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STUDY OF THE NATIONAL STANDARDS FOR DIRECTIONAL AND OTHER OFFICIAL SIGNS

Overview of Their Adequacy

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16. Abstract

This report contains the results of an evaluation of the National Standards for Directional and Other Official Signs (Part 21, Section 131(c), Title 23, United States Code). It is the third in a series of three reports. The other reports in the series are:

FHWA-RD-116 STUDY OF THE NATIONAL STANDARDS FOR DIRECTIONAL AND OTHER OFFICIAL SIGNS. Synthesis Report. Truman M. Mast, Office of Research, Federal Highway Administration.

FHWA-RD-117 STUDY OF THE NATIONAL STANDARDS FOR DIRECTIONAL AND OTHER OFFICIAL SIGNS. Laboratory Evaluation. A. G. Klipple and K. M. Roberts, Office of Research, Federal Highway Administration

The results of an evaluation of the Standards conducted by the National Bureau of Standards are presented in this report. The evaluation method made use of a literature review, two different theoretical models and expert opinion. It was concluded that for many speeds, sign locations, and driver characteristics, signs conforming to the Standards but designed for extreme cases of message length and content are inadequate.

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Miss Ann Ramey contacted numerous firms and officials to locate field site information, state sign codes, and resource documents. Mr. Clarke Jones prepared the state code summary after reviewing submitted material. Sign design assistance was provided by Mr. Travis Brooks of FHWA.

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Major inputs to the format and organization of the final report were made by Dr. Robert Cunitz, who contributed much time and effort to meld the separate efforts of the several authors into a cohesive whole.

EXECUTIVE SUMMARY

The Problem

In 1969 the Federal Highway Administration (FHWA) issued National Standards for Directional and Other Official Signs. Under these Standards, certain features of directional signs erected by owners of privately-operated scenic and historical sites are controlled in a zone extending from the edge of the right-of-way to a distance 660 ft *(201.2 m)* beyond.

The National Caves Association (NCA) objected to the Standards and submitted requests for their modification. NCA sought increases in

-- total sign area,

-- height, and

-- length,

-- as well as in the number of signs allowed.

In response to these NCA requests, the FHWA Office of Research:

- performed a study of the effects of angle of regard, and
- requested the assistance of the National Bureau of Standards (NBS) to evaluate the Standards with respect to the needs of motorists.

The Method

In fulfilling this request, NBS personnel have

- examined the present Standards,
- searched data bases and reviewed pertinent literature,
- asked experts in highway-signing to independently evaluate the Standards,
- measured signs which were in compliance with the Standards, and
- developed 15 "worst case" sign designs which were evaluated by two different theoretical models.

The Results

A review of the history of the development of the Standards uncovered few references to technical supporting data and the published research on highway signing was either too general or not directly relevant.

Furthermore, evidence supplied by NCA to support its proposed changes was limited.

However, the literature did indicate that the ability of a driver to read and comprehend a Directional Sign depends upon the following variables:

-- driver's visual acuity (static and dynamic),

-- sign length, height, and placement,

-- vehicle speed,

-- local terrain,

-- driver eye and head movement,

-- message length, content, and arrangement, and

-- sign color and surrounding environmental conditions.

An analysis of the hypothetical signs was performed using reasonable values for each of these variables. The analysis showed that the sign dimensions needed to display legible messages vary considerably as the values of each variable are changed. For example, a 30 ft^2 *(2.8 m^2)* sign located 5 ft *(1.5 m)* from the pavement would be adequate for drivers of 20/23 vision who were traveling at 40 mph *(64.4 kph)*, if a 40° divergence angle was acceptable. At the opposite extreme, with the acceptable divergence angle only 10°, a sign bearing the same message, located 740 ft *(225.6 m)* from the pavement and read by drivers traveling 80 mph *(128.7 kph)* would have to be over 8000 ft^2 *(743.2 m^2)*.

Stated in general form, the results indicate that:

-- most Standards-conforming signs are adequate if the divergence angle is large, the speed is low, the lateral displacement small, and the driver has 20/20 vision.

-- few signs are adequate for the same driver if the divergence angle is small, the speed is high, and the lateral displacement large.

-- few signs would be legible at the outermost edge of the controlled zone (740 ft, *225.6 m*).

