

INTERIM REPORT NO. 2

EVALUATION OF PAVEMENT EDGE INSET
AND
LOW LEVEL ILLUMINATION LIGHTS IN FOG

by

Marion F. Creech
Highway Materials Research Analyst

The number for this report was changed post publication
from 73-R28 to 73-R281 when it was discovered that the
number 73-R28 was used for another report.

Virginia Highway Research Council
(A Cooperative Organization Sponsored Jointly by the Virginia
Department of Highways and the University of Virginia)

Charlottesville, Virginia

December 1973
VHRC 73-R28

INTERIM REPORT NO. 2

EVALUATION OF PAVEMENT EDGE INSET
AND
LOW LEVEL ILLUMINATION LIGHTS IN FOG

by

Marion F. Creech
Highway Materials Research Analyst

BACKGROUND

Literature Review

This study on fog lighting was initiated by a request from the Maintenance Division of the Highway Department to the Research Council to survey available methods for promoting the safety of highway travel under conditions of heavy fog. An in-depth search of the literature on the subject revealed that fog abatement techniques and hardware had not evolved to the point that they were feasible for highway usage. ⁽¹⁾ However, several lighting schemes were discussed in the literature and two appeared to hold potential. In one lights are embedded in the pavement edge to serve as delineation and in the second lights are mounted at low elevations to provide visibility.

These findings were discussed with highway officials who requested that the Research Council obtain several of each of the two types of lights and set up experiments to test their effectiveness.

Initial Experiments

Experiments were initiated on a section of I-64 across Afton Mountain that is frequently covered with fog. These experiments were conducted with unidirectional airport runway lights placed on each edge of the pavement to serve as a lineal guidance system and 500-watt quartz floodlights mounted at low elevations to provide forward visibility. The purposes of the experiments were: (1) to determine if lights inset into the pavement edge would produce sufficient guidance to keep motorists from getting lost in heavy fog and provide enough light to outline the pavement edge so as to allow them to maintain control of their vehicles and keep them on the road, (2) to determine whether these lights could withstand snowplowing, and (3) to determine if the low level lights increased sight distance. Results from the initial testing were reported ⁽²⁾ and they led to a recommendation to make a permanent installation of the runway lights on a half mile segment of I-64 on the Mountain. The evaluation of this installation is the subject of the present report.

DESCRIPTION OF PERMANENT INSTALLATION

The permanent installation consists of pavement inset lights using power from a fixed commercial source and is located in the eastbound lanes of I-64 in Augusta County from milepost 27.90 to milepost 28.40. The lights are installed in both edge lines so as to outline the roadway and are placed in three spacing patterns as follows:

1. A 500 ft. section with lights spaced 100 ft. between centers.
2. A 1,400 ft. section with lights spaced 200 ft. between centers.
3. A 750 ft. section with lights spaced 250 feet apart.

Triggering of the light system is by a fog-sensing device that actuates a fog warning sign that was already in place on the roadway section selected. The daylight intensity of the lighting is 30% of the maximum of the unit with an output of 2,250 candelas and a hot spot of 3,600 candelas.⁽²⁾ For night lighting, where contrast is greater between light and darkness, the intensity setting is 10% of maximum, which produces an output of 750 candelas with a hot spot of 1,200 candelas. At the 30% setting, the light burns at 123 watts of power, and at the 10% setting at 84 watts.

PURPOSE

The general purpose of this study was to evaluate the lights, by input from various individuals, for their effectiveness in delineating the road edges and to determine if such delineation reduced driver anxiety and made for safer travel. The specific objective was to determine if, under actual traffic conditions, the lights provided sufficient delineation in fog to warrant making a six-mile installation across Afton Mountain. Secondary objectives were to:

1. Determine the optimum spacing for the lights, and
2. determine optimum light intensity levels for day and night fog conditions.⁽³⁾

STUDY METHODOLOGY

Test Subjects

Input for the study was obtained from various groups of individuals through the use of personal interviews and mailed questionnaires. The following groups were selected as test subjects:

1. Highway employees who traveled through the area in heavy fog with the lights operating. These individuals were:

- (a) Top administrative officials in the Highway Department.
 - (b) Statewide Department personnel (other than above).
 - (c) Department personnel from the Staunton and Culpeper Districts who on an almost daily basis crossed the mountain.
 - (d) Personnel from the Research Council.
2. Employees of the motel-restaurant complex on Afton Mountain who traveled daily up the mountain from Waynesboro for work.

