Principles and Figures of Merit for Roadway Lighting As An Aid to Night Motor Vehicle Transportation

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● FIGURE of merit ratings for the seeing and traffic effectiveness of roadway lighting is an obligation which has received greatly increased attention during the past year. Numerical ratings will provide a simplified basis for progress in the essential night use of street and highway facilities for motor vehicle transportation.

Organized programs for the investigation and assessment of roadway lighting benefit are underway by groups such as the Illuminating Engineering Research Institute, its Technical Advisory Committee on Light and Vision, several universities, and the I. E. S. Sub-Committee on Roadway Lighting Principles. Other organizations are now formulating plans for participation, on the urgently accelerated action basis which the night traffic problem warrants.

Technical interest results from realization of the opportunity to make an outstanding contribution to the public welfare.

ACCOUNTABILITY FOR ACTION

Accountability and responsibility to the public is in the capable hands of engineers and officials employed by governmental agencies and numerous other organizations or associations. Their success in providing efficient, pleasant, and attractive night driving conditions will be aided by figure of merit ratings for the seeing and traffic benefit of roadway lighting. Recognition and knowledge of its benefits will determine the type of lighting and the extent of its use to improve night driving conditions.

The I. E. R. I. Technical Advisory Committee on Light and Vision has pointed out that assessment of lighting effectiveness should determine how much better several types of good roadway are as compared with poor lighting, or as compared with conditions when no roadway lighting is provided (Fig. 1).

Such comparative ratings will be in terms of seeing factor benefit and benefit in the operation of night traffic. Seeing factor ratings are basic. For example, a certain amount of traffic benefit is produced by improvement of seeing to a specified number rating. Increasing the seeing rating by further improvement of the lighting will usually increase the numerical traffic benefit rating.

MULTI-BILLION DOLLAR NIGHT TRANSPORTATION BUSINESS

The general objective of roadway lighting is to provide night seeing for desireable driver environment, attitude, performance, and night use of motor vehicle transportation facilities.

In comfort, convenience, and safety, the night traffic objectives of roadway lighting are similar to those which provide the background for other work being done in highway and traffic engineering, in street and highway construction and modernization, and in automobile design and development.

The multi-billion dollar motor vehicle transportation business must be kept open after dark. That is an obvious economic and social necessity. Success in this business involves at least some roadway lighting of a type which will produce really good seeing conditions.

NIGHT TRANSPORTATION ESSENTIAL FOR NIGHT LIVING

Many more people could use the roadways at night if conditions are improved for seeing and for night living with motor vehicle transportation.

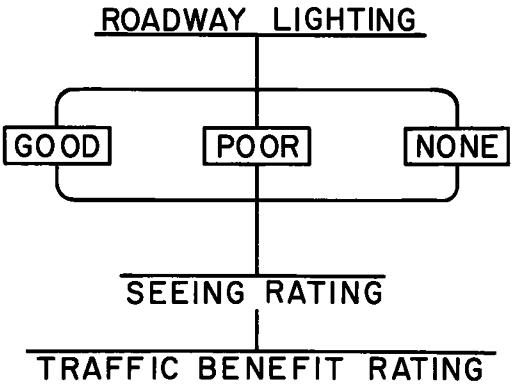

Figure 1. General basis for assessment of roadway lighting effectiveness.

Night living takes on new and even greater significance when future night traffic conditions are anticipated. Traffic engineers predict that motor vehicle traffic will increase by one-third by 1965 and double in volume by 1975. The seeing comfort, convenience, and accident prevention value of roadway lighting influences the night use of the multi-billion dollar investment in streets, highways, autos, trucks, and buses. The value of this investment depends upon the night usefulness desired by the people; for instance, an automobile is of small social or economic value standing in a garage.

For existing roadway systems and new streets and highways now in the planning stage it is vital that careful studies be made for improving night seeing conditions. Obviously, the human desire and efficiency of the drivers is a basic consideration for progress. Figure 2 diagrams the basic interrelations.

COMFORT FOR NIGHT TRAFFIC

The traffic objectives of roadway lighting are shown in Figure 3. These are similar to objectives of street and highway construction for daytime use; that is, comfort, convenience, and safety.

Traffic comfort is the comfort people like and enjoy—which the Virginia Department of Highways features on its detour signs, which say: "This construction is for your future comfort and safety. Drive Carefully." This is the comfort objective which sells automobiles and smooth, pleasant, and attractive streets and highways. It must be an important objective in the use and choice of roadway lighting.

The comfort quality of driver seeing deserves greatly increased attention. The phychological and physiological condition of the driver is involved.

The necessary seeing depends upon the more obvious adverse factors, such as fatigue, monotony, carelessness, driver vision, concentration, attention, judgment, driver reaction, and even intoxication. Poor seeing may induce and accentuate the effect of these and other adverse factors.

Good seeing generally alleviates such conditions, making night driving easier, less tense, more pleasant and attractive, with greater freedom from fear or annoyance. Some safety factor in comfort should be provided. Comfort is one of the principal night-driving objectives. In many instances it applies to the pedestrian as well as the driver.

DRIVER ALERTNESS

Favorable comfort conditions for night driving may lessen the extent and effect of driver alertness factors such as fatigue, hence improve visibility conditions.

CONVENIENCE

Quality of traffic flow is another traffic benefit of roadway lighting. Good seeing may expedite traffic and help relieve congestion. Roadway lighting generally makes possible higher safe or "critical" vehicle operating speeds during night hours. These speeds may be 10 to 20 mph higher than

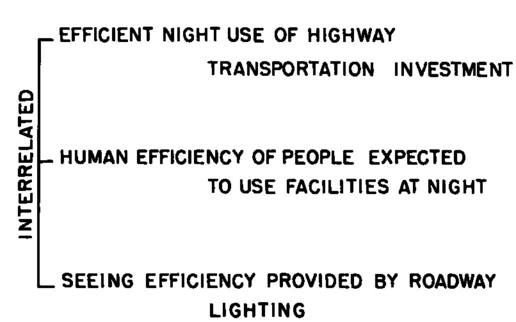

Figure 2. Basic interrelations in night roadway lighting.