The Conclusions and Recommendations

For many speeds, sign locations, and driver characteristics, signs conforming to the Standards but designed for extreme cases of message length and content are inadequate. Their utility depends on the values of the "real world" variables used by FHWA as design criteria. Independent of specifying such values, the following conclusions were reached:

-- The Standards should require that sign characters be legible at the levels of visual acuity required by state driver licensing regulations.

-- Maximum sign size should be specified in terms of the visual angle subtended, rather than as a maximum physical size.

-- Neither reviewed material nor consultant recommendations support any change in the number of signs allowed, in the maximum distance from sign location to site location, in the one-mile *(1.6 km)* spacing between signs, or in the proximity limits between directional signs and interchanges or exits.

The consultants also made several recommendations which could possibly improve the Standards but which were unrelated to the question of adequacy.

Research is needed to provide supporting data for changes to the Standards. This research should include:

-- More field tests of sign legibility outside the right-of-way.

-- Field validation of laboratory studies and theoretical models.

-- Surveys to define the actual visual acuity level of drivers.

Additional data are also required on:

-- Drivers' visual abilities, including the gestalt of sign perception.

-- Drivers' information needs.

An Overview of the Adequacy of National Standards for Directional and Other Official Signs

1.0 Introduction

1.1 1965 Highway Beautification Act

In support of the 1965 Highway Beautification Act the Department of Transportation in 1969 issued National Standards for Directional and Other Official Signs (Part 21, Section 131(c), Title 23, United States Code). As amended in late 1973, the Standards control outdoor advertising signs, displays, and devices which are visible from highways in non-urban areas or are located within 660 ft *(201.2 m)* of the nearest edge of the right-of-way in urban areas. These Standards limit signs outside commercial areas and industrial zones to ". . . directional and other official signs and notices, which signs and notices shall include, but not be limited to signs and notices pertaining to natural wonders, scenic and historical attractions, which are required or authorized by law, which shall conform to national standards hereby authorized to be promulgated by the Secretary hereunder, which standards shall contain provisions concerning the lighting, size, number, and spacing of signs, and such other requirements as may be appropriate to implement this section . . .,".

These Standards cover a variety of sign parameters ranging from specific prohibitions to general guidelines. Of particular importance are the following parameters:

Size - The maximum dimensions allowed, including border and trim, but not supports, are:

Area	-	150 ft^2 *(13.9 m^2)*
Height	-	20 ft *(6.1 m)*
Length	-	20 ft *(6.1 m)*

Spacing - The location of each directional sign must be approved by the State highway department and none can be located within 2,000 ft *(609.6 m)* of an intersection or exit along the Interstate system or freeway, or within 2,000 ft *(609.6 m)* of a rest area, parkland, or scenic area. These signs must be within 75 air miles *(120.7 km)* of the activity for the Interstate System and within 50 air miles *(80.5 km)* for the Primary System. Such signs must be spaced at least one mile *(1.6 km)* apart.

Number - No more than three directional signs for a given activity and facing the same direction of travel may be located along any single approach route to the activity.

Content - Message content on directional signs is restricted to identification of the activity and directional information such as mileage, route number or exit numbers.

1.2 Objections to the Standards

A report from the Commission on Highway Beautification (1973) cited numerous examples of businesses which were denied the privilege of erecting signs in the protected zone - motels, restaurants, and points of interest. The operators of such businesses were not satisified with the Act and have criticized the Standards for being too restrictive. Others have criticized the Standards for being too liberal and the National Caves Association (NCA), an organization of private cavern owners who are permitted to erect directional signs in the protected zones, has criticized the Standards for being inadequate. The NCA objections to the Standards cited an anticipated loss of income, an inability to relocate sites, and a heavy reliance upon one-time visitors. The NCA proposed modifications to the size and spacing (number) allowed, which would result in the following changes:

Area - from 150 ft^2 *(13.9 m^2)* to a new maximum of 600 ft^2 *(55.7 m^2)*.

Height - from 20 ft *(6.1 m)* to 30 ft *(9.1 m)*.

Length - from 20 ft *(6.1 m)* to 50 ft *(15.2 m)*.

Spacing (Number) - from "Not more than three directional signs pertaining to the same activity and facing the same direction of travel may be erected along a single route approaching the activity" to "Not more than six . . ."