Information Collected

The information collected was all of a subjective nature and sampled motorists' reaction to the lights. As may be seen from the questionnaire (Figure 1), it is of a multiple-choice type and asks the motorists to make judgments as to the answer that most closely agrees with his reactions to the lights.

SCOPE OF STUDY

As mentioned above, this study was of a subjective nature and was limited to collecting the opinions, responses, etc. of motorists. No traffic flow data such as headways, densities, weaving, etc. were collected before or after installation of the lights. This type of data is being collected by the Traffic Section at the Virginia Highway Research Council. Although subjective data is looked upon in some quarters with suspicion, the author feels that an integral part of a study dealing with driver behavior should be an assessment of what the driver feels and sees.

A second limitation of the study was the relatively small sampling in the survey. Although returns from a rather large cross section were obtained, the actual number of completed questionnaires was not great.

A final problem occurred with the fog sensing device used to activate the lights and overhead sign. The instrument did not operate properly and often fog would be on the mountain and the lights not in operation. On other occasions the device operated in such a manner as to continually turn the lights on and off and cause erratic operation of the sign. The fog sensing device has since been replaced with a different model which appears to be more reliable.

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. _____

Date you crossed mountain in fog _____

Type of Fog in Lighted Area: Heavy _____ Medium _____ Light _____

Check only one block under each of the following items:

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:

- ☐ Did not cause an uncomfortable glare.
- ☐ Caused an uncomfortable glare.
- ☐ Caused a blinding glare.

3. The pavement lights:

- ☐ Reduced the anxiety of driving in fog and produced a feeling of security.
- ☐ Did not help.

4. The pavement lights:

- ☐ Outlined vehicles ahead.
- ☐ Did not outline vehicles ahead.

5. An overall assessment of the lights suggests that:

- ☐ A complete installation across the mountain should be made.
- ☐ A complete installation should not be made.

6. COMMENTS: _____

MAIL TO:

MR. MARION F. CREECH
P. O. BOX 3817 UNIVERSITY STATION
CHARLOTTESVILLE, VIRGINIA 22903

RESULTS

In the presentation of the results, each question is evaluated separately and conclusions formulated for each.

QUESTION 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.

Of the 100 people who supplied input into the study, 65.6% reported that the lights clearly outlined a pattern that one's vehicle should follow; 20% reported that the lights did not clearly outline a pattern but helped in outlining the road edges. No one indicated that lights did not help in outlining pavement edges. Of the total returning questionnaires, 1.6% did not answer question 1. Figure 2 is a graphic representation of the response to question 1.

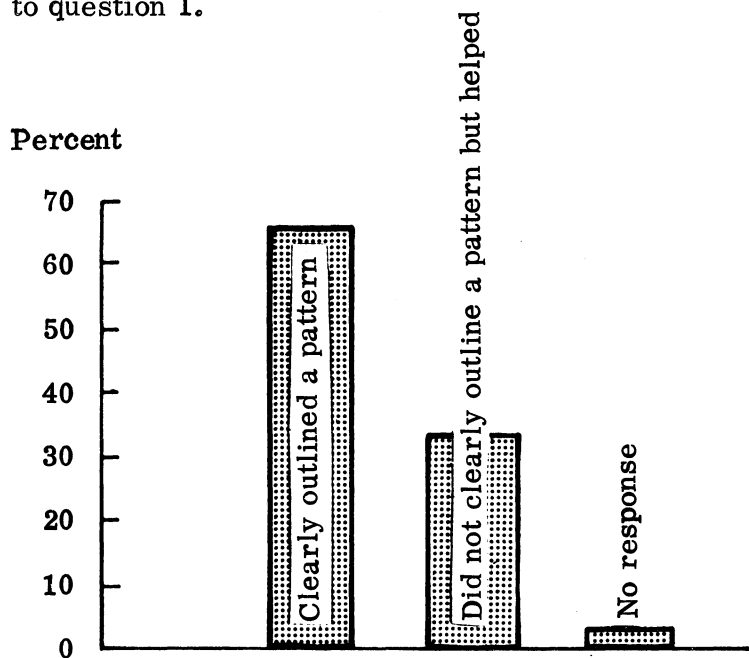


Figure 2. Bar graph of responses to Question 1.