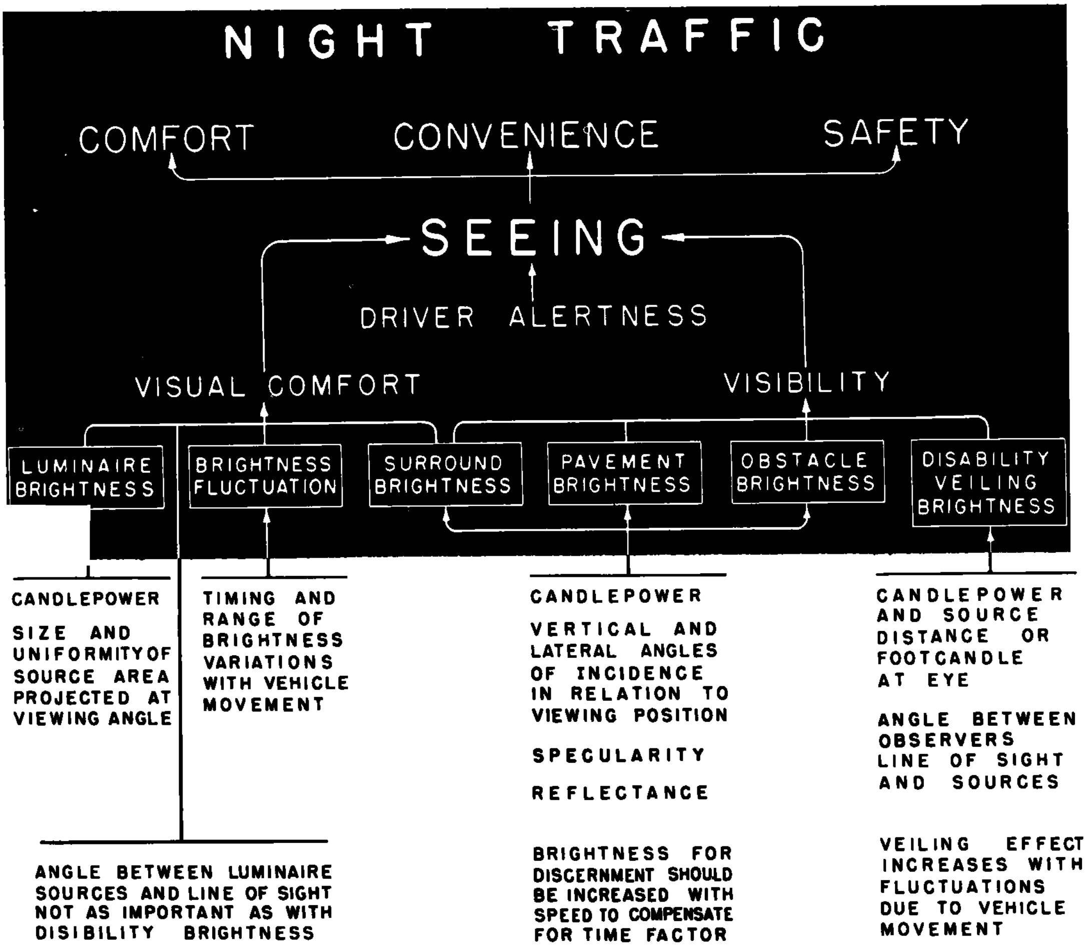

Figure 3. Traffic objectives of roadway lighting.

the speeds which might be safe when seeing conditions are poor. The economic value of the time thus saved may be many thousands of dollars per mile of roadway per year.

When designed for good seeing, roadway lighting will encourage and increase night use of the roadway system, distributing a portion of the traffic loads to the night hours. Those who use the streets and highways at night generate motor fuel tax revenue.

Proper vehicle headways, spacing, use of full pavement width and proper lanes, acceptance of available passing opportunities, are some of the operational and capacity benefits. A lighted roadway background or "vehicle-path" aids judgment of speed and direction of vehicles. It also tends to minimize any adverse effect of bright lights in the field of view.

TRAFFIC SAFETY

Roadway lighting aids law enforcement. It is also very convenient for those who might otherwise be timid about flat tires, on-the-journey trouble, or nocturnal crime.

The traffic safety benefits of good seeing are generally well known. The prevention of night accidents involves seeing the situation soon enough and far enough in advance to avoid collision. This sight distance at night generally involves visibility safety factors of brightness or brightness contrasts which are sufficient for quick and certain discernment. Knowing the route or vehicle path ahead (the roadway contour and alignment) often makes the difference between a hazardous or safe condition for the driver and the "other fellow," whether he be driver or pedestrian.

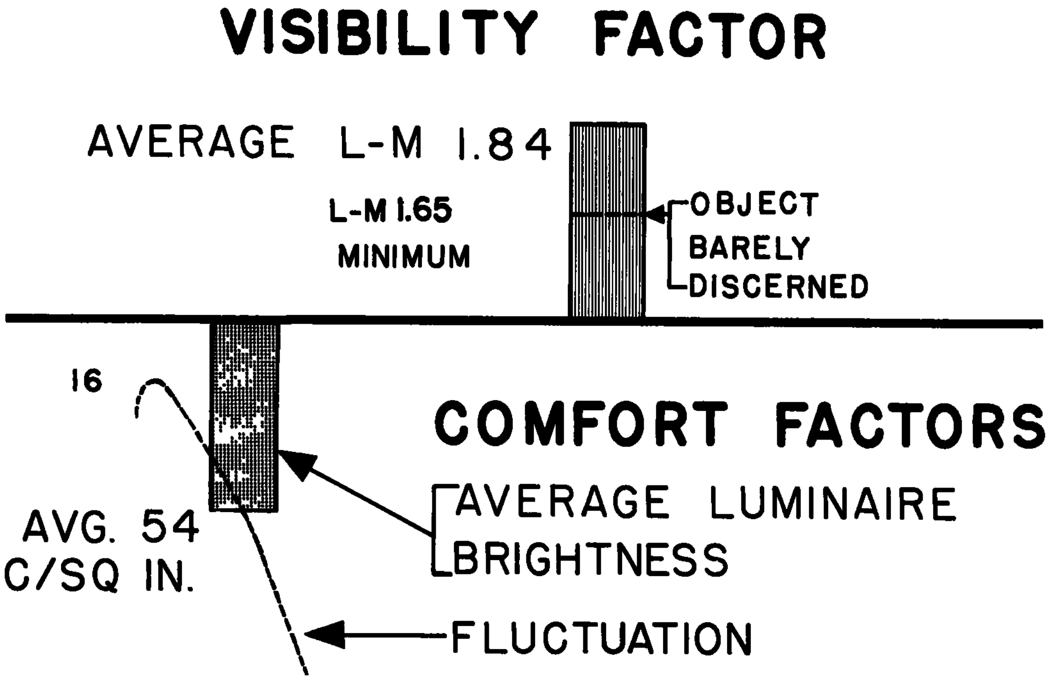

Figure 4. Calculated seeing factor ratings.

EVALUATION MAY BE THE PROBLEM

Evaluation of traffic and seeing benefit of roadway lighting, including the relative importance of seeing comfort and visibility, should also obviously involve many highway traffic engineers. The public, those responsible for the installation and operation of roadway lighting, and those responsible for the successful night operation of motor vehicle transportation systems, are interested participants.

Rating is a big job, even when all concerned are participating, including those who represent various segments of the nation's 70 million drivers.

VISUAL FACTORS IN SEEING

Performance data pertaining directly to the seeing objectives of roadway lighting systems can be presented using the outline shown in the mid-portion of Figure 3. Visual comfort, driver alertness, and visibility data should have a common basis consistent with the roadway, its lighting, the vehicle, and the driver. Many of these factors are interdependent.

An over-all numerical rating combining several seeing factors may materialize based on understanding of objectives and assumed conditions.

CALCULATED RATINGS BASED ON BEST AVAILABLE DATA

Certain of the factors in seeing under roadway lighting may be calculated using the data available. Such calculated ratings are shown in Figure 4.

The calculation method now being used was described before the 1955 I. E. S. National Technical Conference in the paper "Luminaire Light Distribution Principles." This paper was published in Illuminating Engineering (December 1955).

The calculated seeing factor ratings also were described in a paper "Improving Seeing Efficiency with Roadway Lighting" published in the August 1956 issue of Traffic Engineering.

Pavement brightness visibility data for the foregoing papers are based on studies presented in a paper by Reid and Chanon, entitled "Evaluation of Street Lighting" (Illuminating Engineering, 1939).

The I. E. S. Sub-Committee on Roadway Lighting Principles is currently using the evolved method of rating seeing factors averaged and shown in Figure 4. This subcommittee and the I. E. S. Committee on Street and Highway Lighting are sponsoring studies on discomfort glare under roadway lighting conditions. The work of Putnam and associates at Case Institute has progressed considerably during the summer of 1956 under a new grant sponsored by the Illuminating Engineering Research Institute.