A letter from a sign manufacturer was included as evidence of the need for these changes. The letter referenced the dimensions needed to display messages on signs located 660 ft *(201.2 m)* from the highway. Full details were not provided, but a criterion of one inch *(2.54 cm)* of character height for every 40 ft *(12.2 m)* of viewing distance was used. However, it was not clear how such figures were subsequently translated into the larger physical dimensions of the signs requested by NCA.

An internal Federal Highway Administration (FHWA) study of these objections cited a re-evaluation of the Standards by the Office of Traffic Operations (FHWA Correspondence #TO-21, 1974). The requested 700% increase in area (from three to six signs and from 150 ft^2 to 600 ft^2 *(13.9 m^2 to 55.7 m^2)* each) was considered excessive. However, FHWA conceded that some messages could not be adequately displayed on a 150 ft^2 *(13.9 m^2)* sign. For this reason, changes for freeways and expressways were recommended by the Office of Traffic Operations in an internal response to the Office of Right-of-Way and Environment, as follows:

"Rather than to just place a limit on the size of the sign, it is suggested that the limit be placed on the size for the alphabets and the amount of directional information. For example on freeways and expressways: (1) restrict the maximum size of legend to 24-inch uppercase and 18-inch lowercase letters in the destination name and 18-inch uppercase in the directional copy, (2) limit the directional copy to two lines not exceeding the width of the name of the attraction, (3) utilize interchange numbers where appropriate, and (4) sign size to be determined solely on legend size and spacing, however, the maximum size sign shall not be greater than 400 square feet. Apply same criteria to other roads except utilize 20-inch uppercase/15-inch lowercase alphabets in the attraction name and 15-inch uppercase in the directional information. For these facilities the maximum size should be limited to 300 square feet.

The current limitation as to the number of signs per approach to the activity is adequate, in our opinion, for directional guidance."

Official FHWA policy has not been modified to reflect these or other internal responses to the question of adequacy.

Additional FHWA study of Standards modifications has emphasized problems of implementing any changes. These studies indicate that active cooperation with the states is absolutely necessary to meet the objectives of the Highway Beautification Act of 1965. If the changes to Part 21 of the Standards result in double standards for states to enforce, the "beauty-programs" would be in serious jeopardy. In addition to the problems of double standards, should changes be made there is some question about the legal status of the larger signs which are now scheduled to be removed from highways.

1.3 FHWA/NBS Research Efforts

In response to such questions regarding the adequacy of the Standards, the FHWA Office of Research initiated a human factors study of the importance of divergence angle (the angle of regard between the direction of roadway travel and the driver's line of sight to the sign) and requested the assistance of the National Bureau of Standards (NBS) to complete an overview of the Standards' adequacy with respect to the needs of motorists. It was the intention of Congress that the Standards allow adequate guidance and information for motorists but that strict advertising be avoided. Technical data which supported or conflicted with portions of the Standards were sought.

To examine the adequacy issue, NBS personnel:

1. reviewed the available FHWA files on this topic, discussed the Standards' history and problems with FHWA personnel, and prepared the background material discussed above;

2. completed literature searches of recently published reports relevant to highway signing, and obtained pertinent articles for closer examination;

3. reviewed selected State Codes pertaining to privately-erected directional signs;

4. completed field measurements of four signs in the Washington, D.C. vicinity erected in compliance with the Standards;

5. asked four recognized experts in sign research to provide reviews of the Standards and of research dealing with various specific points;

6. designed a variety of fictitious signs according to several criteria and compared each with "real world" parameters; and

7. summarized the technical objections to specific parts of the Standards and made recommendations to satisfy these objections.

2.0 Approach

It was the goal of this project to provide FHWA with an overview of the adequacy of the 131(c) Standards - in terms of motorists' needs. The limited time and resources and the restricted scope of the effort permitted little original research to be done. Instead, a limited literature search and review, discussions with and reports from consultants, field site measurements, and two theoretical signing models were used to evaluate specific points in the Standards.

2.1 Review of Technical Material

A number of benchmark articles, annotated bibliographies and texts were available which summarized a great deal of the early highway signing research. To complement these publications, several data bases were searched to identify more recent research.

