

ROADSIDE DELINEATION CONCEPTS: A NATIONAL STUDY

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The need for national, uniform designs and applications of roadside delineation has long been recognized by traffic authorities. A comprehensive study was, therefore, undertaken to obtain a better understanding of present practices of roadside delineation and to further establish criteria for the selection of an optimum roadside delineation treatment at a given condition. In this study, an extensive literature review and a national survey of all state highway departments were conducted to form a state-of-the-art summary of roadside delineation concepts. Attempts to formulate a uniform selection process for roadside delineation treatments involved discussions of evaluation criteria and presentation of a suggested selection program. The results of this study provide updated and thorough knowledge of existing and proposed roadside delineation techniques.

●WHAT is it that causes night driving to be so hazardous? It has been found that more than 50 percent of night accidents can be directly attributed to poor roadway visibility. A large percentage of all night traffic accidents are single-car accidents that occur when the vehicle runs off the road. Those accidents are the result of complex interactions among vehicle design, visibility, and other design characteristics of the roadway.

Daylight delineation of the roadside can be accomplished with reasonable satisfaction by using currently available materials and methods. Night roadside delineation, however, requires an entirely different approach and frequently leaves much to be desired. ReflectORIZED materials of various types have been used with considerable success. Those materials best serve their intended purpose when properly placed. Even when properly placed, many of the present materials will not function adequately on a wet night.

The two most common forms of roadway delineation are the post-mounted delineator and the pavement-level markings with paint or raised pavement markers. Post delineators of various forms have gained wide acceptance throughout the country as a roadside delineation treatment. This treatment has been recognized by the Joint Committee of the Institute of Traffic Engineers, Federal Highway Administration, and American Association of State Highway Officials. As a result, the use of delineators is authorized in the Manual on Uniform Traffic Control Devices (MUTCD) (22). The popularity of post delineators is undoubtedly due to their effectiveness both at night and during inclement weather when painted markings are ineffective.

Many reflective materials are available for increasing roadway visibility, but there is limited information concerning the effectiveness of these materials. In recent years, most of the highway delineation studies have been directed toward the physical efficiency of the materials themselves. Yet, one of the greatest needs is to specify effective uses of reflective materials. The effective use of roadside delineators depends on a number of variables such as the type of material, its self-cleaning ability, the durability of the device, the maintenance cost, and the rate and methods of application. Because guidelines do not recommend a standard installation, many highway agencies do not get optimum results from roadside delineation devices.

Traffic safety is linked directly to visibility. When a motorist has good visibility, he will also have good roadway definition. Conversely, if good roadway definition can be provided, better visibility will be realized, and that in turn should result in a reduced accident rate. Adequate visibility requires that delineators be correctly placed and illuminate efficiently. A delineation technique must be effective under all conditions, including rain and fog at night and during the day. The delineator must retain visibility under conditions of typical wear, deterioration, and dirt buildup.

The warrants and the practices regarding the application of roadside delineators vary widely among states, even among districts within a state. Delineators have been applied without regard to national standards, particularly on roadways that possess one or more of the following characteristics: metal guardrail dividers, fences mounted on raised concrete or blacktop dividers, reinforced concrete wall dividers, center island dividers with curbing, entrance and exit ramps, bridge abutments, lampposts, and road edges. These all pose a potential hazard to the driver especially since the speeds on such highways are in the 40- to 70-mph range.

STUDY OBJECTIVES

The primary objectives of this study were to review current delineation techniques, define current needs, and stimulate research and development to improve the present roadside delineation. The specific objectives of this study were to review past and present practices of roadside marking delineation, establish a standard set of criteria for the selection of roadside delineation techniques, and suggest a simple yet thorough procedure to help determine optimum roadside delineation treatments for given conditions.

PROBLEM OF INTERESTS

A literature review of the state of the art of roadside delineation techniques produced some very interesting findings. The pertinent information is summarized as follows:

1. No nationally accepted technique has been developed to evaluate the effectiveness of roadside delineation techniques;
2. Although a wide variety of raised pavement markers is being used, no single marker has been developed that is suitable for both day and night use;
3. The state highway departments do not devote particular attention to delineation but generally handle it as a part of their overall operations (the delineation task force in California is an exception);
4. Post delineators provide good advance delineation at night, especially during inclement weather, but there are questions concerning their placement with respect to curves; and
5. Driver information is a principal part of delineation treatments and falls into 2 areas—advance delineation to clearly define the driver's path and near delineation to aid the driver in his lateral placement.

