

EVALUATION OF THE 5.8-MILE HIGHWAY LIGHT SYSTEM
FOR GUIDANCE IN FOG ON AFTON MOUNTAIN

by

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(The opinions, findings, and conclusions expressed in this report
are those of the authors and not necessarily those of the sponsoring agencies.)

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SUMMARY

This report presents the results of an evaluation of the 5.8-mile fog guidance light system on I-64 across Afton Mountain. It is a companion to "Interim Report No. 2, Evaluation of Pavement Edge Inset and Low Level Illumination Lights in Fog," which gave the results of an evaluation of the 0.5-mile, semipermanent test section of lights installed in 1973. Data for the current evaluation were obtained through questionnaire and interview contacts with highway employees, local residents, professional truck drivers, and travelers who cross Afton Mountain frequently. It was found that the responses were overwhelmingly positive; so much so, that the authors suspect that even the slightest aid to motorists who must travel through dense fog is enormously appreciated. For example, 97% of the people supplying data said that the lights either formed a pattern for their vehicle to follow or helped in outlining the road edges. Approximately 90% indicated that the lights reduced the anxiety of driving in the fog. Responses to all of the questions, with the exception of those dealing with increasing the visibility of a vehicle ahead, were similarly positive. Most motorists said the lights did not increase the visibility of vehicles ahead.

Since the survey reported was performed while the system was still new and novel, and problems with the control system giving incorrect intensities of light for certain fogs were not completely solved, the authors recommend that a similar evaluation be made one year hence. The results of the three opinion surveys could then be compared and the final evaluation made.

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INTRODUCTION

The research leading up to and the installation of the Afton Mountain highway light system for guidance in fog is well documented.(1,2,3,4) This report deals entirely with the reaction of the motoring public to the completed light system. Briefly described, the system stretches almost the breadth of Afton Mountain, a distance of 5.8 miles, and is divided into three contiguous sections—one on each flank of the Mountain and one on top. Each section is automatically controlled in that the lights are activated and deactivated and can be adjusted to 5 levels of brightness in daylight and 3 levels during darkness by fog sensing devices. Furthermore, the sections act independently and the lights are activated only in those sections where fog is present.

Two types of lights are utilized in the system, the majority being pavement inset lights, which, as the name implies, are embedded in the pavement. These lights are installed in the edge lines to form a guidance system for motorists to follow when vision is reduced to the extent that the pavement markings cannot be seen. A total of 841 of these lights are installed at spacings of 200 ft. on tangent sections and 100 ft. on curved sections. They all are white, with the exception of those on the ramps, which are amber. The second type of lights, referred to as low level lights, are mounted above ground level. They are 500-watt quartz floodlights with narrow vertical and wide horizontal beam spreads. Whereas the inset lights are for guidance, the low level lights are to increase sight distance. A short section of 50 lights of this type was installed under the guardrail of the entrance ramp at the Afton interchange. These lights were not included in the evaluation.

PURPOSE

The purpose of this study was to evaluate the effectiveness of the system of lights in delineating the road edges as judged by motorists traveling through the system during fog. The information obtained will serve as an aid in making adjustments to the equipment in the system and as a data source for other agencies contemplating the installation of such a system.

STUDY METHODOLOGY

Test Subjects

Input for the study was from various groups of motorists through the use of personal interviews and mailed questionnaires. It would have been better to interview the motorists just after they had left the fog area, but this was not possible. The following groups were selected as test subjects:

1. Department of Highways and Transportation employees who traveled through the area in heavy fog with the lights operating. This group comprised
 - (a) top administrative officials in the Department,
 - (b) statewide Department personnel other than the top administrators,
 - (c) Department personnel from the Staunton and Culpeper Districts who on an almost daily basis crossed the Mountain, and
 - (d) personnel from the Research Council
2. Area residents and employees of local manufacturing firms and businesses.
3. Professional drivers of two interstate trucking firms.
4. Teachers in local schools.

INFORMATION COLLECTED

The information collected was of a subjective nature and sampled motorists' reactions to the light system. Figure 1* is the questionnaire employed. It consists of two parts; one for

*All figures are appended.

general information and one for information on the lights. The section pertaining to general information was included because it was thought that persons who had traveled over the Mountain before the lights were installed might have a different opinion of the system than those having traveled only after the lights were in place. It was also surmised that time of day or night might influence the reaction to the lights. The section on the lights was devised to elicit straightforward reactions to their effectiveness.

SCOPE OF STUDY

As previously indicated, the study was of a subjective nature and was limited to collecting the opinions of motorists. No traffic flow data such as headways, densities, weaving, etc. were collected. Data of this type are being collected by traffic personnel at the Research Council. The data were collected during troubleshooting and debugging activities on the system, and some problems in the control system for the lights occasionally prevented them from being set at the proper intensity.

RESULTS OF SURVEY

General Information

It was found that 96.2% of the respondents had crossed the Mountain before the lights were installed. The fact that the situation without guidance lights had been so bad almost certainly was a factor in the preponderance of the positive responses to the lights. Approximately 58% of the respondents thought that the fog was heavy when they crossed the Mountain with the lights on; and approximately 24% of the motorists crossed the Mountain twice a day in traveling to and from work. Forty-one percent said they had passed over the Mountain with the guidance lights on after dark.

Information on Lights

Question one under the section relating to information on the lights dealt with how well the lights formed a pattern for motorists to follow. Seventy percent of the respondents said

that the lights clearly outlined a pattern that one's vehicle should follow, 27% reported that the lights did not clearly outline a pattern, but helped in outlining the road edges, 1.5% indicated the lights did not help in outlining the pavement edges, and the remainder did not answer the question. Figure 2 is a graphic representation of the responses to question 1.