The data bases examined were the:

- HRIS (Highway Research Information Service),
- NTIS (National Technical Information Service),
- Compendex (Engineering Index),
- PASAR (Psychological Abstracts Search and Retrieval), and
- New York Times Information Service.

Unfortunately, most potential sources were either too general to be applicable or were not directly relevant. Most research concerned right-of-way signs - not directional signs positioned out of the right-of-way. Advertising-sign literature was primarily concerned with attitudes of the public and advertising effectiveness, and was less concerned with layout, character height, or total area.

Section 21.4 of the Standards requires participating states to submit their signing codes for review by FHWA. Ten states have thus far submitted the required material. Three other states in the Washington, D.C. area submitted their codes to this project for review. The extent of compliance and magnitude of local exceptions were studied to identify difficulties faced by states in implementing the Standards.

2.2 Consultants

Four experts were selected whose published research dealt with subjects relevant to parts of the Standards. (Brief vitae are included in Appendix D.) These four men served to acquaint project personnel with relevant publications and different frames of reference to evaluate the Standards. Each also responded to the question of Standards adequacy and submitted a report summarizing their conclusions. The four were:

- Dr. Theodore Forbes (Professor of Psychology and Research Advisor, Highway Traffic Safety Center at Michigan State University),

- Dr. Slade Hulbert (Research Psychologist in the Psychology Department at the University of California at Los Angeles),

- Dr. Thomas Rockwell (Professor of Industrial and Systems Engineering, Driving Research Laboratory at the Ohio State University), and

- Dr. L. Ellis King (Associate Professor of Civil and Environmental Engineering and Associate Director of the Center for Urban Transportation Studies at the University of Colorado).

2.3 Hypothetical Signs

It was not possible to obtain a representative sample of actual signs in the field for comparisons with the provisions of the Standards and with published research. Consequently, hypothetical signs were developed for this purpose, based on established signing principles. Four actual signs were measured to provide a frame of reference for evaluating the hypothetical signs and to serve as examples of field problems and practices.

The message content and arrangements of these hypothetical signs were selected to conform to the Standards, satisfy the guidelines suggested in the Manual on Uniform Traffic Control Devices (MUTCD, 1971), and present the extreme of dimensions likely to be encountered in the field. It was assumed that if the Standards were adequate for such extreme cases, they would be more than adequate for signs of lesser message length and content which were also better arranged.

A fictitious sign text was generated and arranged on two, three, and four lines. In the previously cited FHWA study, the longest line of text used was "SIX FLAGS OVER GEORGIA." To avoid direct criticism of this or other existing signs, a fictitious name, "Schmillingrass Caverns," was constructed which used the same number of characters and spaces (i.e., 22). The recommendations (FHWA internal correspondence #TO-21, 1974) mentioned above suggested that all text should occupy only two lines on a sign. However, for the Six Flags example, text had also been considered as three- and four-line arrangements. For these reasons, comparable arrangements were used here. Figure 1 illustrates upper and lowercase (UC/LC) and uppercase (UC) only examples of each sign.

Each of these formats (two-, three-, or four-line) was arranged in five configurations (based on MUTCD guidelines and research conclusions, Kindersley, 1960):

-A) All UC characters, spacing between lines of text equal to 0.75 character height;

-B) All UC characters, SCHMILLINGRASS CAVERNS line(s) 1.5 times the size of other line(s), spacing between lines equal to 0.75 character height;

-C) All UC characters, spacing between lines equal to 0.33 character height (Kindersley, 1960);

-D) Same as configuration A, but with UC/LC characters;

-E) Same as configuration B, but with UC/LC characters.*

All characters are from Series E, as recommended by Standard Alphabets (1966).**

For each of the 15 resultant signs, the length/height combination which made best use of the available area was determined. The character

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*Other specifications are discussed in Appendix A.

**The recommendation applies only to UC/LC characters but for consistency Series E characters were used for UC only configurations as well.