NATIONAL QUESTIONNAIRE SURVEY

An opinion survey was conducted to determine more accurately the existing state of the art of roadside delineation. A survey questionnaire (Fig. 1) was sent to all state highway departments, the District of Columbia, and Puerto Rico. Of the 52 questionnaires distributed, 49 were returned. The intent of this survey was to gain a thorough knowledge of current roadside delineation practices and especially to obtain an insight into new delineation techniques. Emphasis was placed on the raised pavement marker and the post-mounted delineator. Also of importance in the survey are the comments of the highway departments with respect to the policies in the MUTCD concerning these markers. Increasing interest in the possible use of a pavement edge marker has created questions concerning the existing policies of height and placement of roadside delineators and has suggested modifications for uniformity and new delineation techniques. This survey presents the current opinion of highway departments in this area and trends related to roadside delineation.

Figure 1. Roadside delineation questionnaire.

1. Which of the following roadside delineation techniques do you most commonly employ?
 - () Post-mounted delineators
 - () Raised Pavement-edge Markers
 - () Contrasting Shoulders
 - () Lighting
 - () Painted Curbs
 - () Indirect Methods, i.e. trees, etc.
2. List any new methods and/or materials of roadside delineation in addition to the above which are employed by you.
3. What, if any, are the dominant factor(s) in the above choice(s)?
 - () Type of roadway
 - () Traffic condition of roadway
 - () Physical condition of roadway
 - () Economic
 - () Other (please specify)
4. The revised Manual on Uniform Traffic Control Devices, MUTCD, states that "delineators should be placed at a constant distance from the edge of the roadway" and spaced from 200 to 528 feet apart. "They shall be placed not less than 2 nor more than 6 feet outside the face of the curb or the outer edge of the shoulder..." Are you in agreement with this policy of delineation placement and, if not, what do you think would improve it?
5. By having a delineator at pavement level, it would be affected by both high and low headlight beams and also keep the driver's attention on the actual pavement edge rather than some four feet above it. If a maintenance problem incurred equal to or less than present delineator maintenance costs, would you accept a lower roadway delineator if it were available?
6. What is your practice for delineation along limited access highways with respect to:
 - (a) Metal guardrail dividers
 - (b) Fences mounted on raised concrete or blacktop dividers
 - (c) Reinforced concrete dividers
 - (d) Center island dividers with curbing
 - (e) Entrance and exit ramps
 - (f) Bridge abutments
 - (g) Lampposts
 - (h) Road edge
7. The revised MUTCD specifies a minimum 4 foot height for post delineators. Are you in agreement with this standard? If not, what alteration do you suggest?
8. Do you feel that delineators have value in lighted sections?
9. An expressed opinion on this topic will be greatly appreciated.

The first question of the survey related to current roadside delineation techniques and their employment by the state highway departments. The results are as follows:

<u>Technique</u>	<u>Percent</u>
Post-mounted delineators	93
Raised pavement edge markers	30
Contrasting shoulders	5
Lighting	42
Painted curbs	49
Indirect methods	3

The highway departments were also asked to indicate any new roadside delineation methods or materials or both in addition to those mentioned in the questionnaire. The following states reported additional techniques:

<u>State</u>	<u>Technique</u>
District of Columbia	Barricades, flex-posts
Idaho	Snow poles
Nebraska	Pavement grooving
Pennsylvania	Experimental raised pavement markers

<u>State</u>	<u>Technique</u>
Kentucky	"Codit" reflective paint
Utah	Flexible post delineators
Wisconsin	Flexible (spring and plastic) delineators

The highway departments were also asked to indicate the dominant factors considered in the selection of roadside delineation techniques. A summary of those factors and the order of their relative importance follow:

1. Type of roadway,
2. Traffic conditions of roadway,
3. Physical conditions of roadway,
4. Economic considerations,
5. Ambient conditions, and
6. High accident locations.