Question 2 related to the level of brightness of the lights. Approximately 77% of the motorists said the lights were at the right level of brightness, 13% said the lights were too bright, 8% said they were too dim, and the remainder didn't respond to the question. Figure 3 is a graphic representation of the responses to question 2.

Question 3 represented an attempt to determine if the lights reduced the anxiety of driving in the fog. Nearly 90% of the motorists said the lights did reduce the anxiety of driving in the fog, 2% said the lights did not help, and 8% did not respond. Figure 4 graphically represents the responses to question 3.

Question 4 sampled motorists' opinion as to how well the pavement lights were aimed. Eighty percent thought they were well aimed, 10% indicated they were in need of adjustment, and 10% did not respond. The responses are shown graphically in Figure 5.

Question 5 was devised to assess the efficiency of the fog sensing and light activating apparatus. For the lights to be on in all places where fog was present, they almost certainly would be on in places where no fog was present, except when the entire Mountain was covered with fog. This is true because the breaks in the fog patterns seldom are exactly where the system is sectioned, and therefore a portion of lights in one section will often be on where there is no fog. A response stating that the lights were not on indicates a malfunction of that portion of the system where fog was present. Figure 6 gives the motorists' responses to the question.

Briefly, question 6 dealt with whether the pavement inset lights made it easier for a following motorist to see a car in front. Forty percent of the respondents said they did, 47% said they didn't, and 13% didn't respond. The responses are graphed in Figure 7.

The reasoning behind question 7 was to see if the advance warning sign prior to the roadway pavement lights advised the motorist of what to expect ahead on the roadway. The responses showed 72% of the motorists thought it did, 12% thought it did not, 2% found the sign confusing, and 14% did not answer. Figure 8 represents the responses.

Question 8 was included to determine if the advance warning sign message was easy to read. Positive replies were given by 74.8% of the motorists, 11.7% reported the sign message was difficult to read, and 13.5% did not respond. Figure 9 is a graph of the responses.

DISCUSSION

That the lights do, indeed, help motorists find their way across Afton Mountain in the fog is indisputable. However, the degree of aid is virtually impossible to measure. If motorists have been in situations where they were almost completely blinded by fog, they are apt to overreact in a positive way to even the slightest improvement. The writers caution that the data in this report may reflect a somewhat overly positive response on the part of those persons queried. It was found that 96% of the respondents had crossed the Mountain before the lights were installed, so these individuals knew just how bad the situation was without the lights. At the risk of being redundant the authors would like to restate their opinion that in heavy fog at night a motorist without some aid is in a state approaching total blindness.

A comparison of the data from the present study with those given in Interim Report No. 2(3) reveals that 66% of the first group and 70% of the second group said that the pavement lights clearly outlined a pattern that one's vehicle should follow. Additionally, 30% of the respondents in the first study and 27% of those in the second study said that, although they could not clearly discern a light pattern, the lights nevertheless helped in outlining the road edges.(3) When over 95% of the motorists indicate they have been aided by a system, then there can be no doubt that the system is effective.

In an attempt to find out why approximately 30% of the motorists said that the lights did not outline a pattern for them to follow, the data sheets were reevaluated and it was found that all the respondents in this group had crossed the Mountain in very dense fog. This being the case, the situation could be remedied by spacing the lights more closely, a corrective measure that in the opinion of the authors is economically prohibitive, especially since the maximum gain would be only that 30% who reported they did not see a pattern to follow. The intensity of the lights will be adjusted in an attempt to alleviate this problem, i.e., to produce a pattern that all motorists can see. This attempt may not prove successful for two reasons.

First, fog particles act as tiny prisms; thus when intensities are increased, the light rays are still scattered by these prisms and don't have much better chance of reaching the target than at lesser intensities. Secondly, even if the pattern definition can be increased with greater light intensities, motorists driving out of heavy fog areas into clear areas where the lights are on (and this occurs frequently) may be blinded. The lights appear to be adjusted properly for brightness, but if the level of brightness should become a problem, an adjustment is simple.

Approximately 90% of the motorists in both studies reported that the lights reduced their anxiety while driving in fog. This again is a case where the degree of relief is almost impossible to measure. From a consultation with a psychologist, the authors learned that to measure the degree of anxiety that an individual is experiencing, he must be electrically wired with a recording device and monitored under non-stress and stress situations. This was impossible to do in the evaluations conducted. The information gathered during the evaluation of the 0.5-mile, semi-permanent test section provided the basis for the most effective aiming of the lights, which involved positioning them so that the beams from opposing fixtures converged at a distance of 200 ft.

Both studies showed that the pavement inset lights increase the visibility of cars ahead only slightly. Since the lights point toward the oncoming vehicles, the vehicles ahead have to be seen in silhouette. During heavy fog this silhouette effect apparently is greatly diminished.

According to the second survey the advance informational signs located 500 ft. ahead of the lights on the east and west flanks of the Mountain adequately inform the motorists of what to expect ahead and are easy to read.

The questionnaire included a space for comments by the respondents. As is the case with this type of solicitation, the comments were varied but two recurred frequently. These comments were:

1. The reliability of the system needs to be improved. This comment resulted from the fact that the survey was conducted during the debugging and troubleshooting period.
2. Some type of lighting system needs to be designed for Route 250 at the Afton interchange area.

