Some Night Views of a Highway Lighting Test Installation

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● IN connection with the design of the Connecticut Turnpike, a new expressway from the New York State line at Greenwich, Conn., to the Rhode Island State line at Killingly, Conn., a distance of approximately 129 miles, one of the many problems was night visibility on such a roadway. Everyone recognizes the contribution that street and highway lighting has made toward traffic safety, so progress demands investigation and acknowledgment of the advancements in the art, particularly with regard to expressway lighting.

When Commissioner Newman E. Argraves, of the Connecticut State Highway Department took office, he was faced with a choice of many types of lighting and luminaires for installation on some 53 miles of the western section of the Connecticut Turnpike; for each, the vendors made claims of superiority, especially in the form of better visibility. There is no recognized instrumentation for determining visibility; therefore, the installation of a highway lighting test strip on Route US 1 in the town of Old Lyme, Conn., was authorized for the purpose of measuring by competent comparative observations the relative effectiveness of the various types of highway lighting installed. Details and results of this installation have been given in "A Highway Lighting Test Installation" presented at the National Technical Conference, Illuminating Engineering Society, Boston, Mass., Sept. 17-21, 1956.

It is preferred to call this a report to the Night Visibility Committee, rather than a paper, as a report is a factual outline of what was done, and how it was done. A paper would require drawing definite conclusions from the results, which, in this case, would require further research.

At this point it might be well to outline the conditions under which the pictures were taken and processed. In an attempt to evaluate visibility under the different types of lighting installed on the test strip, a sequence of pictures was taken for each type with the camera placed approximately 50 feet behind the luminaire (Figure 1) for one sequence, and approximately 50 feet in front of the luminaire (Figure 2) for the second sequence. The film was selected so that it had a flat curve in the color spectrogram, and thus had approximately equal sensitivity to blue and green. The exposures were chosen so that they would be beyond the range of the film in both the upper and lower regions. In each sequence men were stationed 200, 300, 400, and 500 ft from the camera. As far as possible, similar clothing was worn for each of the sequences.

After the first group of photographs had been taken, it was noted that there was a variation in pavement brightness background due to curves and grades in the roadway, so the photographs for the conventional mercury and fluorescent installations were taken in the north lane with the camera ahead of the luminaire, and in the south lane with the luminaire ahead of the camera. Under the linear mercury installation all photographs were taken in the north lane and the physical conditions are the same for all the sequences; these can be compared without qualification.

The pictures were taken and processed under the following conditions, using the noted materials:

Camera

1. 4 x 5 Speed Graphic.
2. Graflex Optar f/4.7, 135-mm lens.

Speeds

Shutter speeds for each sequence were 1/25, 1/10, 1/5, 1, 2, 4, and 8 sec. with lens wide open at f/4.7.

Film

1. High-speed panchromatic Ansco Superpan Press.
2. Exposure index, daylight 125.
3. Development, 5 min. in Permadol at 68 F.

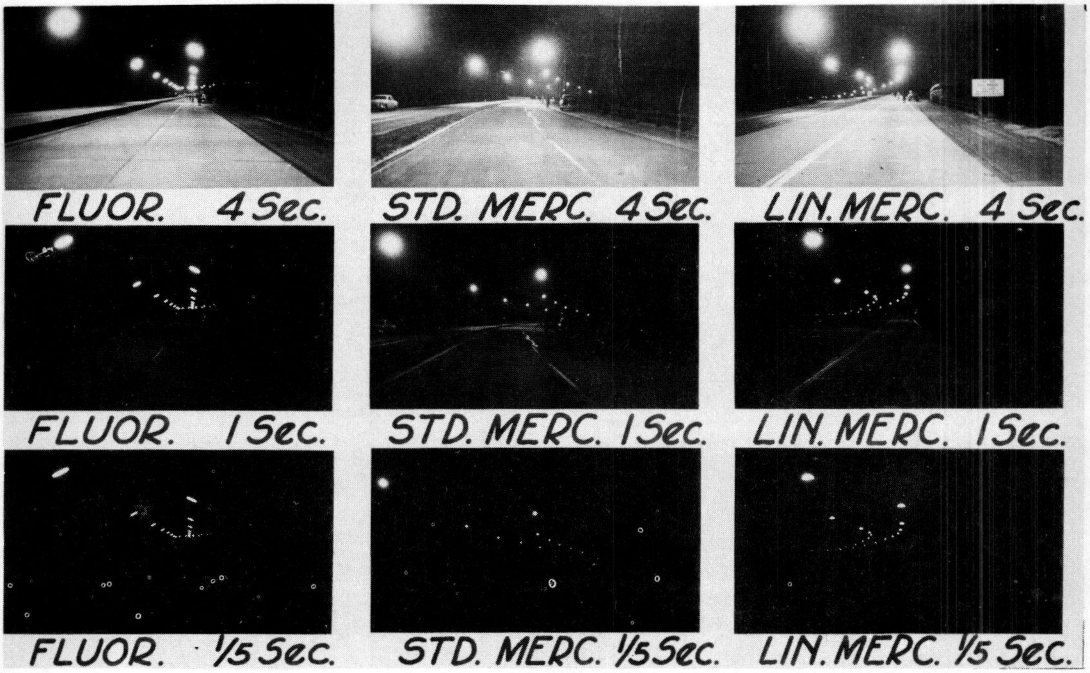

Figure 1. Luminaire located about 50 feet in front of camera. (Courtesy of ''Illuminating Engineering'')

Figure 2. Luminaire located about 50 feet behind the camera. (Courtesy of ''Illuminating Engineering'')

Enlargements

1. Omega D-2, 4 x 5, condenser-type enlarger.
2. 8 x 10 Kodabromide F-2, single-weight paper.
3. Exposure, 5 sec. at f/16.
4. Development, 1½ min. in Dektol at 68 F.