Data for rating typical roadway lighting discomfort conditions in ratio to B. C. D. (borderline between comfort and discomfort) should be available soon. These data will help correlate the combined luminaire brightness ratings, now shown in Figures 4 and 5, with luminaire size in visual angle, surround brightness, and viewing angle. Comfort sensation ratings then will be expressed in discomfort ratio to B. C. D. This ratio to B. C. D. will be combined for each driver position (Fig. 5) and longitudinally averaged for the representative roadway lighting system as now shown as average luminaire brightness in Figure 4.

RATINGS FOR SIMPLIFICATION

Seeing factor ratings for representative roadway lighting systems will at least simplify to numbers similar to those shown in Figure 4.

The rating may be in terms of:

1. Relative visibility (a) Average (b) Minimum.
2. Relative comfort sensation (a) Average (b) Fluctuation range and time.

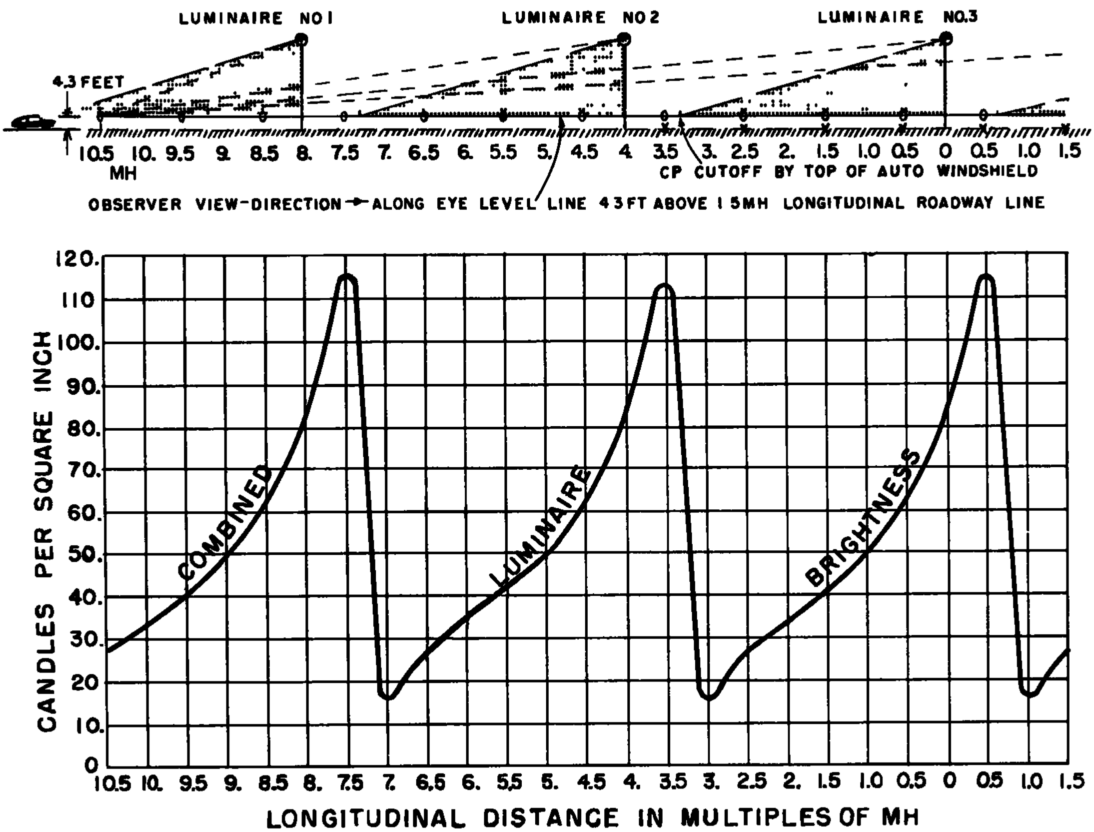

Figure 5. Rating seeing comfort factors involves the dynamic effect of fluctuation in combined brightness of luminaires in the driver's eyes as he proceeds.

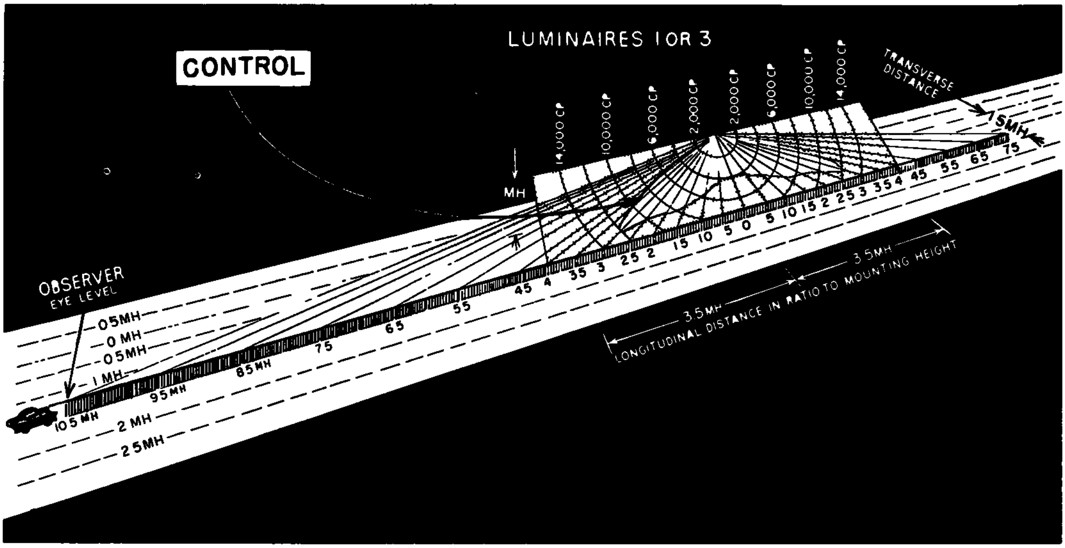

Figure 6. Control and diminution of luminaire candlepower at high angles is shown by new inclined plane type light distribution curves. Perspective diagram shows control of candlepower distributed along a representative driver-observer eye-level line at 1.5 MH (or 45-ft) transverse distance from the luminaire. Such candlepower control restricts the luminaire brightness factor in discomfort (Fig. 5) and loss of visibility due to disability veiling brightness (Fig. 8). Generally the candlepower distribution is restricted at longitudinal distances from the luminaire greater than the 3.3 MH top-of-auto-windshield cutoff.

VISIBILITY RATING

In this instance the average relative visibility to the scale of the Low-Range Luckiesh-Moss Visibility Meter is 1.84.

The 1.64 minimum relative visibility may be more significant. How much better does the visibility rating have to be to assure adequate tolerance or safety factors for conditions such as typically tired drivers and high speeds. The Luckiesh-Moss Low-Range Visibility Meter used in the visibility studies by Reid and Chanon was the basis for the following definition:

"A visibility of 1 (as applied to seeing for safety on streets) is defined as mere discernment of a one-foot obstacle of zero brightness on a background having a substantially uniform brightness of approximately 0.01 footlambert, by a stationary observer with normal vision, standing 200 feet away, at fixed attention, with no source of direct glare in the field of view."

VISUAL COMFORT RATING

For comparison with the plus visibility factor, relative comfort sensation rating will be provided. This rating will be based on representative systems. It probably will be given in ratio to B. C. D., in accordance with the data being established by the Putnam studies at Case Institute.

In the interim, Figures 4 and 5 present luminaire brightness, one of the principal negative factors in roadway lighting. The longitudinal average combined luminaire brightness from the system in the drivers view is about 54 candles per square inch.