CONCLUSIONS

1. The pavement inset lights do a good job in outlining a pattern for motorists to follow in different types of fog.
2. The present intensity settings appear optimum in all types of fog, except the densest.
3. Of the respondents who could not distinguish a pattern, all had traveled in heavy fog. This finding indicates that eventually intensity and/or spacing may need adjusting.
4. The lights reduce the anxiety of driving in fog.
5. The lights are well aimed in the curves.
6. The lights were on where fog was present and also at times in places where fog was not present.
7. The pavement lights do not do a good job of increasing sight distances.
8. The informational signs placed ahead of the lights are easy to read and do an adequate job of informing the motorists of what to expect ahead.

RECOMMENDATION

It is recommended that a similar study be made in one year, when the novelty and newness of the system have worn off, and that the results of the three studies be compared to develop a final evaluation of the system.

ACKNOWLEDGEMENT

The authors express sincere thanks to the individuals who cooperated in the study by completing the questionnaires and giving interviews. The majority of these people were employees of manufacturing firms on both sides of Afton Mountain and the motels and restaurants on top of the Mountain, professional truck drivers, teachers, and Department of Highways and Transportation personnel.

REFERENCES

1. Creech, Marion F., "Fog— A Review of the Literature Pertaining to Highway Problems and Possible Solutions," Virginia Highway and Transportation Research Council, VHTRC 72-R2, Charlottesville, Virginia, July 1972.
2. "Interim Report No. 1— Evaluation of Pavement Edge Inset and Low Level Illumination Lights in Fog", Virginia Highway and Transportation Research Council, VHTRC 73-R28, Charlottesville, Virginia, February 1973.
3. "Interim Report No. 2— Evaluation of Pavement Edge Inset and Low Level Illumination Lights in Fog," Virginia Highway and Transportation Research Council, VHTRC 73-R28, Charlottesville, Virginia, December 1973.
4. "Installation of Fog Guidance Lights on Afton Mountain", Virginia Highway and Transportation Research Council, VHTRC 76-R12, Charlottesville, Virginia, August 1976.

Figure 1

**QUESTIONNAIRE TO EVALUATE THE EFFECTIVENESS OF PAVEMENT INSET LIGHTS
INSTALLED ON I-64**

(FILL OUT ONLY IF FOG IS IN LIGHTED AREA)

Name _____, Phone No. _____

Check only one block under each of the following items:

GENERAL INFORMATION

1. Did you cross the mountain in the fog before the lights were installed?
 - Yes
 - No
2. Have you crossed the mountain with the lights on?
 - Yes
 - No
3. When you last crossed the mountain the type of fog was:
 - Heavy
 - Medium
 - Light
4. The date you last crossed the mountain in the fog with lights on _____.
5. Please check the block which corresponds most closely to the time or times you last crossed the mountain in the fog with lights on:
 - Morning travel to work and evening return from work
 - Morning travel
 - Afternoon travel
 - Travel near midday (10-2)
 - Travel after dark
6. Direction of travel (if both ways, designate morning direction)
 - East (toward Charlottesville)
 - West

INFORMATION ON LIGHTS

1. The pavement lights:
 - Clearly outlined a pattern that one's vehicle should follow.
 - Did not clearly outline a pattern but helped in outlining the road edges.
 - Did not help in outlining pavement edges.
2. The pavement lights:
 - Were too bright
 - Were at the right level of brightness
 - Not bright enough.

Figure 1 continued

3. The pavement lights:

- Reduced the anxiety of driving in fog
- Did not help

4. The pavement lights in the curves appeared to be:

- Well aimed
- In need of adjustment

5. When you last traveled over the mountain in the fog:

- The lights were on everywhere there was fog.
- The lights were on in places where there was no fog as well as where the fog was located.
- The lights were not on in places where there was fog.

6. The pavement lights:

- Made it easier to see a car in front of you.
- Had no effect on seeing a car in front of you.

7. The sign prior to the lights:

- Adequately informed you on what to expect ahead.
- Did not clearly indicate what to expect.
- Confused you.

8. The sign message prior to the lights was:

- Easy to read
- Difficult to read

9. What in your opinion would make the light system better for the motorist?

MAIL TO:

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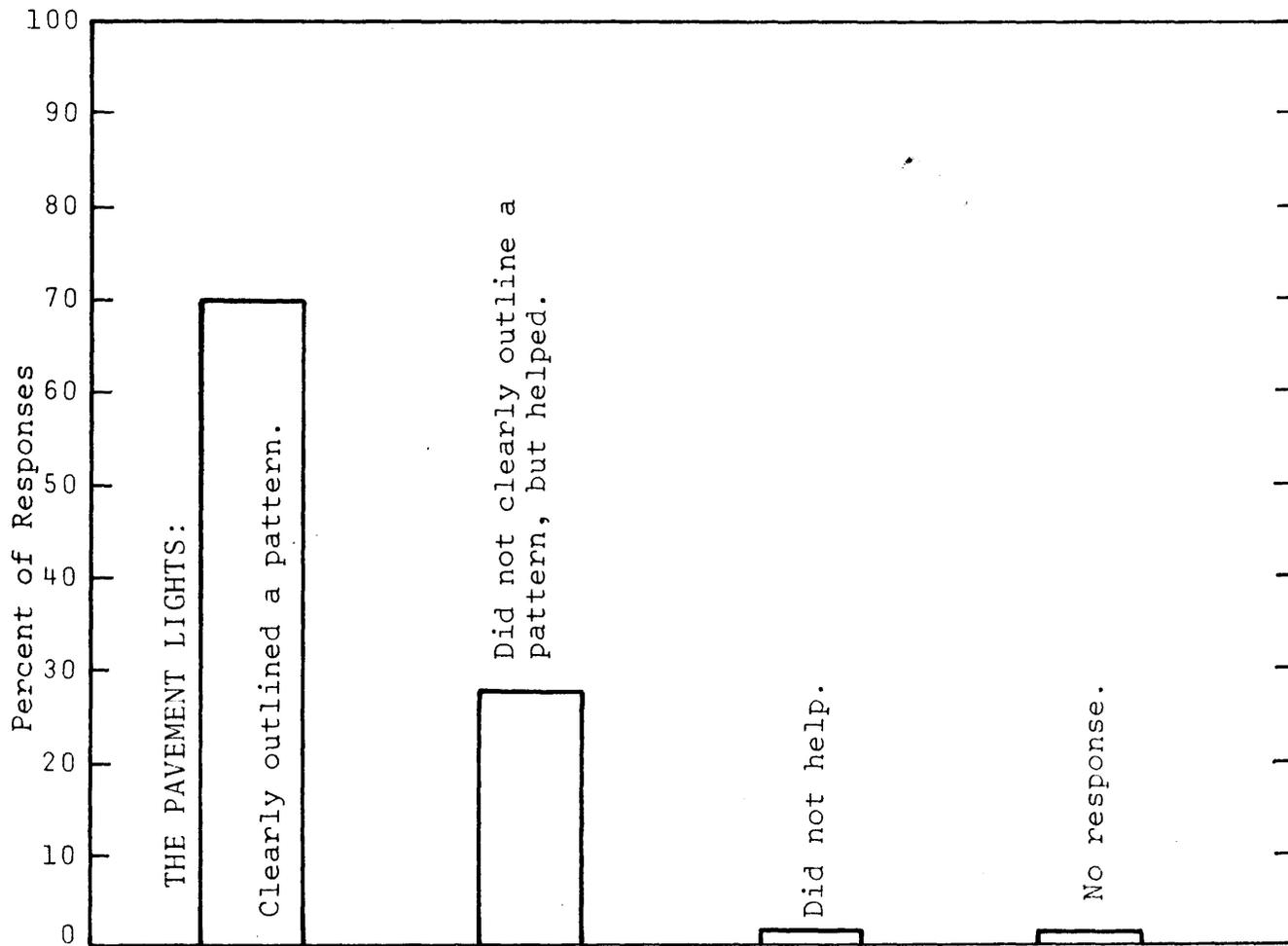


Figure 2. Responses to Question 1.

