

## REPORT OF COMMITTEE ON NIGHT VISIBILITY

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### SYNOPSIS

The objectives of the Committee are: (1) To assemble results of researches in the whole field of night seeing and to determine wherein additional researches are needed; (2) To encourage organizations and persons fitted to do so to conduct needed researches on subjects relating to night visibility; and (3) To coordinate and bring to public attention, results of researches on night visibility.

A selected bibliography on night visibility subjects has been completed in tentative form by the library staff of the Highway Research Board at the request of the Night Visibility Committee.

A list of subjects for researches has been prepared and sent to a number of institutions where such researches might be conducted.

The Committee reports its discussion to date and states its plans for further study. Subjects under scrutiny are:

*Headlight Dimming or Depressing*—Some 44 states have statutes requiring that headlights be dimmed or depressed. A study in Connecticut showed that 6.2 percent of the operators ignored the dimming requirement of the Connecticut law. A study in New Jersey involving approximately 500 drivers showed that over 11 percent of the total vehicles met did not dim or lower their lights.

*Use of Colored Eyeglasses for Reducing Glare*—The Committee feels that further research on this subject is warranted. A Bureau of Standards report states in part: "Tests by a number of observers indicate that there is some basis for claims of increased visibility and reduction of glare through this type of glass."

The French have passed a law requiring yellow in headlighting. General Electric Company tests of tinted night driving eyeglasses showed that with opposing glare, identical seeing distances were found with and without the glasses, and that without opposing glare there was a reduction of seeing distance with the glasses.

*Highway Lighting*—The extent to which darkness alone contributes to the higher accident rate at night is not known. One of the questions remaining is when to use incandescent lighting and when it is advisable to use mercury, sodium, or possibly fluorescent lighting. A special subcommittee prepared a statement concerning conditions under which each of the four types of lighting might well be used which is being reviewed by the Committee.

*Roadway Delineation*—Phases of roadway delineation by use of spaced reflectors requiring further investigation are: (1) the effectiveness of delineators in highway accident reduction; (2) methods of testing the optical performance of "reflex" or "retrodirective" reflectors; (3) the place of roadside delineation and of fixed roadway lighting.

*Polarized Motor Vehicle Headlighting*—Little progress seems to have been made during the past year on the subject. The developers of polarized headlighting say their product is technically ready for adoption. The automobile manufacturers have recommended against its adoption at this time. The matter seems to be on "dead center." It is hoped that the Committee on Night Visibility can develop some plan which will help get worthwhile new action.

The Committee will concentrate now on advancing its clear-cut objectives. Special emphasis will be placed on getting qualified agencies and persons to conduct needed researches for later reporting through the Committee. The selected bibliography and priority list of recommended research projects will be useful in encouraging researches.

The Committee on Night Visibility is new growth of the 10-year-old Committee on in name and scope of activity. It is an out-Highway Lighting. It was increasingly real-

ized with the passage of years that a committee established to encourage, sponsor and report on researches in only one phase of the whole night visibility problem had undesirable limitations. Important as fixed roadway lighting is, the question of night traffic accidents and the efficient use of streets and highways at night involves numerous additional visibility questions—many warranting research. The entire question of night seeing comes within the purview of the Committee on Night Visibility as now conceived.

An exploratory meeting was held in July to which were invited members of the former Committee on Highway Lighting plus some 25 additional persons believed to be interested in the other phases of night seeing. A majority of the new people attending the meeting have since been invited to serve as members of the Committee on Night Visibility. A number have already made encouraging contributions.

Objectives of the committee, briefly stated, are:

1. To assemble results of researches in the whole field of night seeing and to determine wherein additional researches are needed, with due consideration of desirable priorities among such researches.

2. To encourage organizations and persons fitted to do so to conduct needed researches on subjects relating to night visibility.

3. To coordinate and bring to public attention, results of researches on night visibility.

Two basic committee activities warrant reporting upon at this point. They are:

*Bibliography of References on Night Visibility*—It was agreed that one of the first staff jobs should be the preparation of a selected bibliography on night visibility subjects. This has been completed in tentative form by the library staff of the Highway Research Board at the request of the Night Visibility Committee, and will be reproduced for general distribution as soon as committee members agree upon a sufficiently complete list. As a result of committee discussion this week, annotations will be prepared for a sample portion of the listings, to enable the committee members to decide whether limited descriptive text is desirable for all listings.

*List of Night Visibility Research Projects*—A list of subjects for researches was prepared as a result of proposals made by those participating in the July meeting. After distribution among committee members, the list was sent to a number of institutions where such researches might be conducted. Suggested research subjects are now being rated by committee members for the purpose of establishing recommendations as to priorities for research work.