Two questions concerned specifications in the MUTCD and whether the state highway departments were in agreement or would accept substantiated modifications. With respect to the placement of the roadside delineators, 63 percent of the states agreed with the present standards, 5 percent disagreed, and 32 percent partially agreed. In regard to the acceptance of a lower delineator of the post-mounted type, the following conclusions were obtained: (a) 47 percent accepted the lower delineation, if the maintenance cost incurred is equal to or less than the existing cost; (b) 34 percent would not accept the new delineation technique; and (c) 19 percent partially accepted the technique and requested more information.

The question associated with the 4-ft delineator height closely parallels the previous question but puts more emphasis on delineator height standards. Of those returning questionnaires, 84 percent agreed with the present standard and 16 percent disagreed.

Responses to the question about the effect of delineators in lighted sections were extremely varied. Of the 49 states returning questionnaires, 23 or 47 percent stated that the delineator definitely has value in a lighted section, 14 or 29 percent disagreed, and 12 or 24 percent partially agreed. The major criticism arose from the fact that most highway departments felt that delineators lose their effectiveness in a lighted situation. The typical agreement and disagreement comments are respectively as follows:

Delineators assist and guide motorists in the lighted section during daylight hours as well as at night and during adverse weather conditions. The delineators are dependable and a great aid to motorists.

We do not feel that delineators have sufficient value on lighted sections to be worth their expense. Failure of the entire lighting system is so rare that delineators serve little useful purpose. Delineators tend to prevent vehicles from pulling far enough off the highway when an emergency stop is made.

This policy inconsistency of the highway departments warrants future consideration and research aimed at standardizing a policy.

Question 6 attempted to ascertain how the various state highway departments employ delineation with respect to specific roadside hazards. Eight specific hazards were listed in the questionnaire, and the following are the reported techniques of delineation for each hazard:

<u>Technique</u>	<u>States</u>
Metal guardrail divider	
Post-mounted delineators	14
Reflective tab inserts	11
Edge line striping	6
No practice	11
Fences mounted on raised concrete or blacktop dividers	
Post-mounted delineators	4
Edge line striping	4
Reflective tabs	3
No practice	26
Reinforced concrete dividers	
Hazard markers	9
Edge line striping	5
Reflective paint or tape	3
White slurry concrete	2
No practice	21
Center island dividers with curbing	
Painted curb	20
Post-mounted delineator	11
Edge striping	10
No practice	6
Entrance and exit ramps	
Post-mounted delineators	23
Painted edge line	12
Raised pavement markers	12
Bridge abutments	
Hazard marker	34
Post-mounted delineators	8
Reflective paint	3
Lampposts	
Reflective paint	2
Breakaway units	1
No practice	38
Road edge	
Painted edge line	39
Post-mounted delineator	26

This survey of roadside hazards clearly revealed a need for improved roadside delineation practices. The number of states reporting no practices for the marking of the hazards warrants further studies if the national roadway system is to be made safer.

UNIFORMITY OF ROADSIDE DELINEATION

The MUTCD sets forth the basic principles that govern the design and usage of traffic control devices including roadway delineation. The manual gives the design, application, placement, and maintenance of the delineators and strives to create uniformity. The application of delineation devices along highways and streets is designed to communicate either desired or needed information to motorists to help them pass over the particular section of highway safely and expeditiously. There is another reason for stressing uniformity. If similar situations on the highway are treated in the same manner, drivers can see, recognize, and understand the delineation treatment quickly.

The selection and the use of roadside delineators have become a challenging task. To be successful, delineation programs must be administered by trained engineers.

As the result of the literature review and national questionnaire survey, two sections of roadside delineation in the MUTCD have come under question.

Delineator Placement

The first area of question concerns the placement of roadside delineators, especially post-mounted delineators. The MUTCD presents the following specifications:

Delineators, if used, shall be mounted on suitable supports so that the top of the reflecting head is about 4 feet above the near roadway edge. They shall be placed not less than 2 nor more than 6 feet outside the outer edge of the shoulder, or if appropriate in the line of the guardrail.

Normally delineators should be spaced 200 to 528 feet.