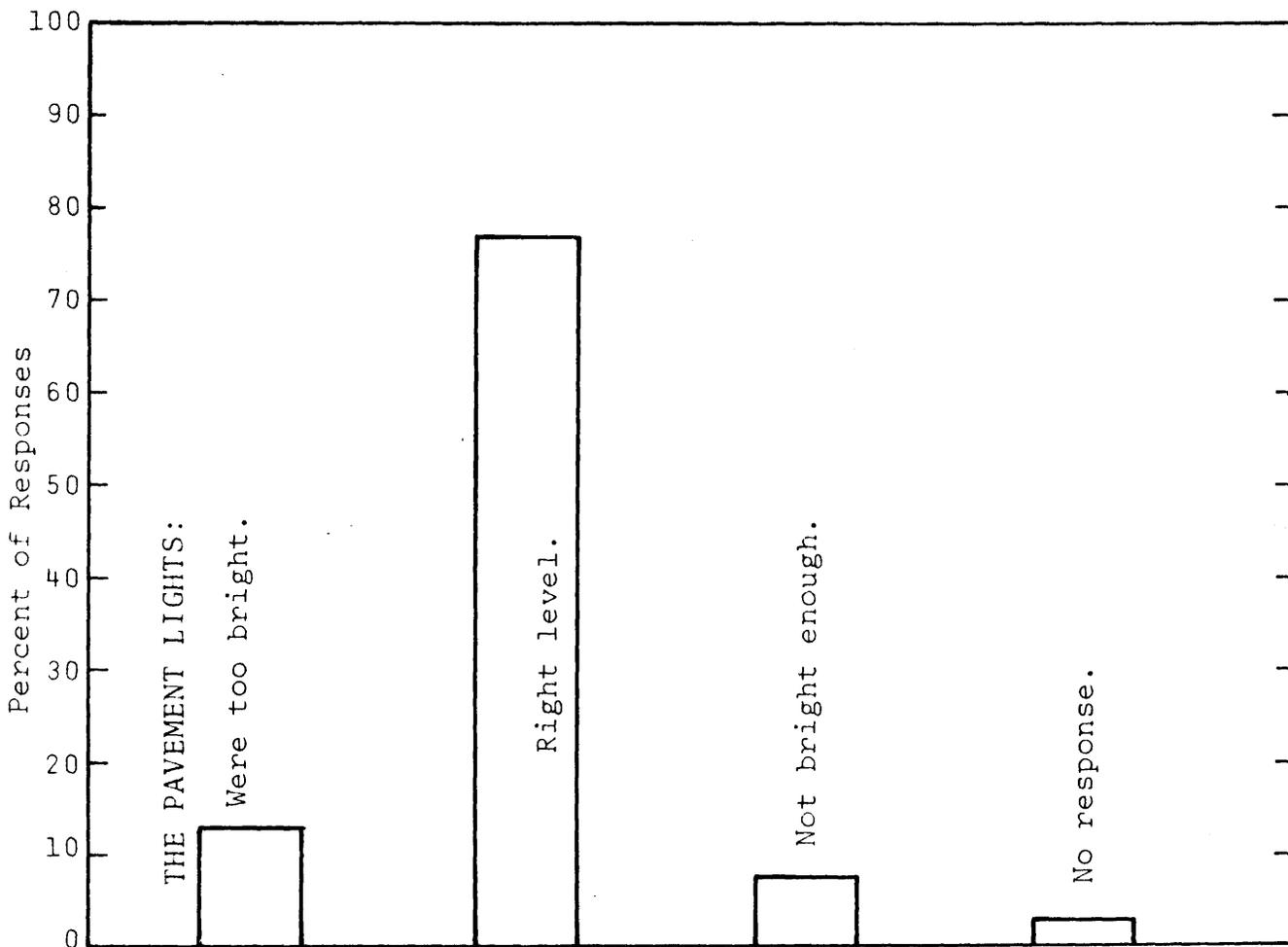


Figure 3. Responses to Question 2.

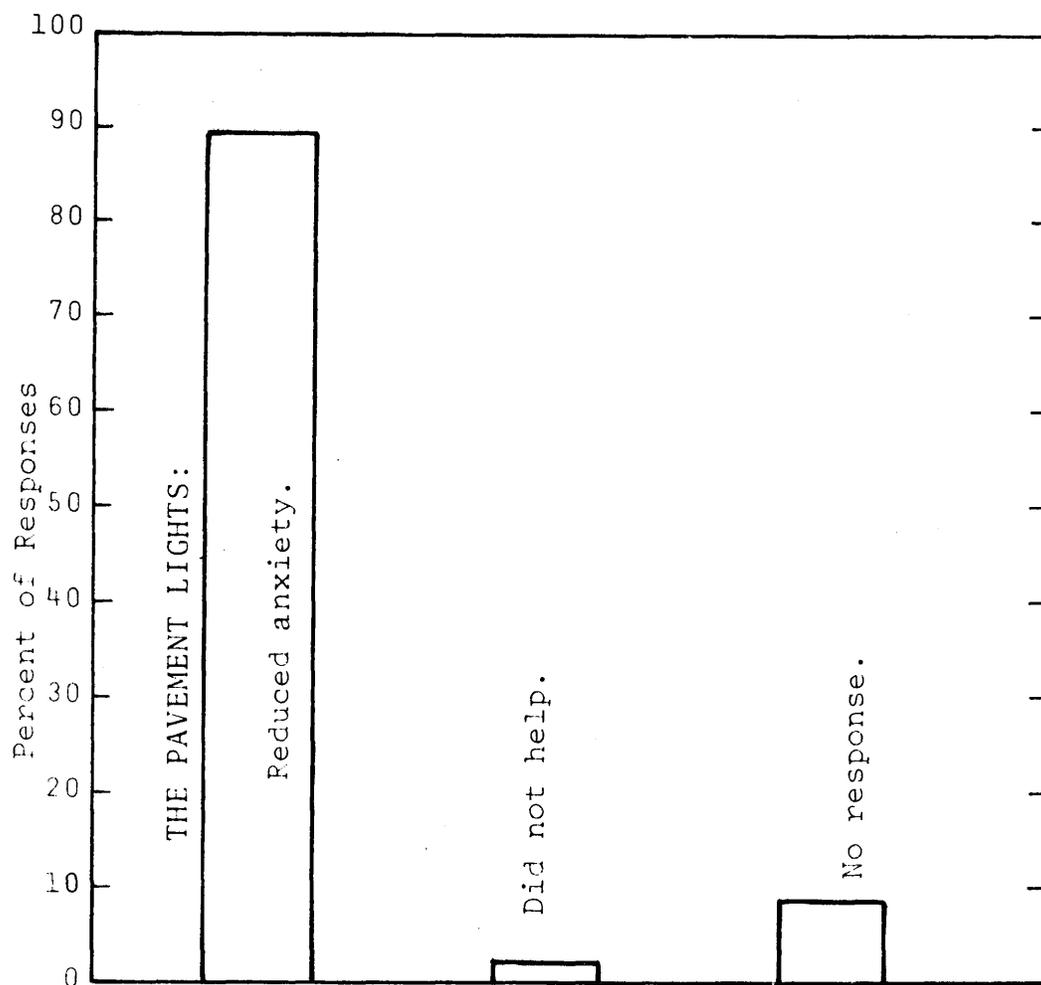


Figure 4. Responses to Question 3.