Several conclusions may be drawn from the fact that over 30% of the sample answered that the lights helped in outlining the road edges but did not clearly outline a pattern. This question was studied in some detail and it was determined that the loss of pattern was probably due to horizontal curvature and the aiming of the lights. The lights were aimed along the edgeline markings and this worked well for horizontally tangent sections, but on the extremely curved section the lights on the shoulder side are aimed out over the guardrail and away from the motorist. The lights on the inside of the curve are aimed toward the middle of the road. The result of this is that the lights have a narrow horizontal cut off and the pattern is broken. Should a full installation be made this problem will be solved by aiming each succeeding light inward toward a point on the centerline 200 feet from the light. If by the very slim chance that this does not solve the loss of the pattern then the spacings of the lights in the curved sections will be cut in half. The conclusion from Question 1 is that the lights do a good job of outlining the roadway and can with minor improvements do an excellent job.

QUESTION 2

The pavement lights:

Did not cause an uncomfortable glare.

Caused an uncomfortable glare.

Caused a blinding glare.

For question two, 91.8% of the motorists reported that the lights did not cause an uncomfortable glare; 4.9% said the glare was uncomfortable; and 1.6% stated the lights caused a blinding glare; and 1.6% did not answer. Figure 3 is a graphic representation of the responses to Question 2.

The explanation of why 6.5% of the motorists reported that the lights produced an uncomfortable or blinding glare can only be intuitive since these data came by mailed questionnaire. In reviewing the data, it was found that all persons excepting one reporting a glare problem passed through the lighted area in light or medium fog, which allows greater penetration of light than does a heavy fog; yet numerous other motorists passed through the area with the same levels of fog and did not report any difficulty. The tentative conclusion is that with a little more sensitive control of the lights (a lesser degree of light in lighter fogs) glare will not be a problem.

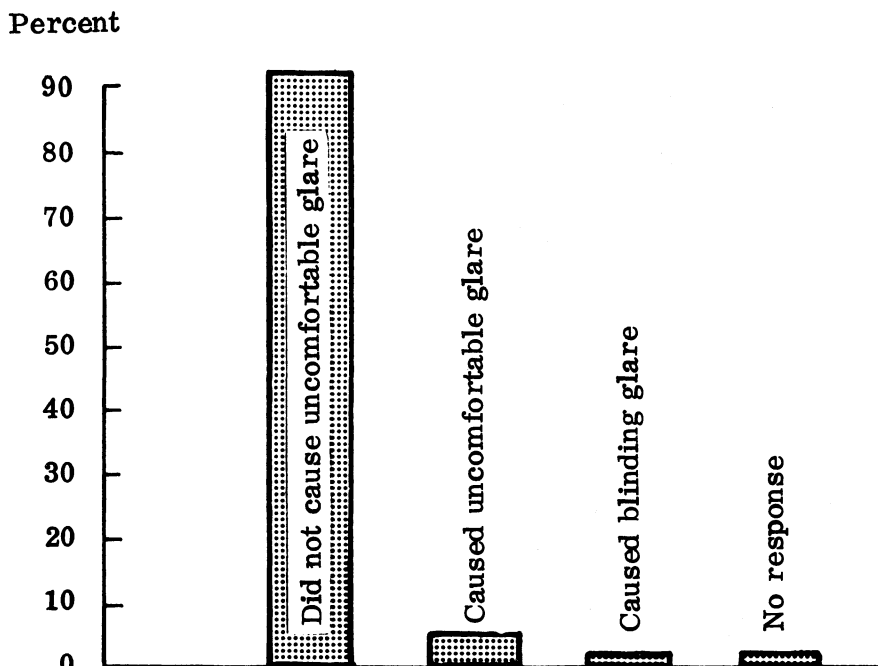


Figure 3. Bar graph of responses to Question 2.

QUESTION 3

Question 3 was included to determine if the lights alleviated the feeling of near panic that many motorists have reported experiencing while traveling over Afton Mountain in fog. There are reported incidents in which people have had to walk alongside cars to lead the way over the mountain. These reported incidents occurred on Route 250 before I-64 was opened but one might surmise the potential hazard that a situation like this would create on an interstate highway.

The wording of this question was:

The Pavement Lights:

Reduced the anxiety of driving in fog and produced a feeling of security.

Did not help.

Responses to this question showed that 93.4% of the sample said the lights reduced the anxiety of driving in the fog; 3.3% indicated the lights did not help; and 3.3% did not answer. Figure 4 is a graphic representation of the responses to Question 3.