Spacing should be adjusted on approaches and throughout horizontal curves so that several delineators are always visible to the driver.

Many state highway departments are generally in agreement with the above policies; yet, there are some who feel that the policies should be modified. In the questionnaire, the state highway departments were given the opportunity to express views on these policies, and the following responses were received:

Arizona: We concur with the main-line placement, but we do not concur with the policy of placement of delineators on ramps. We feel that a maximum spacing of 200 ft should be allowed.

Maryland: Spacing along road should be more specific.

Montana: We specify a minimum distance of 15 ft from centerline to delineator. This allows for snowplowing and wide loads on narrow roadways.

Ohio: Delineators are spaced 200 ft on tangent sections and are spaced on horizontal and vertical curves so as to make 5 delineators visible ahead of the driver.

Tennessee: Disagree with the policy because it provides a range of spacing between delineators and a range in the spacing from the edge of the roadway. The motoring public is best served when we provide them "constants" on which they can develop conditional responses.

Minnesota: We would consider a maximum lateral limit of 7 or 8 ft reasonable; that would avoid conflict with our snowplowing operations without reducing delineation effectiveness.

Wisconsin: We have been placing delineators 200 ft apart, but experience indicates that it would have been better had we started placing them 20 to the mile. We lose quite a few which are placed 2 ft outside of the shoulder but feel that they should not be placed farther away from the roadway because their effectiveness decreases rapidly as they are moved out.

Illinois: Should be placed a minimum 2 ft outside the curb or usable shoulder or in line with the face of the guardrail.

Idaho: The Idaho Department of Highways supports the basic standards set forth in the MUTCD. However, it is felt that allowances should be made for some flexibility to permit deviations such as snow poles. The delineator spacing on horizontal curves set forth in the MUTCD results in too many delineators.

Those comments reveal that the principal criticisms of the policy deal with the range of values presented by the MUTCD. It appears that the spacing for delineators would satisfy most departments with respect to main-line placement but that present standards for horizontal curves and ramps are adequate. Placement of delineators 15 ft from roadway centerline and approximately 250 ft apart on the main line appears to be an acceptable compromise.

The extended distance between the delineators reduces the number of delineators per mile, does not sacrifice effectiveness, and reduces overall installation cost. The distance, if accepted nationally, would standardize delineator spacing and provide a "constant" for the road user. This constant would allow the driver to judge his speed at night without taking his eyes from the roadway by repeated glances at the speedometer. In time, the road user would develop a conditioned response to the placement of delineators and thus gain driving security. A more secure driver performs better and would be able to achieve the highest as well as the safest level of service of the delineated road.

This modification would also provide for the uniformity of specifications within the MUTCD and make it more acceptable to all state highway departments. The altered policy could be supplemented with another policy stating that engineering judgment and personal experience can be and should be employed in any questioned situation. That would allow states to handle special delineation problems in their locality. Furthermore, it would be more in line with the true purpose of the MUTCD and the manner in which it is to be employed.

Delineator Height

The second area of question concerns the policies of the height of roadside delineators. The present policy specifies that "delineators, if used, shall be mounted on suitable supports so that the reflecting head is about 4 ft above the near roadway edge." That policy is in conflict with one given in the Interstate Manual, which specifies a 3-ft height.

The rationale of the present specification is that delineators placed lower than 4 ft above the pavement surface are quickly rendered ineffective by "road splash" and film from passing vehicles. A delineator is supposed to indicate to the driver where the pavement bounds are located and the direction of the roadway. However, it is felt that the present delineators located in a plane 4 ft above the pavement give the driver a false impression of the roadway edge and do not satisfy the driver's 2 major needs:

1. A progression of delineators to best accentuate the contour of the road ahead of the driver's perspective; and
2. A device low enough in profile and close enough to the road to be seen clearly when the driver uses the low-beam headlights.

