0.46	0.79
Turns 4-18	0.14	0.93
Doubtful errors omitted:		
Turns 1-18	0.31	0.86
Turns 4-18	1.54	0.47

[1] The probability shown is the probability of obtaining by chance alone a chi-square value as large as, or larger than, that observed; e. g., a chi-square value as large as or larger than 0.46 would be expected to arise almost 8 times out of 10 merely from chance.

cant differences in frequencies of errors among the turns. These differences had been anticipated and the experiment was designed accordingly.

Figure 9 shows the numbers of errors for the different breakdowns plotted by relative specific luminance of the background materials at a $\frac{1}{2}$-deg divergence angle. The scales on the right-hand side of the graph are the percentages of errors based on the number of sign encounters for each of the breakdowns. Consideration of the errors for all turns shows the occurrence of errors to be approximately $8\frac{1}{2}$ percent. Omission of the doubtful errors brings the percentage down to 7. If the first three turns are eliminated, total errors drop to approximately $4\frac{1}{2}$ percent; and with the doubtfuls omitted, $3\frac{3}{4}$ percent. Differences in the percentages of errors between the different background materials do not amount to more than about 1 percentage point. These differences were previously shown not to be statistically significant.

FURTHER CONSIDERATIONS

This study was designed to test one aspect of the relative effectiveness of different degrees of sign background reflectorization—the ability of subjects to react correctly to information displayed on signs. Therefore, the analysis is directed primarily to a comparison of the relative frequency of errors for signs with different background materials. Although the study did not take account of the differences in the acutal

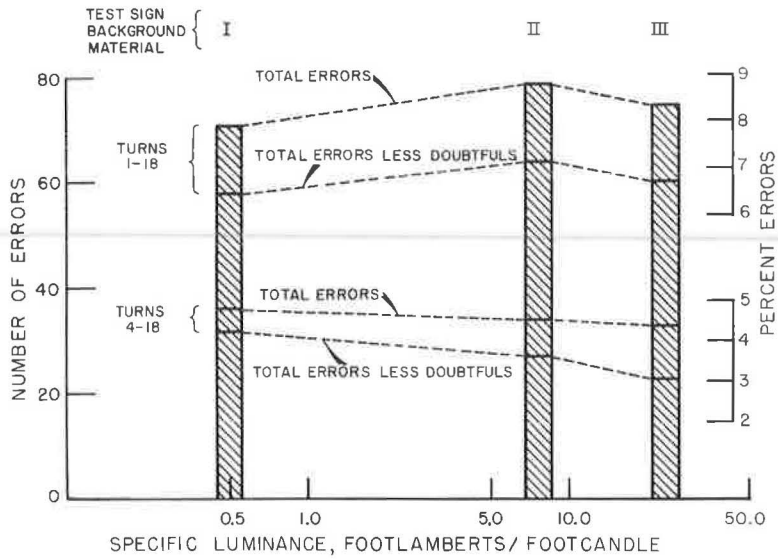

Figure 9. Frequency and percentage of errors by specific luminance of test sign background materials for the different types of error and turns. (The upper scale of percent errors is based on 900 possible correct turns for each material for turns 1 to 18; the lower percent scale is based on 750 possible correct turns per material for turns 4 to 18.)

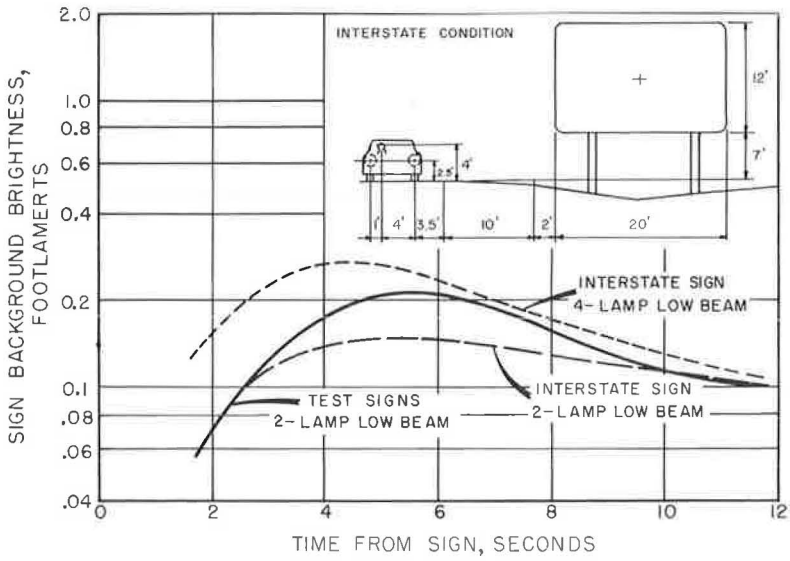

Figure 10. Comparison of center-of-sign brightness of standard sheeting background material under low-beam illumination for the test signs and for typical Interstate highway signs. (The solid-line curve is the median curve for the standard sheeting test signs for 2-lamp illumination; and the upper and lower broken-line curves have been calculated for 4-lamp and 2-lamp illumination, respectively, for the assumed Interstate geometry shown in the inset.)

brightnesses of the signs at the different locations, it should be pointed out that the same material varies in brightness, depending on the highway alignment on the approach to the sign. Alignment affects the incidence angles and the intensity of headlight illumination on the sign. In fact, because of the differences between locations, the moderately reflective material II was brighter at some locations than material III, the standard sheeting, was at other locations. Although the experimental design was set up so that turns were balanced by background material, there was no balance between turns and brightnesses of the backgrounds. This was further confounded by the reduction in the brightness of some of the signs due to the moisture condensation. However, since the relative frequencies of errors by nights was not statistically significant, it is concluded that the reductions in sign brightness did not result in an increase in errors.