Figure 5 shows the dynamic effect of fluctuation in the combined brightness from several luminaires in the drivers field of view as he travels, from left to right, along a representative roadway path. The brightness varies from 16 to 116 or in a ratio of more than 7:1. The "flicker," or fluctuation ratio, is 7.25 to 1. The 116-candle-per-square-inch maximum may be most significant. The brightness peaks successively at

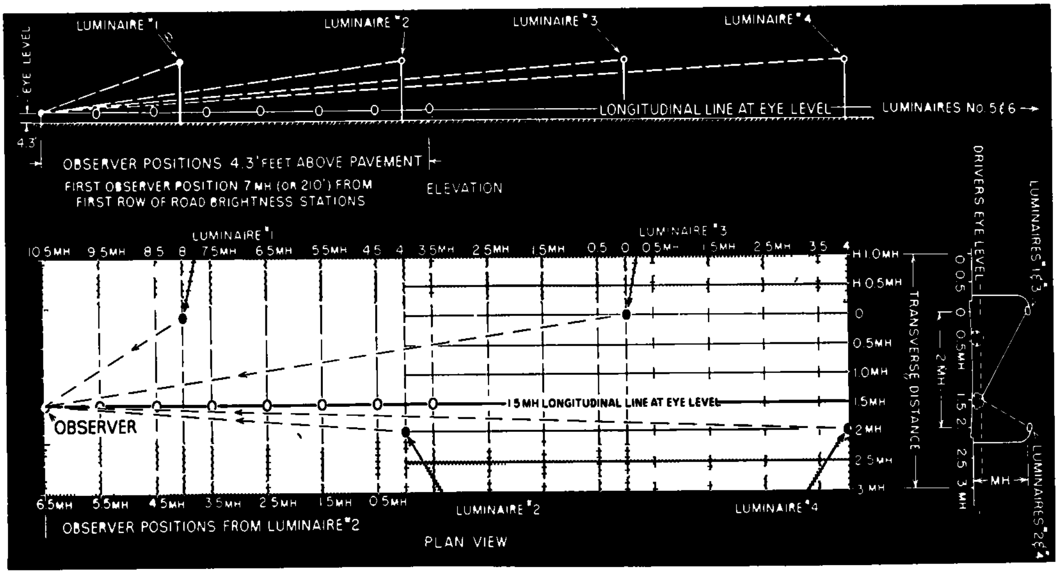

Figure 7. Representative roadway lighting layout showing the series of driver-observer viewing positions along the longitudinal eye-level line 4.3 ft above the pavement and at transverse distance of 1.5 MH (45 ft) with respect to luminaires on the driver's left, such as No. 3. This eye-level line is also at 0.5 MH (15 ft transverse distance) with respect to luminaires on the driver's right, such as No. 2 and No. 4. The combined discomfort and disability effect of several luminaires is calculated for each of the series of driver observer positions.

intervals of 2 sec for a driver traveling at about 40 mph along the roadway lighting system assumed to be representative.

Figure 5 includes the brightness of luminaires at distances including 10. 5 MH, generally about 315 ft. The luminaire brightness data assume that the projected area of the luminaire light sources is constant at 100 sq in.

It should be borne in mind that the relative comfort sensation or discomfort ratios should be compared with the visibility which the roadway lighting system provides. There is more over-all comfort driving along a well-lighted roadway than on a roadway having no lighting at all to produce visual discomfort from the luminaires.

RATINGS MAY BE COMPARED WITH DESIRE

The foregoing describes the type of ratings to be furnished for user guidance. Ratings desired may be compared with ratings obtained with the representative types of lighting systems. Such ratings may also be compared with the desire and preferences of those who use the roadways at night. These results also may be compared with the effectiveness of the roadway lighting system in producing the traffic comfort, convenience, and safety objectives.

Visibility and the relative comfort sensation produced by luminaires in the field of view can be seen and appreciated. The following pertains to the new methods of presenting and using data on the factors shown in the lower portion of Figure 3.

CONTROL OF CANDLEPOWER ALONG EYE-LEVEL LINE

Figure 6 shows the new inclined plane method of presenting the luminaire candlepower distribution along the representative driver eye-level line. The candlepower is controlled and diminished at high angles extending to distances from the luminaire greater than the 3. 3 MH distance at which the top of the typical auto windshield cuts off the light from the luminaire.

Inclined-plane candlepower curves really show the desirable light control for seeing:

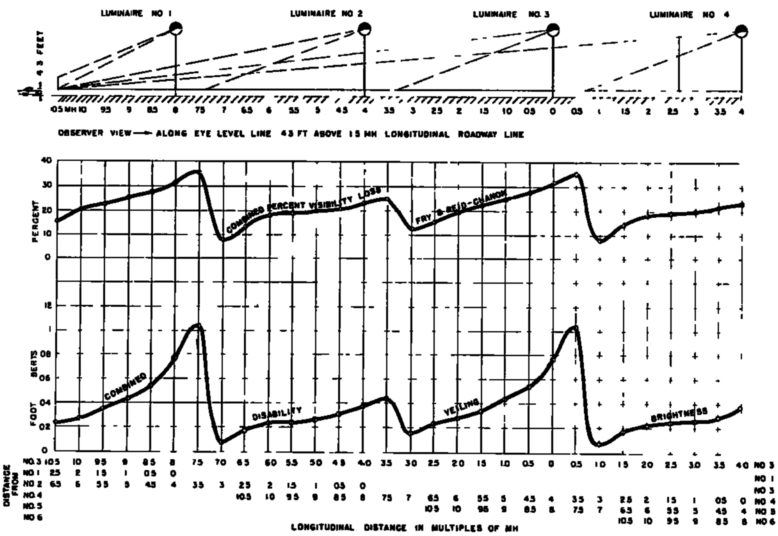

Figure 8. The combined percent loss in visibility due to disability veiling brightness varies with the dynamic driver-observer movement along the roadway, control of combined luminaire candlepower, viewing angle and distance from each luminaire, and the top-of-auto-windshield cutoff.

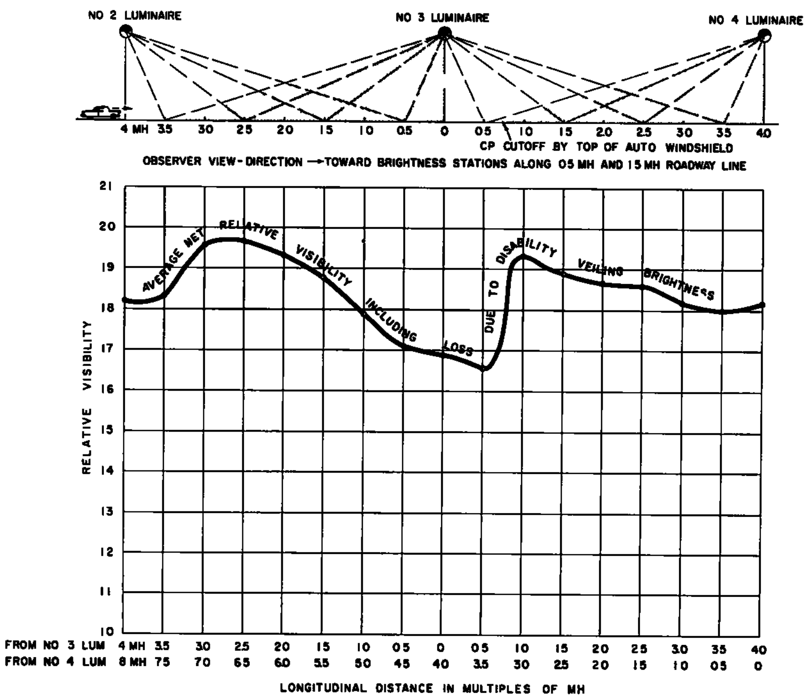

Figure 9. Variation of combined net relative visibility produced by the lighting system with driver viewing position.