To a large extent, information required by the driver in roadway situations is a function of the reasons that dictate the requirement of roadside delineation treatments. Therefore, delineators define the vehicle path more effectively if placed lower to the ground, for then they are directly associated with the roadway. A delineator placed at roadway level more accurately informs the driver of the actual pavement edge and also keeps the driver's eyes on the roadway. Eye-motion studies indicate that drivers tend to look down the road to check for other vehicles and roadway hazards and then view the pavement center or edge for lateral placement guidance. During night driving, the opportunity for long-range forward vision is reduced, and the short-range vision in front of the vehicle and on the sides of the highway lane receives more emphasis, especially when the road is curvy and other vehicles are not present.

The questionnaire also asked the state highway departments how they felt toward the employment of a road edge delineator if it were available and cost no more than present delineators. Some of the constraints placed on the delineator, if accepted, are as follows:

1. It must not interfere with snowplowing;
2. It has to withstand road splatter;
3. It should be readily visible in inclement weather; and
4. It should supplement present techniques.

Existing road edge pavement markers meet most of these constraints, yet they still have a major shortcoming. They improve roadway delineation in wet weather, but do they cause drivers to drive faster than the roadway surface conditions warrant? Several states seem to think that is the case but do not have workable solutions to the problem, excluding actual enforcement or driver education. In addition, because of the wide variation of climatic conditions, it may be improbable that the same delineation device employed by certain states can also be used in others with the same degree of effectiveness. For example, a low-level delineator could readily be employed in most southern states but would not be practical in extreme northern states because of the excessive snow accumulations. Therefore, the idea of uniformity on a national level would have certain limitations that must be considered before it is adopted.

One of the questions concerned the acceptance of a lower delineator of the post-mounted type, and the following responses were obtained:

<u>Response</u>	<u>Percent</u>
Accept the lower delineation if a maintenance cost incurred is equal to or less than the existing costs	47
Would not accept the new delineation technique	34
Partially accept the technique and request more information	19

The question associated with the 4-ft delineator height closely parallels the previous question but puts more emphasis on delineator height standards. Of the returned questionnaires, 84 percent agreed with the present standard and only 16 percent disagreed.

New Delineator Concepts

The existence of a pavement level delineator with the characteristics already mentioned is not totally unrealistic. Experimental markers exhibiting even more advantages are under study and need only extensive acceptance to be readily employed. The Texas Highway Department has undertaken this challenge and has used pavement level delineators in their roadside delineation program. Its comment on this practice is as follows:

Reflectorized pavement markers, which amount to a delineator at pavement level, are now being used extensively and do serve a definite purpose. They do a better job of delineating the intended path of a vehicle than do roadside delineators but being located at the pavement level are not visible for nearly as great a distance. Maintenance problems on the two are about the same; both are vulnerable to traffic and require considerable maintenance mostly in the form of replacement. A combination of the two types of delineation is probably most effective depending on the alignment of the roadway and the intricacies of the vehicle paths to be delineated.

The Florida Department of Transportation expressed its opinion as follows:

Although the pavement delineators are a very helpful device, we do not feel that the present type is the ultimate answer. The cost and maintenance are too high. Several research projects are underway now to find a better system of pavement delineation, and it is hoped that they will overcome the problem of wet night reflectivity.

The experimental markers use the principle of light reflected from the sun and from automobile head lamps and are designed to give the drivers a safer guidance route along increasingly extensive and complicated highways. Those delineators, when placed at close intervals on the very edge of the road, provide the driver with a continual stream of sensory data. Therefore, while the driver can receive through his peripheral vision an uninterrupted picture of the exact contour of the road edge, he can also keep his eyes on the traffic. The device can also aid in helping the driver judge relative speed when either there are no indicators on the highway or the ones passed are unevenly spaced. A driver can sense and measure his speed by observing the rate at which evenly spaced indicators appear to pass by. Sense of speed can become conditional, and indecision can be eliminated in high-speed traffic if the interdelineator spacing is properly varied to give the driver reflected stimuli at a rate that he can interpret from experience to be above or below the reasonable speed for that section of highway.

DELINEATION DESIGN METHODOLOGY

A means of correlating principal parameters to determine the optimum roadside delineator to install on a roadway or to supplement already existing delineation is essential in improving roadway visibility at night. A simple yet thorough procedure is needed to aid in the selection of adequate delineation techniques with respect to certain basic

criteria. Figure 2 shows a decision-making process that may readily be employed for delineation selection based on specific criteria.