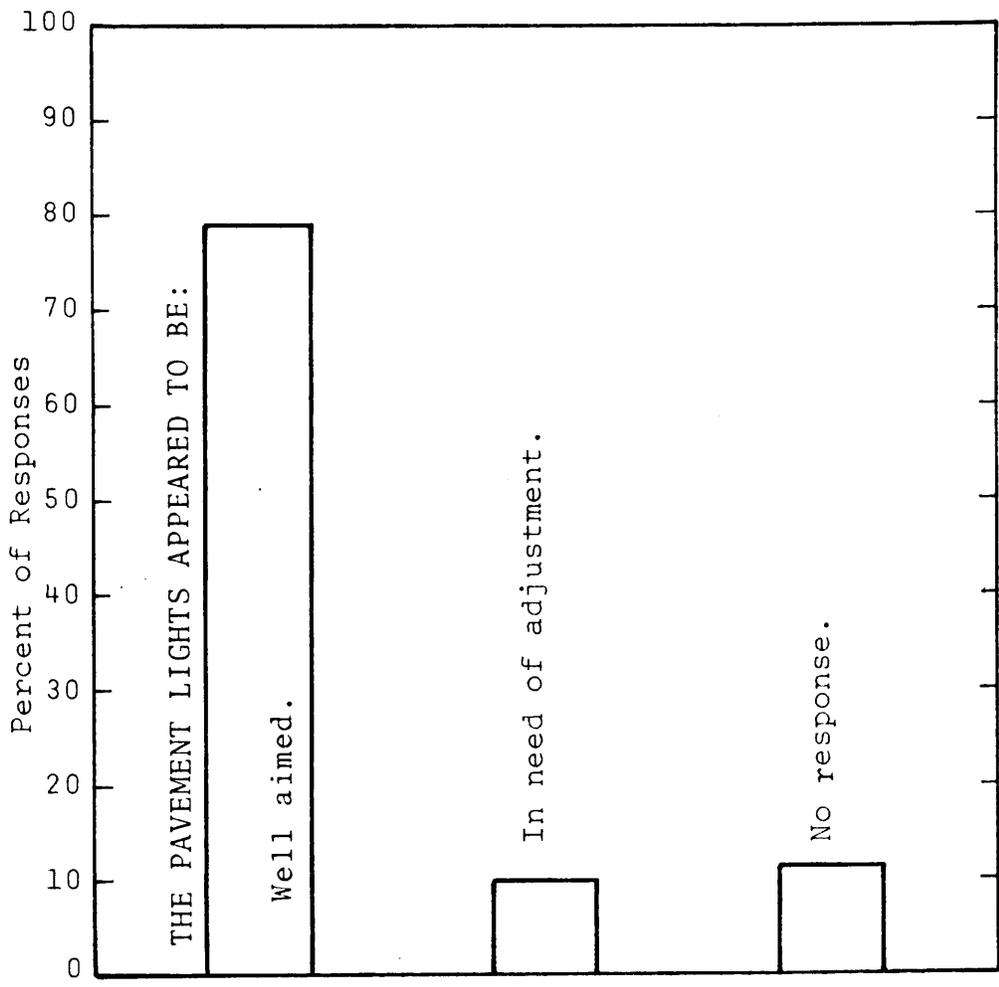


Figure 5. Responses to Question 4.

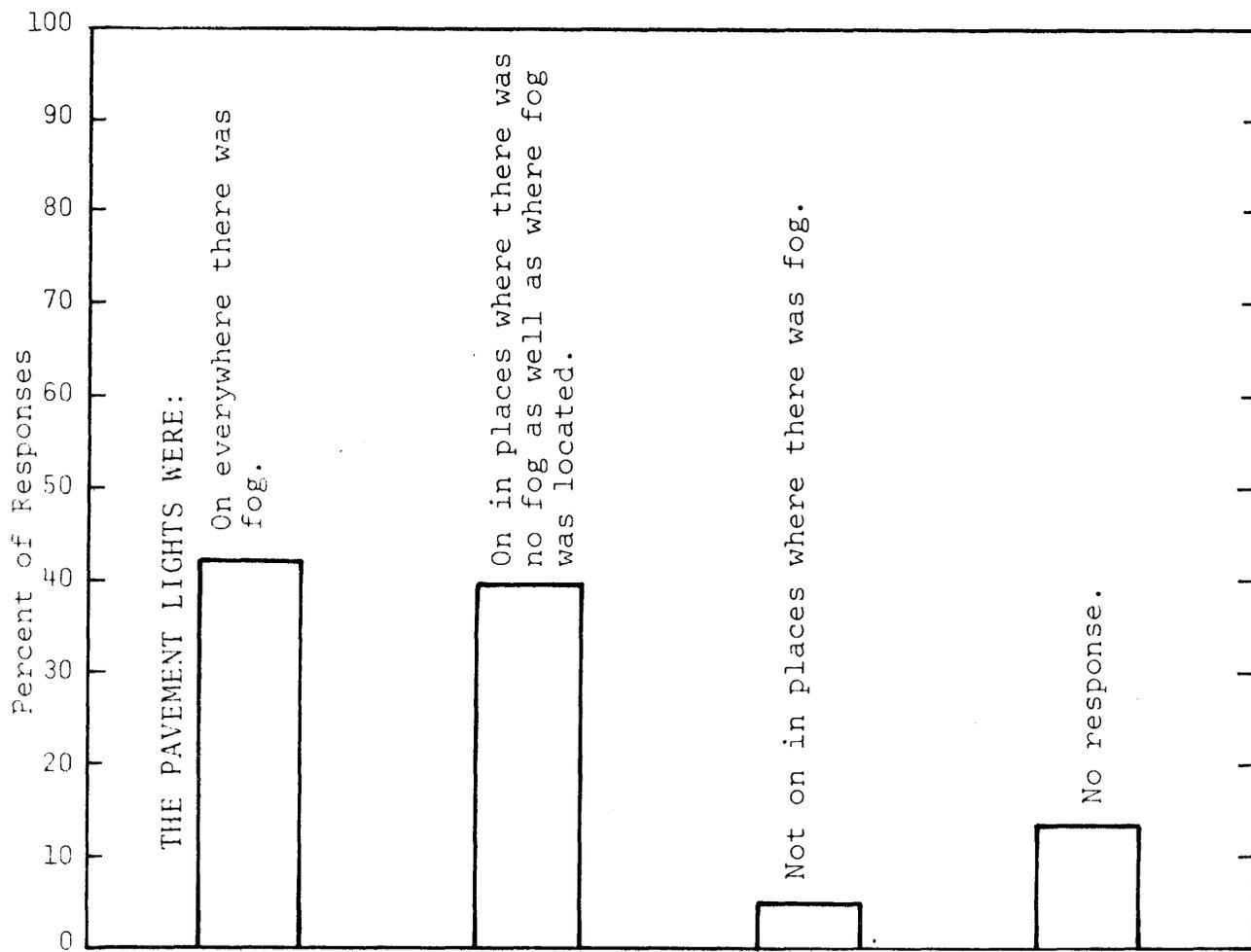


Figure 6. Responses to Question 5.