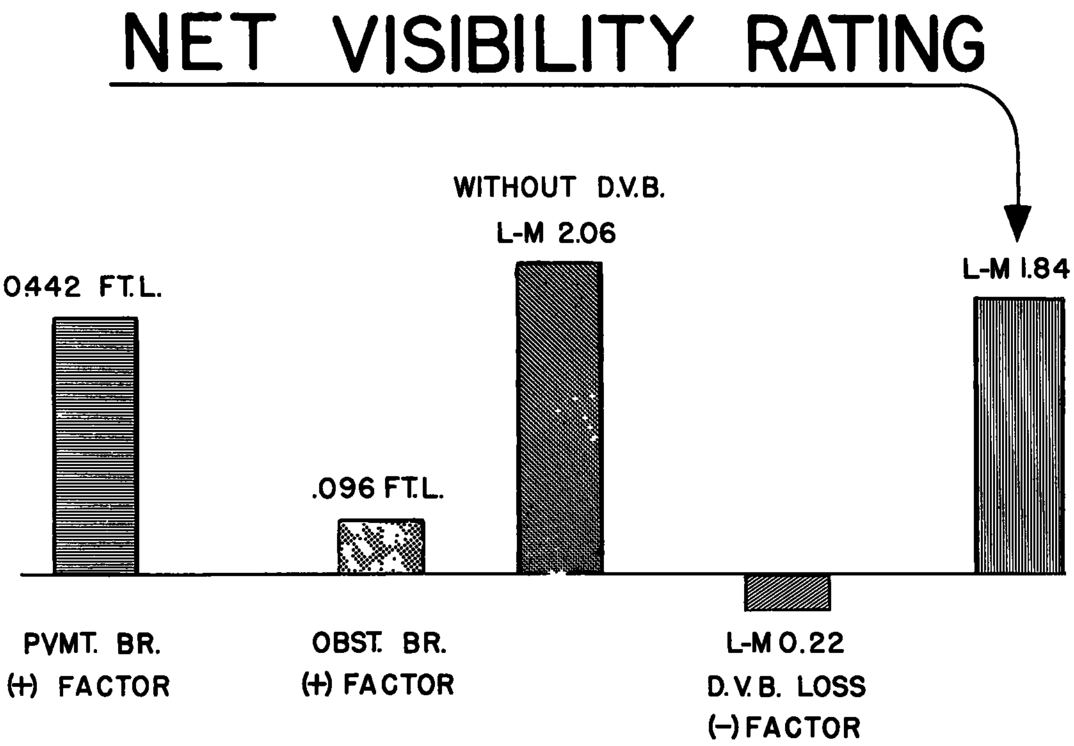

Figure 10. Pavement brightness is a principal plus factor in visibility.

that is, control of (a) luminaire brightness, a principal factor in discomfort sensation; and (b) percent loss in visibility due to D. V. B. (disability veiling brightness).

To show this control of candlepower, representative and uniformly spaced driver eye-level positions are designated along longitudinal roadway lines. The inclined planes and radial lines extend from the luminaire light center down to the eye-level positions. The relative candlepower toward eye-level positions shows the control.

Eye-level candlepower data such as these have not previously been generally available.

REPRESENTATIVE ROADWAY LAYOUT FOR EYE-LEVEL CANDLEPOWER

The candlepower to eye-level data shown in Figure 6 pertain to the luminaires to the left of the driver-observer's path (Fig. 7). As the latter shows, another set of luminaire candlepower data is required for the effect of luminaires at the driver's right. The combined discomfort and disability effect of several luminaires is calculated for each of the dynamic series of driver-observer positions.

DISABILITY VEILING BRIGHTNESS

As the driver proceeds along the roadway the combined percent loss in visibility due to disability veiling brightness varies with driver-observer movement along the roadway (Fig. 8). The fluctuation is due to control of luminaire candlepower, viewing distance from each luminaire, viewing angle, and the top-of-auto-windshield cutoff. The longitudinal average loss in visibility is 21. 5 percent. The maximum-to-average ratio is 1. 67 to 1. The maximum loss occurs when the driver-observer is approaching luminaires on his right, such as No. 2 or No. 4, just prior to top-of-auto-windshield cutoff. The percent loss is for a driver traveling 25 to 40 mph (by Reid-Chanon data). The indications were that the fluctuations cause slightly greater visibility losses at higher speeds.

RELATIVE VISIBILITY VARIES ALONG ROADWAY

The combined net relative visibility produced by the lighting system varies with driver viewing position (Fig. 9). Note the correlation between minimum visibility roadway distance stations and the driver-observer position for maximum loss due to disability veiling brightness (Fig. 8).

The plus visibility is produced by the brightness contrast of targets against a series of roadway stations at 7-MH viewing distance from the driver. Visibility at each roadway station distance is the transverse average of relative visibility at locations along the two representative roadway lines (0. 5 MH and 1. 5 MH). The relative visibility rating for the lighting system is a longitudinal average of 1. 84. The ratio of average to minimum visibility is 1. 11 to 1.

AVERAGE BRIGHTNESS FOR THREE FACTORS

Longitudinal average figures for each of three factors resulting in a net relative visibility rating for a representative roadway lighting system are shown in Figure 10. The transverse average of the pavement brightness and that for obstacle brightness are actually combined at each station for visibility at each station, then reduced by the