Further research might well be undertaken to determine whether the camera can be used as an instrument to measure the acceptability and relative effectiveness of a turnpike lighting installation. In support of this, attention is called to three interesting points developed by the photographic data secured at the test installation and displayed here.

HALATION

A variation is seen in the halation around the luminaires in the first pictures taken with short exposures in the respective sequences, and it is quite possible that this relationship could be a measure of the brightness of the luminaire. It is interesting to note that the measurements taken at the test lighting installation with a Spectra Brightness Spot Meter are similar to the relationship shown in Figures 1 and 2; that is, the 400-watt conventional mercury luminaire registered the highest foot-lambert reading, the 400-watt linear mercury luminaire a lower reading, and the 400-watt fluorescent luminaire the lowest of the three. This relationship is reflected in Figures 1 and 2 in that the pictures taken with the camera 50 ft in front of the luminaire show some halation for the conventional mercury at 1/25-sec. exposure, the 400-watt linear mercury luminaires reflect this halation effect at 1/10-sec. exposure, and the fluorescent luminaires show it at 1/5-sec. exposure.

Recently there have been installed on the test lighting strip five linear mercury low-brightness luminaires with directional unbalanced light distribution and 250-watt EH-1 lamps instead of the 400-watt EH-1 lamps used in the other linear mercury pictures shown. The new units are designed to direct more light toward the vehicle driver and thus favor seeing by silhouette. There has been no opportunity as yet to take instrument readings on this latest installation, but, if the assumption regarding photographic rendition is correct, one would expect to find the brightness of the 250-watt linear mercury luminaire to be very nearly that of the fluorescent unit. This would be based on the fact that the photographs of the 250-watt units show some halation at 1/5-sec. exposure, which is about the same as that for the 400-watt fluorescent unit. A rough check with the Spectra Brightness Spot Meter shows a reading of 9 candles per square inch for the 250-watt directional linear mercury luminaire, and 7 candles per square inch for the 400-watt fluorescent luminaires.

OBSTACLE RECOGNITION

It is interesting to note that obstacle recognition of the fourth man in line, a distance of about 500 ft, takes place at approximately 1/5-sec. exposure in all of the picture sequences. This comparison, however, must consider the camera position with relation to the luminaire, because all of the men moved back 100 ft when the camera was placed in front of the luminaire as compared to their positions with the luminaire ahead of the camera. This change of position places the fourth man in a brighter area when the camera is in front of the luminaire.

The photographs indicate that obstacle recognition was about equal under all the luminaires, despite the fact that foot-candles and foot-lamberts varied considerably. It is possible, however, that a comparison on the basis of threshold recognition may not be the complete answer, and the effects of film fogging (which will be mentioned later) may have to be integrated to secure a proper evaluation. Instrumentation on the test strip showed the following average values:

Luminaire	Hor. Fc. Init.	Vert. Fc. Init.	Ft-Lamb.
Conventional mercury, 400 w	2.30	1.82	0.87
Linear mercury, 400 w	1.24	1.20	0.68
Fluorescent, 400 w	1.10	0.87	0.46

On the basis of threshold recognition, Figures 1 and 2 seem to bear out the claims of some vendors that visibility is better under linear-type luminaires of low brightness, particularly with linear light sources such as the fluorescent lamp, which in this instrumentation showed the lowest foot-candle and foot-lambert readings.

FILM FOGGING

It is realized that the mention of glare, because of the many forms that it takes, introduces a controversial subject, but it would be remiss not to call attention to the fact that the photographic sequences show the effects of over-exposure at different time intervals under the various luminaires.

It is to be noted that in the sequences with the luminaire ahead of the camera (Figure 1), definite fogging of the film takes place after 1-sec. exposure under the 400-watt conventional mercury and the 400-watt linear mercury luminaires, after 2-sec. exposure under the 250-watt linear mercury luminaire, and after 4-sec. exposure under the 400-watt fluorescent luminaire. In contrast to this, the picture sequences with the camera ahead of the luminaire (Figure 2) show fogging starting at 4-sec. exposure under the 400-watt conventional mercury, the 400-watt linear mercury, and the 400-watt fluorescent; and at 8-sec. exposure under the 250-watt linear mercury luminaire.

It would be of interest to determine whether densitometer measurement of the film can be corelated with one or more of the different forms of glare when the camera position is properly chosen, due consideration being given to the camera distance from the luminaire, position in the roadway, and target level, and the results compared with an accepted standard reference film.

Photography is a specialized subject and there are many technical details which must be considered. It is realized, also, that the previously mentioned effects are not new to photographers, and, quite possibly, there have been studies made in connection with their application to lighting evaluation. If such references are available, they have not yet come to the author's attention. The key to the problem may lie in sequential exposures of specified lengths, using specified materials processed under given conditions. It would certainly fill a long felt want, from the engineer's point of view, if the adequacy of a lighting installation could be determined by means of photographic comparison with a reference standard.