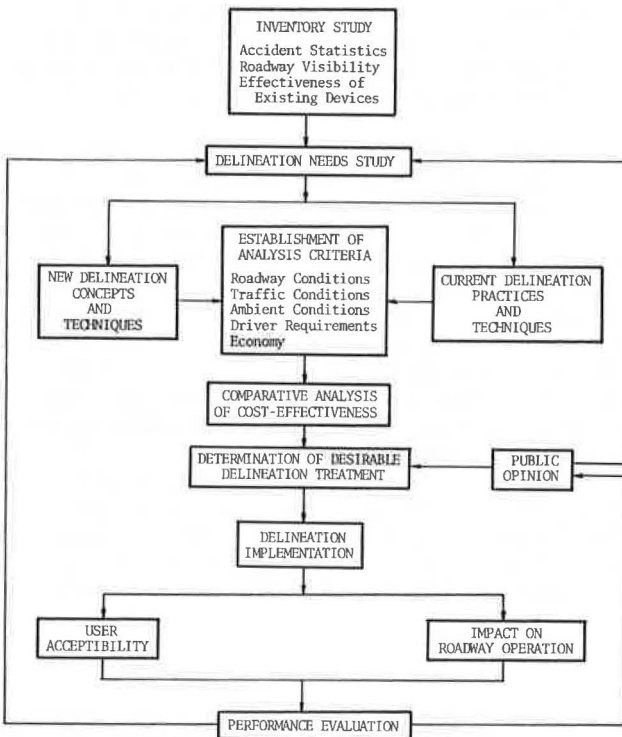
Inventory Study

Numerous roadway characteristics can be shown to be grounds for initiating this process although there are 3 principal ones: frequency and type of accidents, level of roadway visibility, and effectiveness of existing devices. Accidents receive the greatest emphasis and provide the grounds for many highway delineation needs studies. Many single-car accidents in which the vehicle leaves the roadway are attributed to the fact that the driver did not know where the roadway actually went. Roadway level of visibility, particularly during the night, is another means of determining the need for a roadside delineation improvement study. Improved roadway visibility through the use of delineation devices can create an increase in speed and thus a reduction in travel time as more drivers are able to safely identify the road contour and gain a more secure and confident feeling as they travel over the delineated roadway. Another characteristic considered in the inventory study is the effectiveness of the existing roadside delineation devices. The investigating agency studies the existing system and attempts to determine its deficiencies, if any. Once completed, this effectiveness study, joined with the accident and roadway visibility studies, will form the basis for a comprehensive delineation needs study.

Needs Study

The objectives of a needs study can also be simply stated: to formulate a broad plan for the orderly development of the delineation system as a whole, to provide a basis of adequate and systematic financing of the delineation system, and to provide a basis for

Figure 2. Roadside delineation evaluation.



coordinated improvements to all related systems. The needs study results not in an installation program but rather in cost estimates and long-range plans on which annual implementation programs can be based. Its basic goal is a macroscopic picture of total need during a period of years from which a financial program can be arrived at and a construction program can follow.

Each state conducting a delineation needs study should devise its own organization and procedures. Many states set up through legislative action a special agency or commission to conduct the needs study; other states have their highway departments conduct the study. However, a comprehensive delineation needs study requires the full cooperation, assistance, and understanding of all governmental units responsible for highway safety.

Public opinion should also enter into the highway delineation needs study as an indirect result of the performance evaluation of the current delineation technique. The public reaction to the delineation system in use provides the nonprofessional attitude, which is a fundamental part of a well-rounded study. The views of motorists with respect to the system provide the engineer with input that can be effectively used to aid in the development of delineation systems. That will gear the study more closely to actual driver requirements. Coupled with the technical performance evaluation, the public opinion of the implemented system creates a complete picture of the actual needs of the highway and its users.

Two important aspects in the needs study are financial and technical. The financial study incorporates items such as material costs, installation costs, replacement costs, and maintenance costs. The technical study determines what is actually required to delineate a roadway section or to supplement an existing delineated roadway section. The work required leads directly to a thorough review of both new delineation concepts and current delineation practices and techniques.