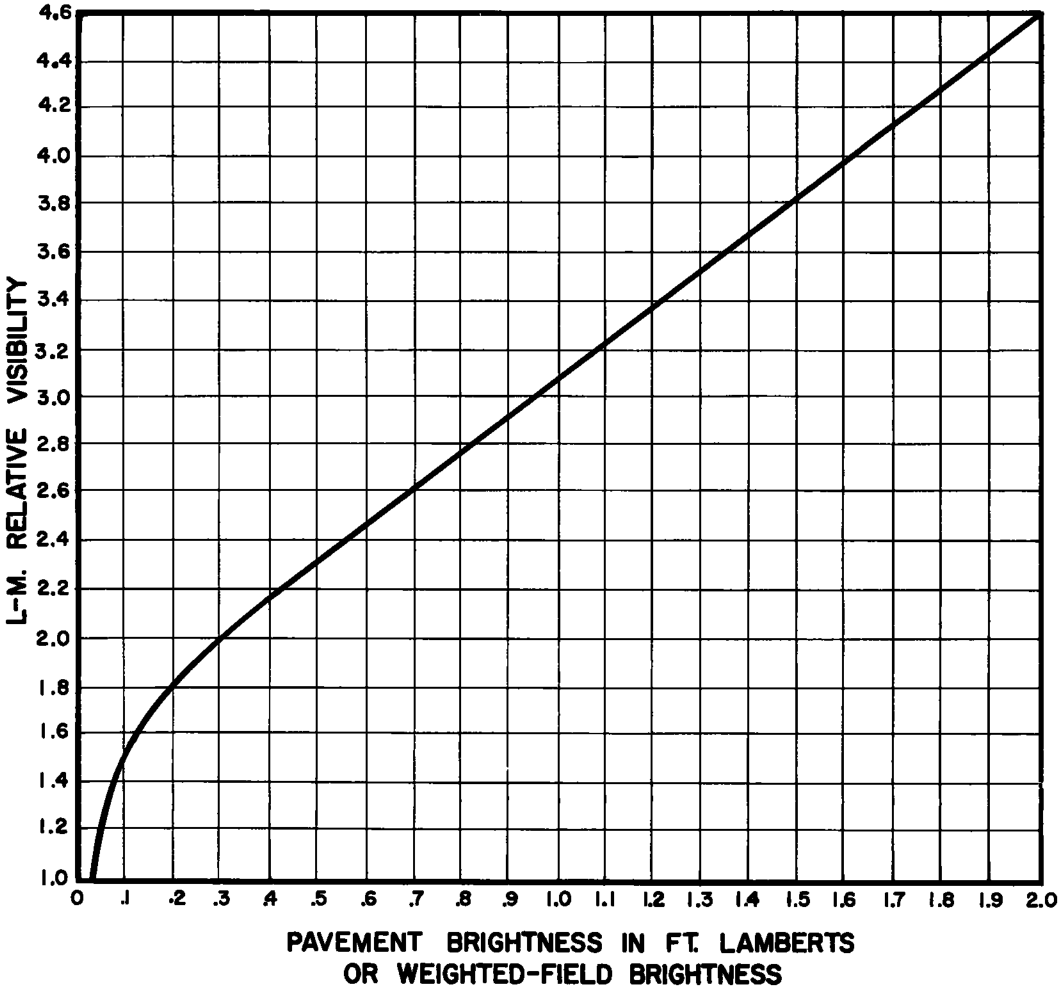

Figure 11. Relative visibility rating produced by pavement brightness or weighted field brightness.

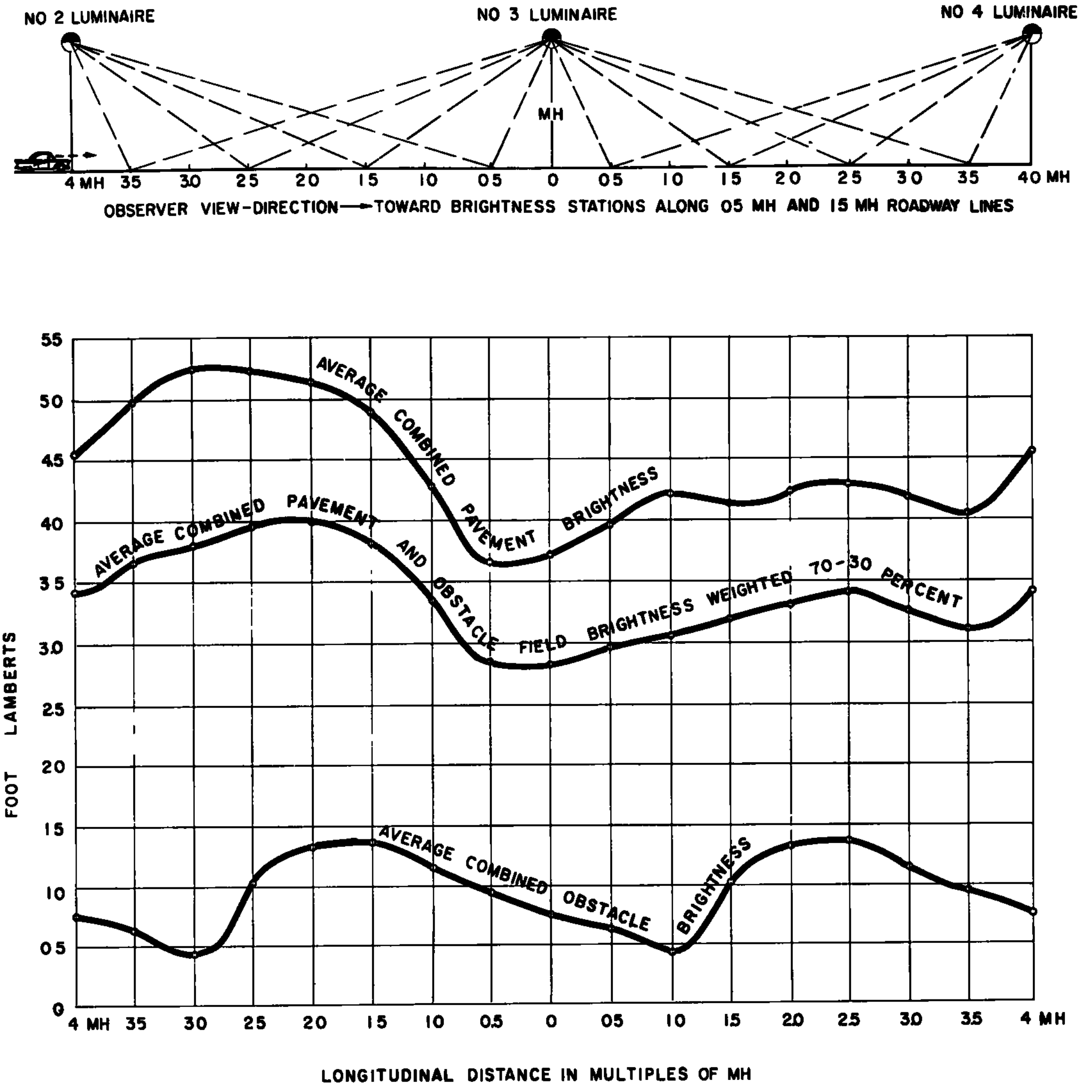

Figure 12. Variation of average combined pavement brightness, average combined obstacle brightness, and field brightness.

percent loss in visibility at each station due to D. V. B. As shown by Figure 10, pavement brightness is one of the principal plus factors in visibility.

RELATIVE VISIBILITY INCREASE WITH PAVEMENT BRIGHTNESS

The relative visibility rating produced by pavement brightness, or weighted field brightness, is shown in Figure 11. The weighted field brightness, for example, may consist of pavement brightness and obstacle brightness, weighted 70 and 30 percent, respectively. The relative visibility is as measured and in accordance with the scale of the Luckiesh-Moss Low-Range Visibility Meter. The field and laboratory correlation of relative visibility with pavement or field brightness is as described by Reid and Chanon.

PAVEMENT AND OBSTACLE BRIGHTNESS

Figure 12 shows variation in the average combined pavement brightness, the average combined obstacle brightness, and the field brightness. At each longitudinal distance the brightness at stations along the 0.5-MH and 1.5-MH roadway lines are averaged transversely. The field brightness at each station is weighted 70 percent pavement brightness plus 30 percent obstacle brightness. Longitudinally the pavement brightness averages 0.442 ftL (see Fig. 10).

The combined pavement brightness (Fig. 12) is based on Reid-Chanon brightness data rearranged for the 0.5-MH and 1.5-MH roadway lines. The pavement brightness data are for asphalt. The sample tested had been in service for eight years. The over-all reflectance was 8 percent.

The combined obstacle brightness for stations along the two roadway lines is based on an obstacle or target having a diffuse reflectance of 8 percent. The longitudinal average obstacle brightness for the system is 0.096 ftL. The ratio of average-to-minimum obstacle brightness is 2.2.

The transverse average of brightness at two pavement stations along the 0.5-MH and 1.5-MH roadway lines is combined with the obstacle brightness at the two target locations at longitudinal distance 1-MH closer to the observer.

One of the variables in seeing rating is the range of light reflection or brightness from the pavement surface. Modern roadway lighting uses special design techniques to produce good seeing with typical traffic-used pavement surfaces. However, some improvement in seeing usually may be obtained by special treatment of the pavement surface for favorable light reflection characteristics.