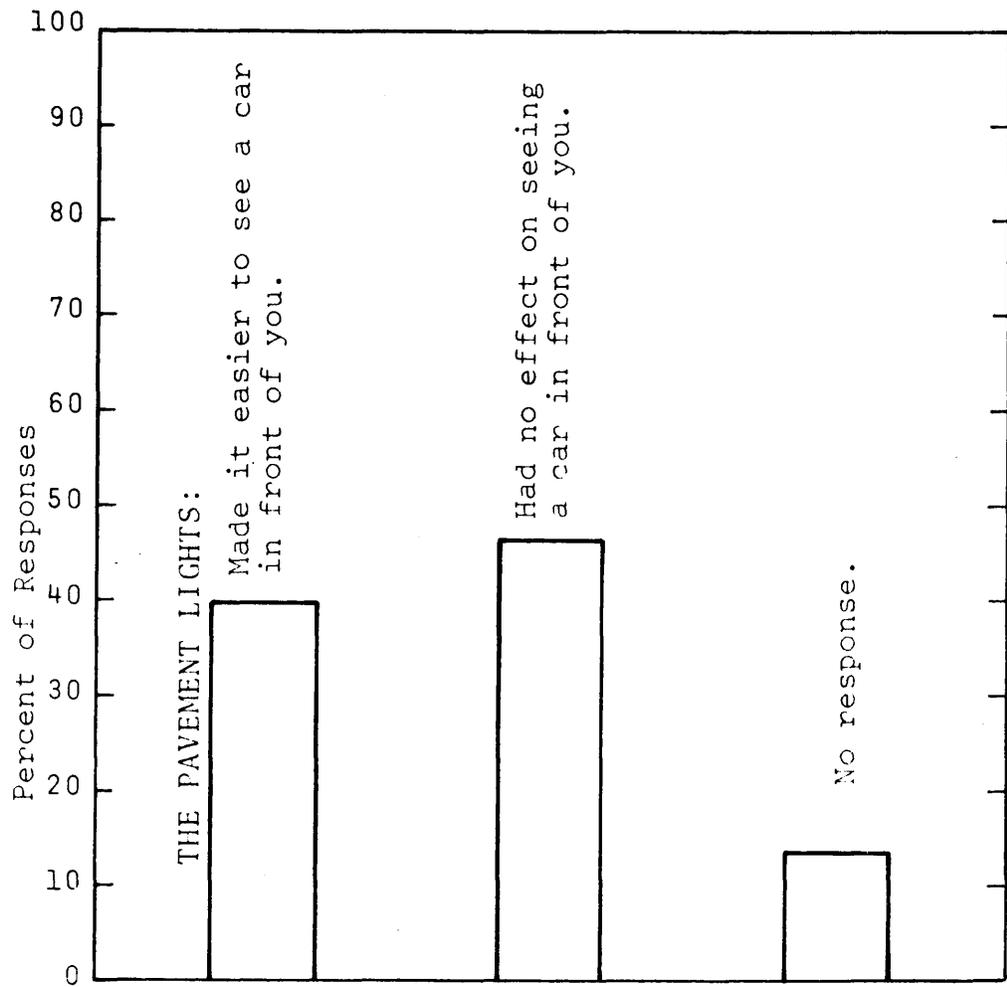


Figure 7. Responses to Question 6.

