

use of this valuable tool. The relationship of industry and government could also be moved from a seemingly adversary position to one of more cooperation by having more effective dialogue prior to issuance of notices of proposed rule making.

More effective research and use of research funds through more carefully coordinated standards—it seems worth a better try than we've been giving it.

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My concern with a symposium on night driving visual needs is to extract from the information presented those concepts and ideas that will help in more effectively serving the public in my capacity as a district lighting engineer in Illinois.

As I review the papers presented, my concern falls into four basic needs:

1. There is need for additional justification of roadway lighting installations,
2. Visibility criteria for fixed roadway lighting must be improved or refined,
3. More sophisticated design techniques for roadway lighting are needed, and
4. New hardware to more effectively implement these techniques and to improve or correct existing deficiencies is required.

ADDITIONAL JUSTIFICATION OF ROADWAY LIGHTING

A solid base for providing roadway lighting is required. Lighting just like other highway projects must be justified. I was encouraged by Irving and Yerrell's report of a 30 percent reduction in nighttime accidents and a parallel reduction in severity when lighting is installed. We have relied heavily on the report by the Illuminating Engineering Research Institute for freeway lighting justification and our own experience of a 40 percent reduction in freeway accidents after lighting. We certainly need more information, better measurements, and controlled studies on the relationship between accident rates and illumination. It will be of great interest to know the outcome of the study being conducted by the British Transport and Road Research Laboratory.

Accident rates related to night illumination are important, but research should explain why these problems occur. Henderson and Burg's paper brings the area to the front: "At this point we know that visual performance is seriously degraded under conditions typically encountered in night driving, i.e., low levels of illumination, glare, and low-contrast targets... Further, we know that some individuals are much more severely affected by these factors than others, and as a result the total variability in visual performance of the driving population increases significantly as the level of illumination decreases, glare increases, or contrast decreases."

Another problem that relates closely to fixed lighting is that of headlight adequacy. I refer now to urban freeways with speeds up to 55 mph where traffic densities are sufficient to warrant fixed lighting. It appears that there are a number of problems with headlights such as misaim, dirt depreciation, changes due to different loadings, and glare production. Thus, whereas the only solution in rural areas is head lamps, in urban areas fixed lighting may be the total solution. Irving and Yerrell's and Mortimer's comments on their problems with head lamp adjustment are of great interest.

Walton expressed the idea that "fixed roadway lighting probably offers the most comprehensive means of correcting poor night visual environments." He also cataloged the night visual requirements of the driver from the standpoint of the three performance levels involved in the driving task. This information will be extremely helpful to the designer in providing the proper illumination to meet driver visual needs. Still there is much work to be done to illuminate those objects that need to be seen.

Rockwell and Rackoff's findings with the eye camera tend to lead to the conclusion that fixed lighting improved driver performance.

This information and continued research and confirmation in these areas will provide administrators with the basis to decide for or against installation of fixed lighting.

IMPROVED OR REFINED VISIBILITY CRITERIA

We desperately need to determine what an adequate night visual environment is as provided by fixed illumination. There is much encouragement in Blackwell's research that indexes of merit of a lighting system will be forthcoming so that present conventional systems may be evaluated.

The research reported by Walton identifies the information the night motorist must have to adequately operate at the three levels described. Perhaps this can be further documented by field studies. Providing the driver with adequate visibility of information sources is an area that needs better definition. There appears to be a need for coordinating the Rockwell and Rackoff findings with those of Walton. Also it would be of great interest to see the results of Rockwell and Rackoff's eye movement technique applied to new concepts of roadway lighting such as high masts. The study of the visibility of some of these objects under existing lighting systems has been reported by the Blackwells.

Certainly Gallagher and Meguire's field experiments verify the concept that contrast ratio is the main criterion for target visibility.

These researchers appear to have solid bases for future formulation of visibility criteria for certain night visual needs.

DESIGN TECHNIQUES FOR ROADWAY LIGHTING

If we are going to provide through fixed lighting the proper night visual environment for the motorist, we need a method of design for such an installation. I am impressed with the work described by Farber and Bhise. Perhaps the techniques they describe can be used to evaluate various lighting designs without the need of constructing the installation.

NEW HARDWARE

The energy crisis has emphasized the need to provide fixed lighting in the most efficient and effective manner. Industry response to this challenge has been outstanding. Lamp improvements and some new luminaires are available, but new designs that provide for light distributions to satisfy revised visual criteria are needed.

In terms of support hardware we are indebted to the Transportation and Road Research Laboratory for its early studies in breakaway light standards. This concept eventually led to the installation of several thousand breakaway or frangible light standards on highways in the Chicago area. These frangible poles have performed extremely satisfactorily in reducing accident severity and cost of replacement.

There is a continued need for practical product development to implement the results of basic research. A number of state and other agencies have installed experimental lighting with some success. These installations, however, generally use equipment currently available rather than new designs based on current research. An effort should be made to implement the results of basic research such that new equipment will be available for field installations.

In summary, I am greatly encouraged by the progress being made in researching the factors that affect drivers' night visual needs. This symposium should be the basis for tying together the efforts of headlighting and fixed lighting researchers. I look forward to the opportunity of installing a system based on these efforts.