Analysis Criteria

Once various delineation concepts and techniques have been thoroughly reviewed, a cost-effectiveness analysis is then carried out. That analysis is preceded by the establishment of criteria for evaluating delineation systems. The principal criteria are roadway conditions, traffic conditions, ambient conditions, driver requirements, and economy. Those characteristics give a complete view associated with the delineation requirement and form the basis for sound engineering judgment in the selection of the delineation system.

The characteristics of roadways are the first logical considerations to be encountered in this analysis. The direction of the traffic (1-way or 2-way), lane width, lateral clearance, and location of weaving areas and ramp terminals all should be considered. In like manner, operating speed, roadway capacity, and demand volume must be also analyzed. Ambient conditions relate primarily to weather and include measures, such as clear, dry, cold, warm, hot, rain, snow, fog, smog, smoke, wind, and wet or icy pavement, that affect the ability of a roadway to accommodate traffic and, thus, are important considerations in an analysis of a delineation system. Moreover, to be able to select the delineation treatment under various conditions, one should also know the minimum as well as the optimum visual information needed by the driver. If "adequate" information is available to the driver, proper driving behavior with respect to roadway conditions should be evident. The information received by the driver must allow him to act on the information under various circumstances. In addition, the delineation treatment must be economically feasible. Of the many costs to be considered in the analysis, those that appear to constitute the largest percentage are material costs, installation costs, maintenance costs, replacement costs, and costs attributed to accidents. The cost analysis usually is the most important and has the greatest weight in determining the final choice.

Cost-Effectiveness Analysis

Once the factors of the analysis criteria have been established, a cost-effectiveness analysis is undertaken. A cost-effectiveness analysis describes benefits and costs as

a function of different levels of achievements and effectiveness. The delineation techniques are compared through trade-off analysis among the criteria discussed previously. Prevailing roadway, traffic, and ambient conditions; driver requirements; and economics are taken into consideration, and the benefits as well as the shortcomings of each technique are rated with regard to those factors. A reliable comparison of various delineation methods and devices must depend on cost-effectiveness on both an initial and a continued basis. The actual selection of the delineation treatment and of the degree of the improvement requires the management decision-making process on a lower level.

Implementation and Performance Evaluation

The selected technique is then put into operation. Once the delineation system becomes exposed to motorists, user acceptability becomes part of the overall performance evaluation of the system. Also, impact on the roadway operation is another input to the performance evaluation. If the system installed proves to be as effective as expected, positive changes should be seen in the number of accidents, the roadway level of service, and the capacity of the delineated roadway. As the driver becomes more secure and confident as a result of the improved delineation, traffic flow over the highway will become steadier.

The performance evaluation not only benefits the road user but also supplies additional input for any future highway delineation studies. This forms a continual process of evaluation and reevaluation of the employed techniques and ensures that the treatments are not kept dormant but undergo continual refinement.

CONCLUSIONS AND RECOMMENDATIONS

The national survey in this study revealed the current practices of state highway departments with respect to roadside delineation concepts. The survey allowed the officials associated with highway safety to express their opinions and to indicate any further studies that they felt should be made. The measure of the relative extent to which the delineation benefit contributes to increased safety is essential to the systematic development of ways and means of obtaining maximum effectiveness of the various types and combinations of roadside delineation.

Based on the results derived from this study and the hope that further research on highway delineation is undertaken, the following recommendations are made:

1. A professional organization should be maintained on a full-time basis to accumulate all of the currently available information on roadside delineation techniques and their effectiveness and to maintain the data on a current basis;
2. Roadside delineation with respect to roadway hazards should be given needed research, especially with respect to delineation techniques and evaluation criteria for effectiveness standard;
3. Further research should be given to areas that require engineering judgment in the specifications of roadside delineation so that the amount of judgment required is reduced to a minimum;
4. Research toward the design of innovative, self-cleaning, nationally accepted delineator devices should be undertaken;
5. A selection program of a roadside delineation technique that is acceptable to all highway departments should be implemented so that uniformity of delineation practices may be more readily obtained and their effectiveness increased; and
6. Further study should be given to a program that all states can readily employ to educate drivers and make them aware of roadside delineation techniques.

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