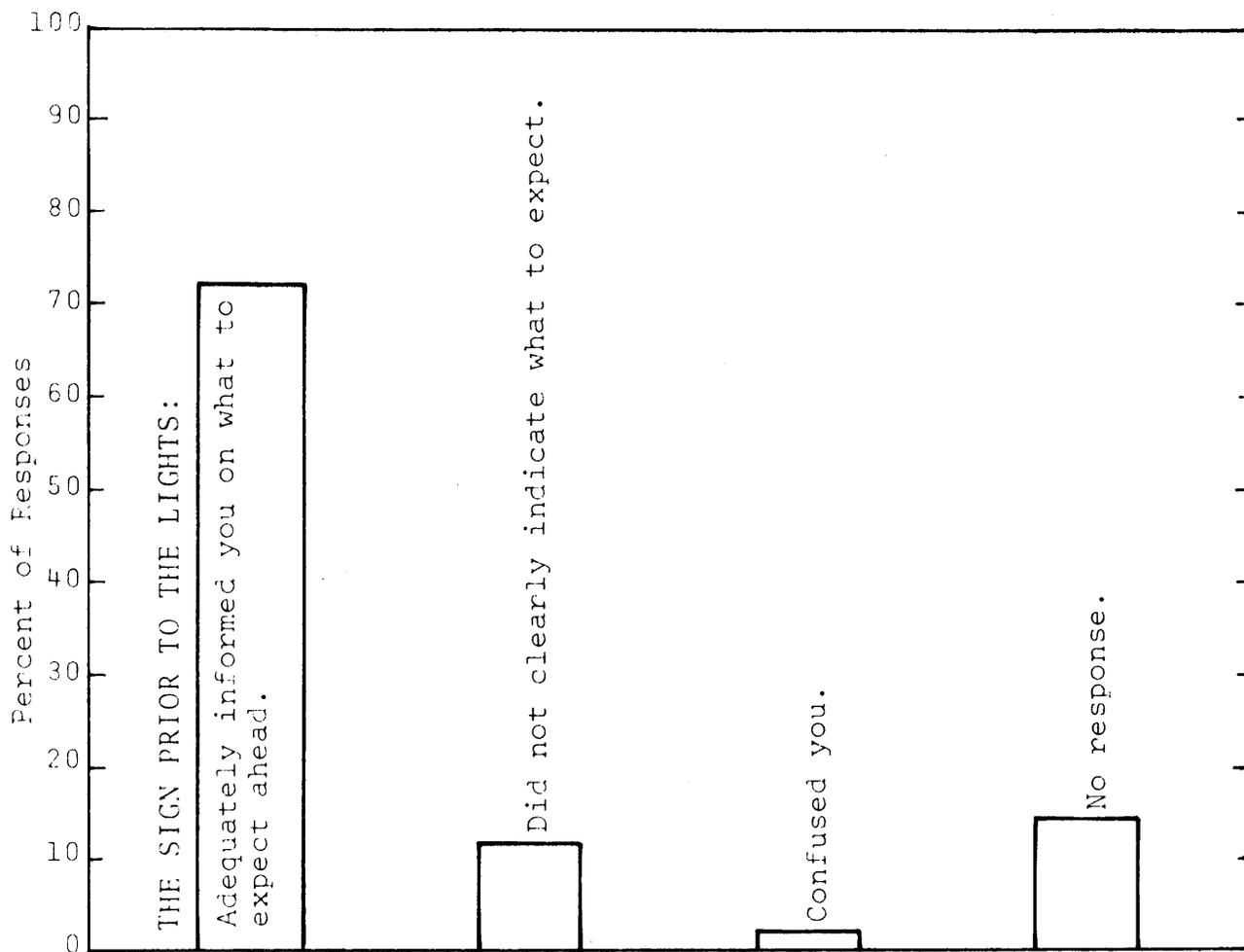


Figure 8. Responses to Question 7.

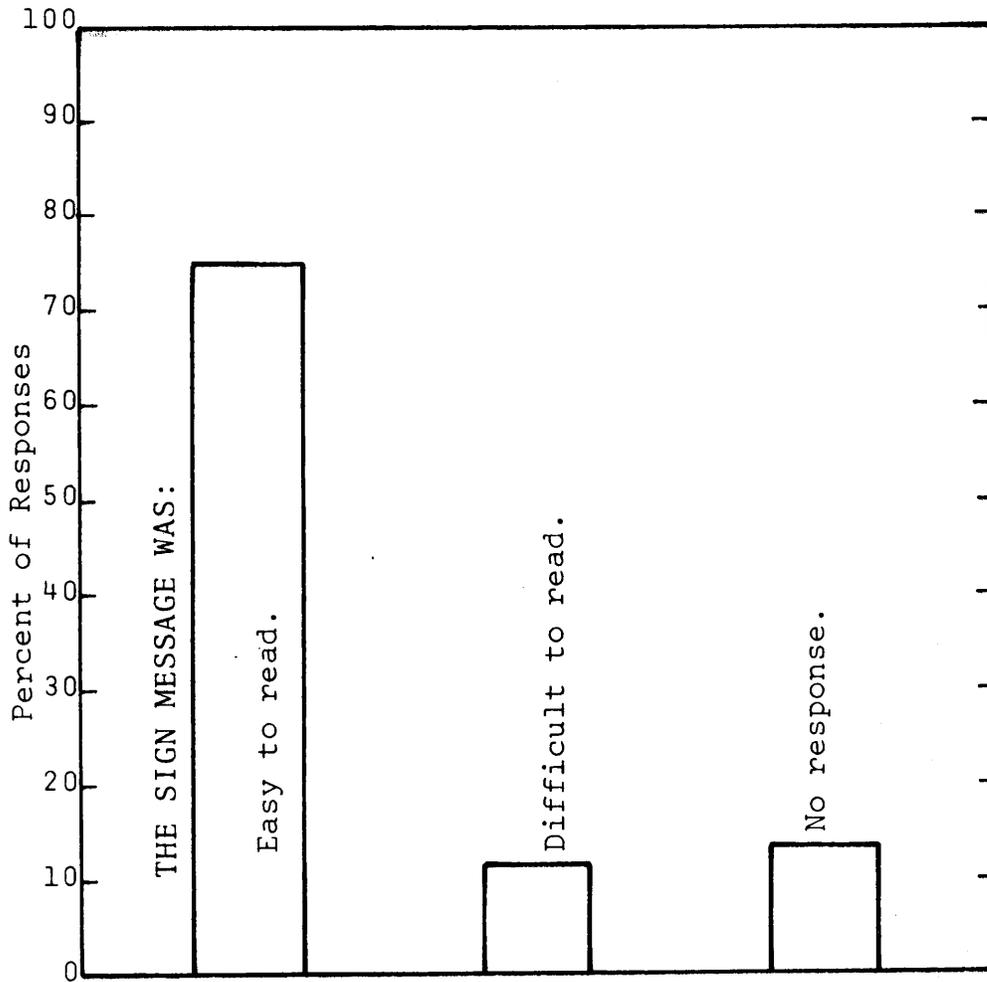


Figure 9. Responses to Question 8.