INCLINED PLANE CANDLEPOWER TO PAVEMENT LEVEL

The new inclined plane candlepower curves provide data extending to pavement level (Fig. 13). This shows the plus factor build-up and proportioning of luminaire candlepower for visibility along the 1.5-MH longitudinal roadway line. From specified driver-observer viewing position distances, variations in pavement brightness and obstacle brightness from specific surfaces will be proportional to variations in candlepower. The brightness resulting from several candlepower distributions, such as this along two roadway lines, are combined (Fig. 14) to represent a system of several luminaires.

Such new inclined plane candlepower distribution curves, which provide the essential

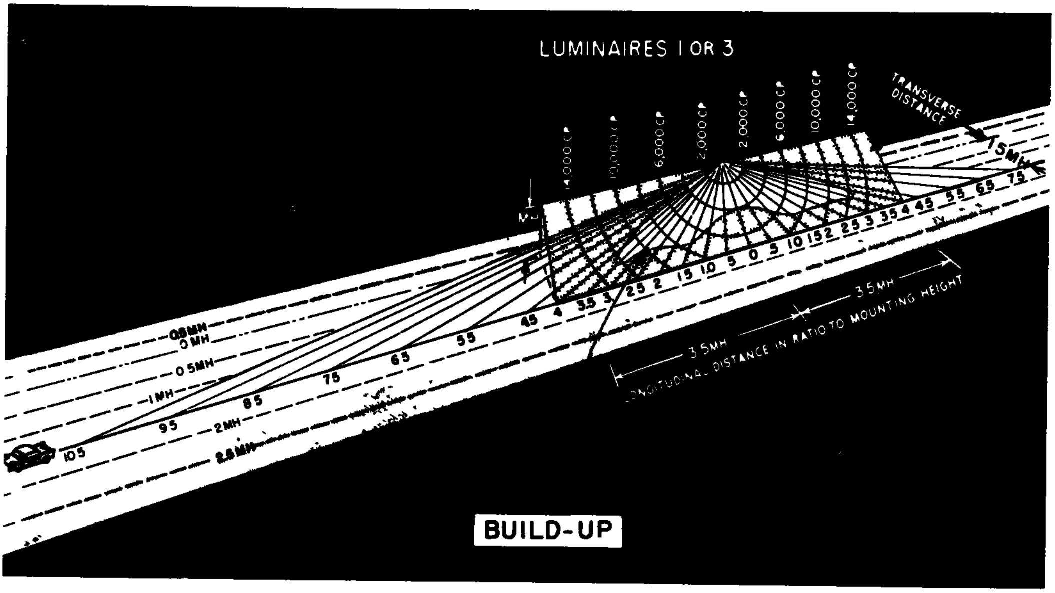

Figure 13. Plus factor build-up and proportioning of luminaire candlepower for visibility along 1.5 MH longitudinal roadway line, as shown in new inclined plane light distribution curves.

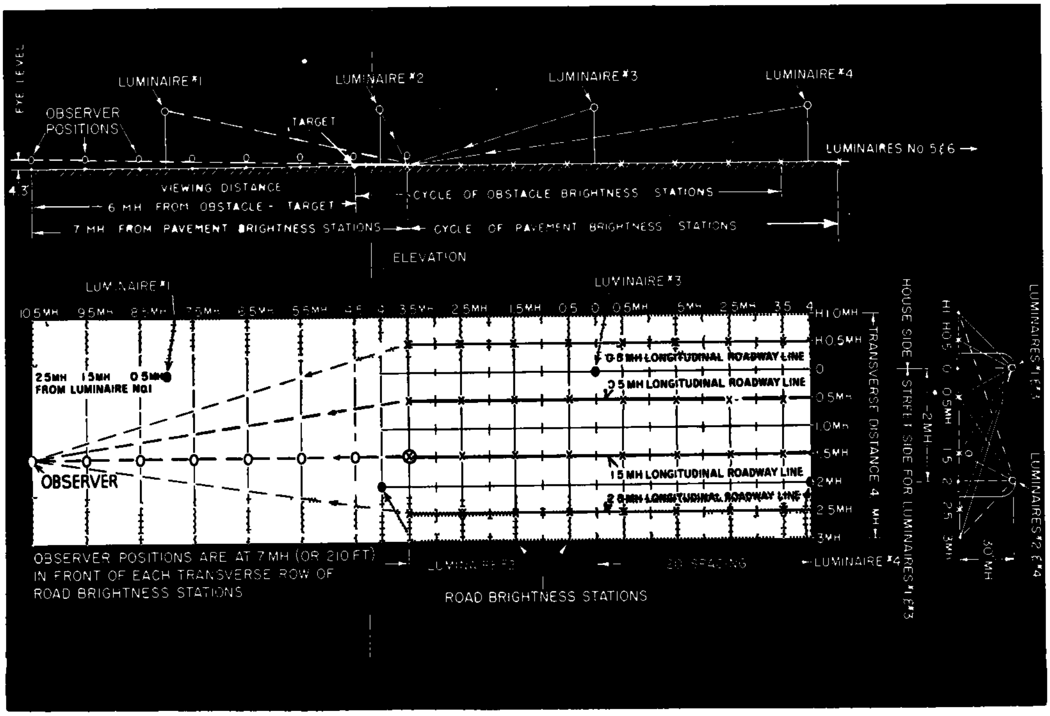

Figure 14. Representative roadway and lighting layout and conditions for calculation of relative visibility.

luminaire performance data, have long been needed to show the buildup of pavement level candlepower for both pavement brightness and obstacle brightness producing visibility. This is shown by the proportioning of candlepower in the inclined plane extending from the luminaire light center down to representative, uniformly spaced, pavement level stations. The pavement brightness or obstacle brightness at a station, such as 3 MH, is proportional to the candlepower when other conditions, such as viewing angle and pavement surface reflection, are constant.

Hence, inclined plane candlepower curves are independently useful. The brightness produced at a series of stations along a specific pavement surface will increase or decrease in proportion to an increase or decrease in the candlepower incident thereto. This assumes constant angles of driver-observer viewing. The effectiveness of different candlepower distribution in such inclined planes may, if desired, be compared directly, without the necessity of the customary intermediate brightness computations.

REPRESENTATIVE ROADWAY LAYOUT FOR VISIBILITY

The representative roadway and lighting layout and conditions for calculation of relative visibility is shown in Figure 14. The pavement brightness is a major factor. Hence, the pavement brightness stations are considered basic reference points. For example, the visibility at stations at 3. 5 MH longitudinal distance in front of luminaire No. 3 is correlated with the obstacle brightness at 4. 5 MH; this contrast produces visibility which is reduced by the D. V. B. percent reductions in visibility 7 MH ahead of the pavement brightness station or at 10. 5 MH front of luminaire No. 3 (2. 5 MH in front of luminaire No. 1.)

For the representative lighting layout 120-ft (4 MH) staggered longitudinal spacing and 60-ft (2MH) transverse distance between luminaires has been adopted. The method for calculating seeing factors is adaptable to other spacings in multiples of the 0. 5 MH (or 15 ft) actual distance between pavement brightness stations.