RESEARCH SUBJECTS REPORTED ON AND  
DISCUSSED AT DECEMBER 6, 1948  
MEETING

At a meeting of the Committee held Dec. 6, 1948 during the 28th Annual Meeting of the Board, several research subjects were reported on and discussed. The following is a brief record concerning each:

*Headlight Dimming or Depressing*—One function which the Committee believes it should perform is educational—indirectly, to be sure, since this is a research committee. The development of facts for educational use in getting greater compliance with headlight dimming laws was considered one proper function of the Committee. The Committee is, therefore, assembling research data which will help meet this objective.

Some 44 states have statutes requiring that headlights be dimmed or depressed. The Committee believes that it is desirable for the states to ascertain the extent to which headlight dimming is practiced, as a basis for determination as to their program for improvement. The Committee is gathering such information as it becomes known.

The most extensive study that the Committee knows of is a study made by the Traffic Division of the Connecticut State Police in December 1947. The whole personnel of the Traffic Division was engaged in this study for one month. 152,097 cars were observed, principally on state highways. There apparently was no distinction made as to whether or not approaching cars already had their beams depressed. Of course, under such conditions no evidence was obtained as to whether or not those motorists would have depressed had they been on the high beam.

In general, better observance was noted on rural roads where traffic was lighter and the

need for dimming was more obvious. In urban areas, more drivers were traveling continuously on the lower beams. The few of those who were on high beam and who were checked stated that they were not aware they were on the high beam, due presumably to the effect of street lighting.

The Connecticut study showed 9822 violations with 350 others listed as possible violators. Thus, 6.2 percent of the operators ignored the dimming requirement of the Connecticut law which is that drivers must depress their headlight beams when within 500 ft. of an oncoming vehicle. In addition, 0.2 percent may not have dimmed, making a total of 6.4 percent. While this is a small percentage, Police Commissioner Edward Hickey pointed out that pro-rated it would mean that in the State there would be some fifty to sixty thousand violators. Hence, a vigorous campaign on headlight beam depressing has been in effect in Connecticut ever since.

On the Merritt Parkway, 25 to 30 percent did not depress. Apparently this is partly because of the high speed, there being other indications that motorists are less likely to depress when they are traveling rapidly. Another factor on the Merritt Parkway was the presence of the medial strip which drivers believe reduces the need for depressing.

The Connecticut report has much other valuable information in it, including an interesting classification of seven kinds of drivers as regards headlight use.

A much less extensive study was made in New Jersey involving approximately 500 drivers. The purpose was to determine the proportion of motorists who "approached and passed . . . a point of observation and failed to use their low beam headlights at least while in what was considered to be the effective zone of influence." The "effective zone of influence" used was a distance of from 1,000 to 1,200 ft. in front of the vehicle occupied by the observers. Observations were made on a four-lane concrete highway having isolated highway lighting units located chiefly at major intersections, and having a 12 ft. medial strip. The medial strip consisted of an 8-ft. grass strip and a 2-ft. sloping, reflectorized, white curb on each side. Observations were made from both standing and moving positions.

Results showed that over 11 percent of the total vehicles met did not dim or lower their lights. Approximately 83 percent of the vehicles approaching were already driving on the lower beam and, therefore, had no occasion to change the beam arrangement. Of those vehicles which entered the effective zone of influence with upper beams, two-thirds failed to dim.

While the number of observations in New Jersey was relatively small and the results apply only to four-lane divided roadways with presumably rather heavy traffic, the results are still significant. The identification of those drivers who are already on the lower beam as they approach, is very worthwhile and should be included in future studies.

#### *Use of Colored Eyeglasses for Reducing Glare—*

The need to reduce or eliminate the discomfort and hazard of glaring headlights is obvious, not just to traffic and transportation technicians but to the general driving public as well. Thus far, almost all devices commonly advocated for this purpose accomplish glare-reducing results at the expense of ability to see.

Recently a number of companies have placed on the market colored glasses which are purported to protect against headlight glare. Most of these are yellow or yellowish. A number of specialists have held the view that little, if any, further research was needed on this matter because the use of any colored glasses at night was detrimental and hazardous, and hence, that the practice of selling colored glasses for glare protection should be condemned.

Further inquiry, instituted primarily after reviewing a report on the subject published by the National Bureau of Standards, developed the thought that the door should not be closed on further research, but that further investigations should be made. The Bureau of Standards report does not specifically recommend the use of yellow glasses for night driving but states in part: "Tests by a number of observers indicate that there is some basis for claims of increased visibility and reduction of glare through this type of glass."

Committee member Mr. J. H. Hunt reported that the French had passed a law requiring yellow in headlighting and had proposed yellow as an international standard

color for automobile headlamps at a meeting in The Hague this year. The proposal was not followed, but the fact that the French felt justified in specifying yellow indicates that further study of this whole matter is desirable.