A plot of errors (not shown) by sign background brightness (measured at 300 ft from the signs, at which distance the maximum median brightness was found) showed such scatter that no definite trend could be observed. A possible trend toward fewer errors at higher background brightnesses was indicated, but the small number of locations at which high background brightness occurred and the lack of balance between turns and brightness made an analysis of errors by brightness virtually meaningless.

The actual brightnesses of the sign materials on the signs in place were shown in Figure 8. Although the analysis of the study results gave no evidence of any difference in the relative frequencies of errors between the materials for the range of brightnesses covered, it is possible that a still higher brightness level might result in fewer errors. Before considering this possibility, it might be well to compare the sign brightnesses achieved in the study with those which would exist in actual practice on an Interstate highway. The standard sheeting median brightness curve for the test signs and brightness curves of standard sheeting for Interstate signs, calculated for 4-lamp and 2-lamp low beams, are plotted in Figure 10. To allow for differences between speeds on the test route and those on Interstate highways, the abcissa is in units of time before reaching the sign based on 40 mph for the test route and 60 mph for Interstate highways. This illustration shows that for the same material, the brightnesses of the test signs fell in the same range as that of Interstate signs. In fact, since the brightness measurements on the test signs were made under the illumination from the low-beams of a two-lamp vehicle, comparison of the curves for two-lamp illumination indicates that the test signs were, on the average, slightly brighter than the Interstate signs. Therefore, sign background brightnesses higher than those tested would have had to be higher than brightnesses ordinarily available from standard sheeting on Interstate signs.

It was pointed out that the highways on which the study was conducted were designed to lower standards than current Interstate highways; and prevailing speeds were also lower. Compared to Interstate conditions, speeds on the test route were approximately two-thirds those on Interstate highways; sign legends were about one-half the size; and the signs themselves were about one-fourth the area of Interstate signs. Therefore, the size ratio between the test signs and Interstate signs was smaller than the ratio between the speeds on the respective facilities and, except for the multiplicity of signs and exits so close to each other, the study conditions may have constituted a more difficult test of signing than would have been the case for Interstate conditions.

The methodology employed for this study may have applicability in other related work. A relatively large number of subjects are needed, however, because of the small proportion of errors typically observed. As in all studies involving test subjects as drivers, precise and concise instructions are essential in order to minimize confusion on the part of subjects. Temperature, humidity, and precipitation are additional factors outside the realm of control.

FINDINGS

The relatively few number of errors and the presence of confounding factors which entered into the tests limit the findings from this study. Observed differences, by type of sign background material, in errors made by test subjects in following the route were not statistically significant, and no evidence is therefore available from the study

to support a conclusion of any difference in the effectiveness of different degrees of sign background reflectorization. Because the data are enumeration data, and therefore insensitive to small differences, much larger samples or larger differences would be required to establish statistical significance.

The occurrence of errors, in absolute terms, was relatively small: total errors from whatever source averaged 8½ percent; and errors attributable to the signs and not to the conditions of the study amounted to less than 4 percent. If the probability of missing a single sign, regardless of the degree of background reflectorization, is in the order of 4 percent, it follows that the probability of missing two advance signs would be in the order of 0.16 percent.

On the basis of the observers' comments it would seem that one of the major problems in providing guidance to drivers is enabling them to relate the information on the sign and the placement of the sign to their desired actions. Another problem facing drivers is that of locating the geometric features to which the sign relates, particularly the exit gore.

ACKNOWLEDGMENTS

A large number of individuals and organizations assisted in this study. Appreciation is extended to Richard N. Schwab of the Traffic Systems Division for assistance during the organization and conduct of the study and direction of the visual and photometric tests.

Region 15 of the Bureau of Public Roads fabricated and erected the sign supports, and placed and removed the signs during the study. The Arlington County Highway Department, the Virginia Department of Highways, and the National Park Service of the Department of the Interior granted permission to erect signs on highways under their jurisdiction. Government Services Incoporated provided the Columbia Island Marina parking lot and boathouse for a staging area, and D. C. Department of Highways and Traffic fabricated the auxiliary signs. The Junior Chambers of Commerce of the District of Columbia and Maryland suburbs, local chapters of the Lions Club, and the local chapter of the Sports Car Club of America provided test subjects. The group of men training as Junior Engineers in the Washington office of the Bureau of Public Roads also took part in the study.

REFERENCES

1. Interstate Sign Tests. Unpublished report, U. S. Bureau of Public Roads, Nov. 1957.
2. Powers, L. D. Advance Route-Turn Markers on City Streets. Public Roads, Vol. 32, No. 1, pp. 12-16, April 1962.