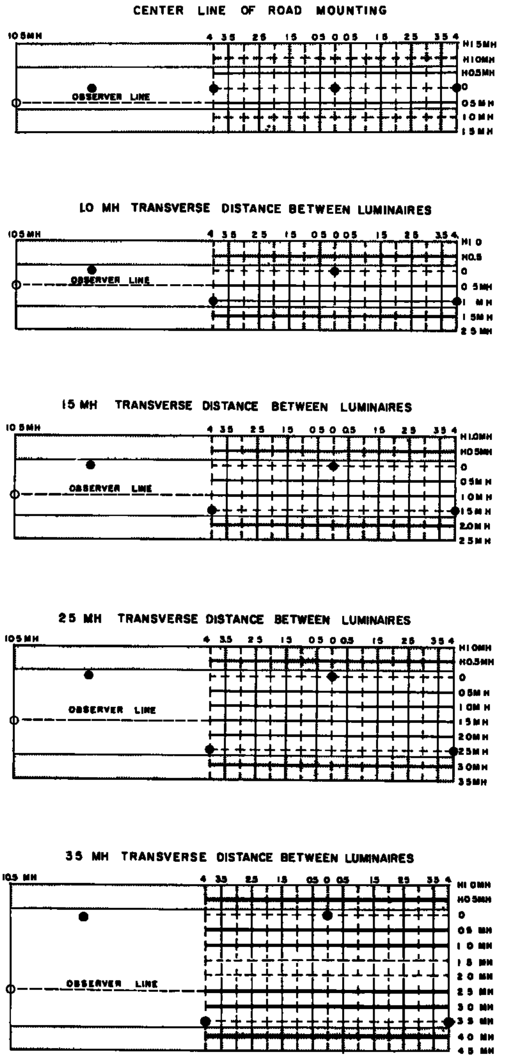

Figure 15. Representative layouts of roadway lines, and driver-observer eye position lines, which will be used in rating factors in seeing with roadway lighting.

The two longitudinal roadway lines, 0.5 MH and 1.5 MH, are assumed to be representative of the traffic-used pavement areas of the typical roadway.

The road brightness stations designated "X" might be typical of those used for field measurement of pavement brightness. However, the pavement and obstacle brightness data have been calculated at longitudinal intervals of 0.5 MH up to distances of 10.5 MH from each luminaire and then combined for the system. At distance of 7 MH (about 210 ft) the driver viewing angle with respect to the pavement surface is about 1.2 degrees. The brightness at this pavement station is contrasted with the brightness of the vertical mid-portion of a 1-ft target or obstacle at a viewing distance of 6 MH. This relative comparison of 6-MH vs 7-MH longitudinal obstacle-pavement brightness is also useful in field testing.

The pavement and obstacle brightness at each of the longitudinal roadway stations shown in Figure 14 is a transverse average of the combined brightness at the respective station distances along the two longitudinal roadway lines, 0.5 MH and 1.5 MH.

The brightness results from incident candlepower from luminaires along both sides of the roadway. The candlepower from each luminaire is derived from inclined plane candlepower distribution curves. Only two such candlepower curves are required for the pavement brightness along the two roadway lines 1.5 MH and 0.5 MH.

AUTOMOTIVE DATA HELP

The 4.3-ft eye-level height is based on 51.7-in. average driver eye height in 25 makes and models of American cars, as of June 1955, according to information supplied by T. J. Carmichael, Engineering Staff, General Motors Corporation Technical Center, Detroit, Michigan.

As indicated in the illustrations, the data are based on top-of-auto-windshield cutoff of the brightness from luminaires at distances closer than 3.3 MH. This is approximately the distance at which the vertical angle of 76 degrees intercepts the driver's eye-level line, as indicated by data available on 1955 cars. This reduces the average luminaire brightness (discomfort) and disability veiling brightness in the driver's eyes even though it is also partly responsible for the peak fluctuations.

The luminaire light distribution used is hypothetical. Except for an increase of each candlepower value by 2.5, this over-all light distribution is similar to that shown in the isocandle diagram (Fig. 15) as given in the Appendix, "American Standard Practice for Street and Highway Lighting 1953."

For information with regard to roadway lines, distance in relation to MH (mounting height) and the 4 MH (120-ft) staggered spacing refer to "American Standard Practice for Street and Highway Lighting" approved February 27, 1953, A. S. A.

SEEING RATINGS FOR TYPICAL ROADWAY LIGHTING LAYOUTS

The I. E. S. Sub-Committee on Roadway Lighting is currently using this method of calculating and rating the seeing factor effectiveness of typical major classifications of roadway lighting and layout, as shown in Figure 15. These ratings may then be compared with average and minimum horizontal footcandles currently prescribed by the "American Standard Practice for Street and Highway Lighting."

Street and Highway Lighting. The user may then compare the seeing factor ratings derived for these examples with his own roadway layouts. Estimates of seeing factor performance may thus be obtained by interpolative judgment with maximum simplicity.

Such simplifications will be welcomed by everyone, including those who may now find it difficult to interpolate between (a) the footcandle levels now prescribed by "American Standard Practice" and (b) the seeing effectiveness desired from a roadway lighting system.

One of the general objectives of the I. E. S. Sub-Committee is to provide a basis for the evaluation of roadway lighting in accordance with the driver's desire and experience. This Sub-Committee now comprises: P. B. Clark, Line Material Co.; W. H. Dorman, Corning Glass Inc.; W. H. Edman, Holophane Co.; M. E. Keck, Westinghouse Electric Co.; H. E. Wall, City of Detroit, P. L. C.; F. D. Wyatt, Consulting Engineer; J. Young, New England Power Service; and Charles Rex, Chairman, General Electric Company.

Ex-officio members include G. K. Glass, Detroit Edison Co.; D. W. Rowten, Westinghouse Electric Co.; and T. J. Seburn, Yale Bureau Highway Traffic.

FIELD MEASUREMENT OF SEEING FACTORS

At Detroit and other locations field measurements are being made of seeing factor ratings under typical roadway lighting installations.

At the University of California Institute of Traffic and Transportation, Prof. D. M. Finch has a new visibility meter under development which may have some advantages over the Low-Range Luckiesh-Moss Meter. He is also investigating three-dimensional targets and other techniques in the measurement of seeing factors. This work has been sponsored by the Illuminating Engineering Research Institute.

Dr. Sylvester K. Guth, Director of Vision Research for the Nela Park Lamp Department, has suggested and is developing a promising and practical device for field measurement of comfort thresholds under roadway lighting. This he calls a "comfort meter box." It is of constant area, with variable brightness, and may be mounted in front of a driver-observer for a calibrated brightness comparison with the brightness of luminaires in the field of view. The equivalent brightness of the controlled and calibrated "box" glare source may provide a "figure of merit" for comfort under roadway lighting.

Dr. Glenn A. Fry of Ohio State University is developing a meter which will integrate and record the total disability brightness in the normal field of view. It is hoped that this device, mounted on an automobile, may provide a quick recording of the disability veiling brightness along representative driver paths under roadway lighting.

SUMMARY

Action for "open after dark" operation of the nation's motor vehicle transportation system must be accelerated. Really significant progress involves acknowledgment of the economic and social benefits to be gained. Progress also depends upon realization of personal accountability to protect and enhance the over-all welfare of the people.

Night usefulness and value of streets and highways depends upon lighting. Although some critical and heavily-traveled sections of roadway have been lighted, more will be properly lighted, the extent depending upon the concentrated attention devoted to night traffic operations. The extra effort is small compared with the importance of the objectives and benefits to be gained.

This paper presents the work of only a small group of engineers and technicians in an area in which the active interest of many is essential. Moreover, it is an effort to interest and implement night traffic progress, both now and in the immediate future.

Observations, appraisals, estimates, and evaluations of the traffic and seeing effectiveness of roadway lighting may not require number ratings any more than that which is obvious. However, as an additional future aid "figures of merit" will be provided.