Mr. Val Roper, General Electric Company, submitted results of some preliminary tests of tinted night driving eyeglasses using observer-drivers on the highway. With opposing glare, identical seeing distances were found with and without the glasses using dummy pedestrians as test obstacles. Without opposing glare there was a reduction of seeing distance with the glasses. Tests are being continued comparing white and amber light from the headlamps. Thus far, it is reported, results confirm previous experience which showed no advantage to the use of amber.

These varied preliminary researches lead to the conclusion that further study of the use of colored glasses is justified. A subcommittee was authorized for this purpose.

*Highway Lighting*—Records show that motor vehicle accident rates based on miles of travel are much higher at night than in the daytime. There are several reasons for the abnormal after-dark hazard. There is more drinking at night, and the use of intoxicants by motorists and pedestrians is an important factor in night accidents. There is more fatigue at night, and there is undoubtedly more careless and irresponsible driving. Yet the National Safety Council's Committee on Night Traffic Hazards states that "lowered visibility seems to be the major difference in the hazards of night and day driving." All aids to visibility at night—including vehicle headlights, pavement striping, delineators, reflectorized warning signs, pavement surfaces of favorable reflectance, as well as street and highway lighting—warrant careful study by federal, state, county, and city officials whose duty it is to provide an effective program for traffic safety at night as well as during the daytime.

Such officials may ask what conditions justify the expense of lighting on highways. This is a proper and important question. A dozen years ago the Committee on Highway Lighting, predecessor of this Committee on Night Visibility, attempted a comprehensive program of research directed to a specific

answer, particularly in regard to the effect of lighting on night accidents. The program in its original concept had to be abandoned because the required financing and man-power were not available. Instead, the Committee has attempted to assemble all data available on the accident experience where lighting has been installed on highways.

These data cannot be considered conclusive, for several reasons. Often the accident reports have not been complete, and the total amount of data is meager, particularly when one attempts to make an analysis by roadway types and traffic conditions. Nevertheless the data are generally indicative that lighting, selectively applied on heavily traveled and hazardous portions of highways, has substantial safety value. In New Jersey, for example, fatal accidents on all roads throughout the state including state highways during two years following selective lighting of a total of 115 mi. were approximately one-third less than during the two years preceding the lighting. As another example, when Bayshore Highway, south of San Francisco, was lighted the accidents per million vehicle miles dropped approximately one-quarter and the fatalities per million vehicle miles dropped more than one-half, comparing two years following with two years preceding the lighting. These and other data on highways where lighting has been selectively applied are in conformance with the extensive experience that lighting on urban streets has substantial value in safeguarding and expediting traffic.

It is widely believed that driving is not only safer on a properly lighted as compared with an unlighted highway, but that driving on properly lighted roadways is more pleasant and less tiring. Discomfort from glaring headlights is less.

Another of the questions remaining, at least among highway designers and builders, is when to use incandescent lighting and when it is advisable to use mercury, sodium, or possibly fluorescent. A special subcommittee consisting of Mr. Kirk Reid, Mr. C. N. Conner, Mr. John Biscoe and Mr. J. L. Shotwell prepared a statement concerning conditions under which each of the four types of lighting might well be used. This is being reviewed by the committee.

*Roadway Delineation*—Various phases of roadway delineation by use of spaced reflectors have been proposed as subjects which should come within the purview of this committee. Among these are three which the Committee considered at its December sixth meeting: (1) the effectiveness of delineation in reducing motor vehicle accidents, (2) the optical testing of reflectors, and (3) the relative fields of appropriate use of delineation and highway lighting.

1. *Effectiveness.* One of the most complete studies which has been made available to the Committee on the effectiveness of delineators in highway accident reduction was made by the Michigan State Highway Department just before the war—on 70 mi. of U. S. 16 between Detroit and Lansing and on U. S. 24 between the Ohio State line and Pontiac. Double-faced delineators were mounted on both sides of these highways. This study involved accident record analyses covering a period of four years—two years before the installation of delineators, and two years after.

Results showed that “the special hazards of nighttime driving were reduced from 20 to 25 percent after the installation of delineators.” Comparisons of records on delineated highways in Michigan with those not delineated but having essentially the same physical and traffic characteristics further substantiated the beneficial effects of delineation.

Other data are being sought.

2. *Testing Methods.* Committee discussion showed very clearly that there is urgent need for further research work relative to methods of testing the optical performance of “reflex reflectors” or “retrodirective reflectors.”

Committee member Mr. Ray Teele, of the National Bureau of Standards, made a very interesting report at the December sixth meeting on retrodirective reflector work at the National Bureau of Standards. Among other points, his report brought out that retrodirective reflectors can be satisfactorily used with polarized headlighting. The adverse effect of wetting the surfaces of certain reflectors was brought out. It was pointed out that measurements are being made of the specific intensities of reflected light from various commercial reflective devices and materials.