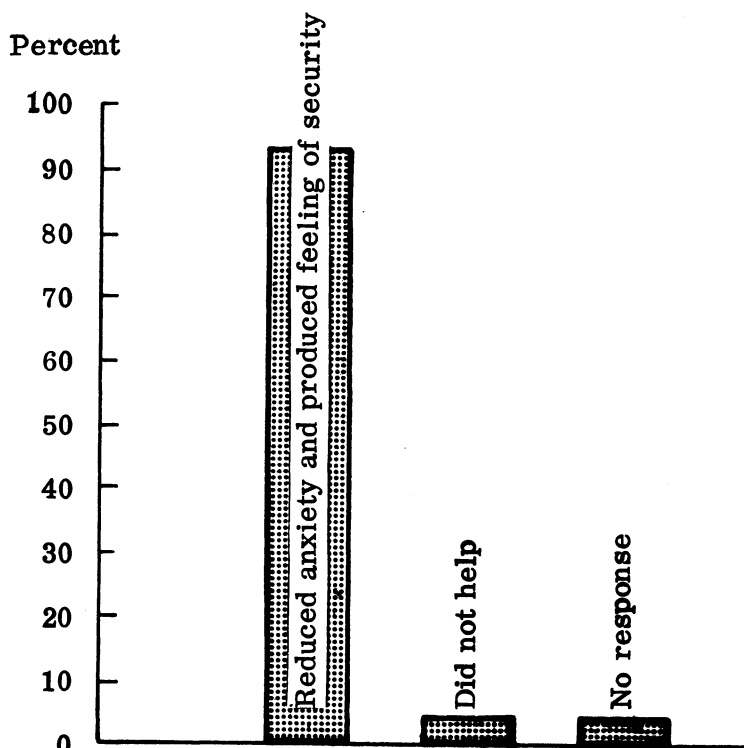


Figure 4. Bar graph of responses to Question 3.

The lights significantly reduced anxiety while driving in fog, although it is the author's contention that none of the motorists felt completely secure and free of anxiety, a situation to be avoided.

QUESTION 4

The fourth avenue investigated was to determine whether the lights outlined vehicles in the traffic stream. From the responses it appears that to a significant number of motorists the lights did not outline vehicles. Of the sample, 24.6% indicated that the lights outlined vehicles ahead, 62.3% said that the lights did not outline vehicles ahead, and 13.1% did not respond. Figure 5 represents the responses to this question.

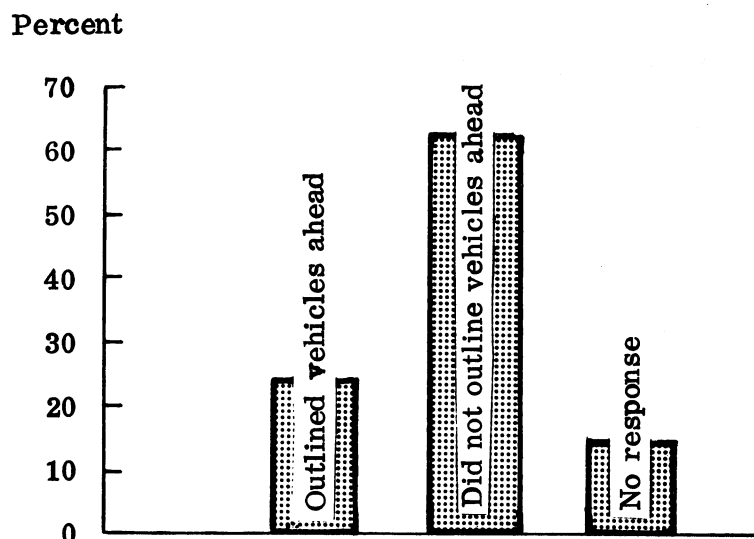


Figure 5. Bar graph of responses to Question 4.

QUESTION 5

The fifth question dealt with motorists' assessment of whether the lights provided sufficient delineation to warrant a full-scale installation. Of the motorists who answered, 80.3% said that a complete installation should be; and 9.8% thought that it should not; 9.8% did not answer.

Comments

Part 6 of the questionnaire was provided for comments. As is the case in every request for comments, some motorists took the opportunity to voice their opinions on almost all related subjects, but the majority of responses were pertinent. They were significantly in favor of the lights and some of the suggestions will be incorporated into the design of the overall light system.

In evaluating the responses to the questionnaire it is evident that the motorists sampled are overwhelmingly in favor of a complete installation of lights across Afton.