Several different laboratory methods are

currently in use. Because they differ in various ways, the results differ and there is no present basis for correlating results from different laboratories. The differences are not slight but are relatively very large, though this does not mean that any of the tests are inaccurate or unsatisfactory.

It would, however, be very worthwhile to secure agreement on a method of testing. The method should be one which will give consistent results, will cover an adequate angular range of the incident beam of light to the face of the reflector suitable to cover the range of effectiveness needed in driving on the highway.

The Society of Automotive Engineers publishes a test procedure for reflex reflectors in the SAE Handbook. A report on the subject of reflector testing is expected from the University of California. These will be studied by the Committee in seeking bases for a recommended standard method.

Another serious problem is that many of the purchasers of reflectors do not have facilities for making proper tests—or it may be said that the present test methods are too complex for purchasers' limited testing equipment and personnel to handle. Furthermore, many purchasers are not financially and otherwise able to have such tests made by private laboratories. They face the practical problem of assuring themselves of getting satisfactory reflectors. This subject is believed by the Committee to warrant prompt attention.

One part of the answer might consist of accepting as satisfactory, types of reflectors which competent laboratory studies have shown are fundamentally sound in design.

Another practical problem remains of checking whether the quality of the reflectors being received, is satisfactory. Interested committee members have agreed to prepare recommendations on how the average purchaser can protect himself as to this matter. One way may be to use a test reflector of the make being purchased which a proper laboratory has certified as being of satisfactory minimum brightness value. Then a sampling of the purchased reflectors could be rather simply compared to the test specimen and if they were at least as bright, the reflectors would be accepted.

Another idea involves using a reflector of standardized brightness and a series of filters

as a basis for visual comparison as to percentage of brightness of a reasonable sampling of the purchased reflectors.

3. *The Place of Roadside Delineation and of Fixed Roadway Lighting.* It was pointed out to the Committee that federal, state and local highway officials would be aided if they could have the benefit of the thinking of best informed persons as to the appropriate utilization of roadside delineation and of fixed roadway lighting. It was fully realized that various researches should be made before any final conclusions on this subject could be prepared. However, it was believed that it might be possible to prepare some guiding material which would have substantial value. With this hope in mind, the following committee was appointed at the December sixth meeting to prepare such a statement or guide: Chairman, Mr. Earl Osterhoudt; Messrs. E. P. Davis, Howard Ilgner, Kirk Reid, and C. F. Post.

*Polarized Motor Vehicle Headlighting*—The papers presented at the Highway Research Board's 27th Annual Meeting in December, 1947 on polarized headlighting, the discussion which followed the presentations, and the interest which is apparent among the general public leave no doubt as to the importance of this phase of the problem of night driving and the elimination or reduction of headlight glare. Technical and historical background can be obtained by reading Highway Research Board *Bulletin 11*, entitled "The Polarized Headlight System," which contains papers presented by Dr. Edwin H. Land of the Polaroid Corporation, Mr. J. H. Hunt representing the Automobile Manufacturers Association, and Mr. Val J. Roper of the General Electric Company.

Little progress seems to have been made during the past year on the subject. The developers of polarized headlighting say their product is technically ready for adoption. The automobile manufacturers have recommended against its adoption at this time. The automobile manufacturers' Engineering Liaison Committee indicated, however, that

it "would be glad to study in cooperation with the motor vehicle administrators any new developments which may promise to make the introduction of polarized headlighting, at some later date, a worthwhile venture in the interest of public safety."

The matter seems to be on "dead center." It is hoped that the Committee on Night Visibility can develop some plan which will help get worthwhile new action.

One technical objection was dealt with in a report presented at the December sixth meeting by Lewis Chubb of the Polaroid Corporation. This deals with the haze-lighting factor which in all but very clear atmospheres indicates an oncoming car where its headlamps are hidden by curve, hill crest or dip. With the polarized headlamp and viewer in use, this warning haze-lighting virtually disappears. Mr. Chubb's paper, which is now before the committee for consideration, describes a method which the Polaroid Corporation believes, as a result of tests, will provide a reasonable answer to the problem. A question raised in the Committee meeting as to the suitability of the proposal leads to the hope that further tests will be made in the year ahead.

#### COMMITTEE PLANS FOR THE FUTURE

The December sixth meeting of the Committee was very well attended and very encouraging interest was shown in the Committee's work. Acceptance of the position of Committee Secretary by LeVerne Johnson means that new energy will be brought to the Committee's work.

The Committee will concentrate now on advancing its clear-cut objectives. Special emphasis will be placed on getting qualified agencies and persons to conduct needed researches for later reporting through the Committee. The selected bibliography and priority list of recommended research projects will be useful in encouraging researches. The outlook is decidedly good. Already a paper has been promised on the application of fundamental principles of seeing to night visibility by Mr. E. P. Bone of the Committee.