CONCLUSIONS

The conclusions arrived at from the study are:

1. The pavement inset lights clearly outlined a traffic pattern or channel to follow in the opinion of approximately 66% of the motorists who responded to the questionnaire. An additional 33% thought the lights aided by outlining the road edges, although they did not think the lights produced a visual pattern to follow. In light of this information minor adjustments in the aiming of the lights need to be made and 100 foot spacings need to be maintained on the curved sections.
2. The lights did not cause a prohibitive glare, and with a more sensitive control system the glare can be almost completely eliminated.
3. The lights are effective in reducing driver anxiety and, to some degree, producing a feeling of security.
4. The lights are not very effective in outlining vehicles ahead. It was thought that perhaps the lights would produce a silhouette effect on cars ahead in the traffic stream. This was not the case, as is demonstrated by the fact that only 25% of the motorists reported seeing cars outlined by the lights.

IMPLEMENTATION

Even before the conclusions of this study were derived and reported, top highway officials in the Central Highway Office, who are keenly aware of the problems with fog on Afton Mountain and who have closely followed the progress of the fog lighting studies, made the decision to install a guidance light system across the entire area of the Mountain most subject to fog.

STATUS OF WORK ON INSTALLATION

Immediately after the decision was made to make the full installation, a committee was formed to design the system. The committee was composed of personnel from throughout the state who had special skills deemed necessary for the project. Divisions and districts represented on the committee are:

Divisions:

Research
Equipment
Construction
Traffic and Safety
Maintenance
Location and Design

District:

Staunton

The first task of the committee was to determine the extent of the system and how the system should be sectioned. Field observations of where fog occurred had been made since the initiation of the study. From those observations, the decision was made to install a 5.8-mile system separated into sections according to breakpoints in the occurrence of fog as follows:

Section I — 1.5 Miles in Length

From: 0.14 Mile West Intersection Rt. 624 (Lyndhurst Exit)
To : 0.14 Mile West Intersection Rt. 250 (Afton Exit)

Section II — 2.7 Miles in Length

From: 0.14 Mile West Intersection Rt. 250 (Afton Exit)
To : 1.6 Miles West Intersection Rt. 690

Section III — 1.6 Miles in Length

From: 1.6 Miles West Route 690
To : Intersection Rt. 690

Each section will be individually controlled by fog detectors and the lights will be on only in the sections where fog is present. In addition, the fog detectors will have the ability to sense different densities of fog and adjust the intensity of the lights accordingly. The lights will be installed in the edgelines of the traveled portion of the roadway and will be spaced 200 feet apart on tangent sections and 100 feet apart on curved sections. The spacings can be halved if necessary.

After the configuration was determined the committee on electrical specifications designed the electrical hardware, wrote specifications for the equipment, and worked out a cost estimate.

The proposal for the installation was drawn up and submitted to the Federal Highway Administration on July 24, 1973, for comments since it will be a federal aid project. The Federal Highway Administration completed its review and returned comments by memorandum on September 6, 1973, with conceptual approval subject to consideration of the comments. Because of the urgency of the project, the equipment is being purchased by the state and the requisition has been submitted. Table 1 gives the anticipated schedule for the installation of the system. It should be noted that at publication of this report several of the items on the schedule have been completed.

TABLE 1

ANTICIPATED SCHEDULE FOR INSTALLATION OF FOG SYSTEM
ROUTE 64 -- AFTON MOUNTAIN

		1973				1974											
		Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Oct.	Nov.	Dec.	
1	Purchase of Equipment																
1a	Lights																
1b	Detectors																
2	Field Inspection																
3	FHWA Design Approval																
4	Final Plan Design																
4a	Control Building																
4b	Elect. Plans & Specs.																
4c	Sign Plans																
4d	Research Plans																
5	Advertisement																
6	Construction																

REFERENCES

1. Creech, Marion F., "Fog — A Review of the Literature Pertaining to Highway Problems and Possible Solutions", Virginia Highway Research Council, Charlottesville, Virginia, VHRC 72-R2, July 1972.
2. Creech, Marion F., "Interim Report No. 1 — Evaluation of Pavement Edge Inset and Low Level Illumination Lights in Fog", Virginia Highway Research Council, Charlottesville, Virginia, VHRC 73-R28, February 1973.
3. Creech, Marion F., "Working Plan — Evaluation of Pavement Inset Lights for Use in Heavy Fog", Virginia Highway Research Council, Charlottesville, Virginia, VHRC 72-WP16, April 1973.