Uppercase Only	Upper and Lowercase

Sign 1

SCHMILLINGRASS CAVERNS ROUTE 99 KENT ST EXIT	Schmillingrass Caverns Route 99 Kent St Exit

Sign 2

SCHMILLINGRASS CAVERNS ROUTE 99 KENT ST EXIT	Schmillingrass Caverns Route 99 Kent St Exit

Sign 3

SCHMILLINGRASS CAVERNS ROUTE 99 KENT ST EXIT	Schmillingrass Caverns Route 99 Kent St Exit

Figure 1. Uppercase only and upper/lowercase versions of each of the three signs.

height was calculated from these dimensions, as was the greatest distance at which characters of that height would be legible. The method used is illustrated below for a four-line sign in configuration A.

0.75	
1.00	SCHMILLINGRASS
0.75	
1.00	CAVERNS
0.75	
1.00	ROUTE 99
0.75	
1.00	KENT ST EXIT
0.75	
7.75 lines of text	

1) From Appendix A, if characters of unit size were used, the length of the longest line would be 15.10 units.

2) Sign height, from the above diagram would be 7.75 units.

3) The ratio, α, of Length to Height would be

$$\alpha = \frac{15.10}{7.75} = 1.95$$

which can be used to calculate the Height and Length of a sign of any fixed area since:

4) Area = Height x Length = Height x α Height = α Height^2.

5) In this example, for a 150 ft^2 sign:

$$150\ \text{ft}^2 = 1.95\ \text{Height}^2;$$

Therefore,

$$\text{Height} = 8.77\ \text{ft}\ \textit{(2.57 m)}\ \text{and}$$

$$\text{Length** } = \frac{150\ \text{ft}^2}{\text{Height}} = 17.10\ \text{ft}\ \textit{(5.2 m)}$$

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*The length of any sign is determined by the length of the longest line of text which, in turn, depends upon the specific characters comprising that line. For example, a line of 10 "m" characters would be longer than a line of 10 "i" characters.

**The length/height ratio which made best use of the available 150 ft^2 *(13.9 m^2)* area (the optimum length/height ratio) was determined for each of the 15 signs. However, the optimum length for two- and three-line signs exceeded the 20 ft *(6.1 m)* limit. Therefore, the height of these signs was calculated from the formula height = length/α = 20 ft/α.

6) The character height is equal to the sign height divided by the number of lines of text. Hence,

$$\text{character height} = \frac{8.77 \text{ ft}}{7.75} = 1.13 \text{ ft } (0.34 \text{ m})$$

OR

13.56 in *(34.44 cm)*

The factors which determine the greatest distance at which characters are legible are the stroke width and the driver's visual acuity. For reading purposes, visual acuity is the ability to distinguish letters on a Snellen chart (Bioastronautics Data Book, p. 638). Persons of "normal" vision (20/20 Snellen) can perceive characters having a stroke width of .0698 in *(.177 cm)* at a distance of 20 ft *(6.1 m)*. This corresponds to a one minute visual angle. Their visual acuity ratio is, therefore, .00349 in/ft *(.029 cm/m)* of viewing distance. As a general rule, the distance at which characters are just legible is obtained by dividing the stroke width by the visual acuity ratio. The just legible viewing distances for various stroke widths are shown in Figure 2, for several levels of visual acuity.

The legibility distance per unit of character height is obtained by dividing the stroke width, expressed as a fraction of character height, by the visual acuity ratio. In the example above, the stroke width of UC only, Series E characters is 17.2% of character height.* For persons with 20/20 vision, the legibility distance/character height ratio is

$$\frac{.172}{.00349 \text{ in/ft}} = 49.3 \text{ ft/in } (5.92 \text{ m/cm}).$$

Therefore for our example the legibility distance is

$$13.56 \text{ in} \times 49.3 \text{ ft/in} = 669 \text{ ft } (203.9 \text{ m}).$$

That is, characters 13.56 in *(34.44 cm)* high, whose stroke width is 17.2% of character height, would be legible 669 ft *(203.9 m)* away to viewers with 20/20 vision.

The legibility distance/character height ratio in the example above (49.3 ft/in, *5.92 m/cm*) is close to the "Rule of Thumb" ratio referred to by numerous highway officials (50 ft/in, *6 m/cm*). As can be seen,

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*Series E characters were used both for UC/LC and UC only signs, for reasons of consistency. It should be noted, however, that Series E UC/LC characters have a stroke width 19.9% of the character height, while UC only characters have a stroke width 17.2% of the character height. The larger stroke width makes UC/LC characters legible at greater distances than UC only characters of the same height.

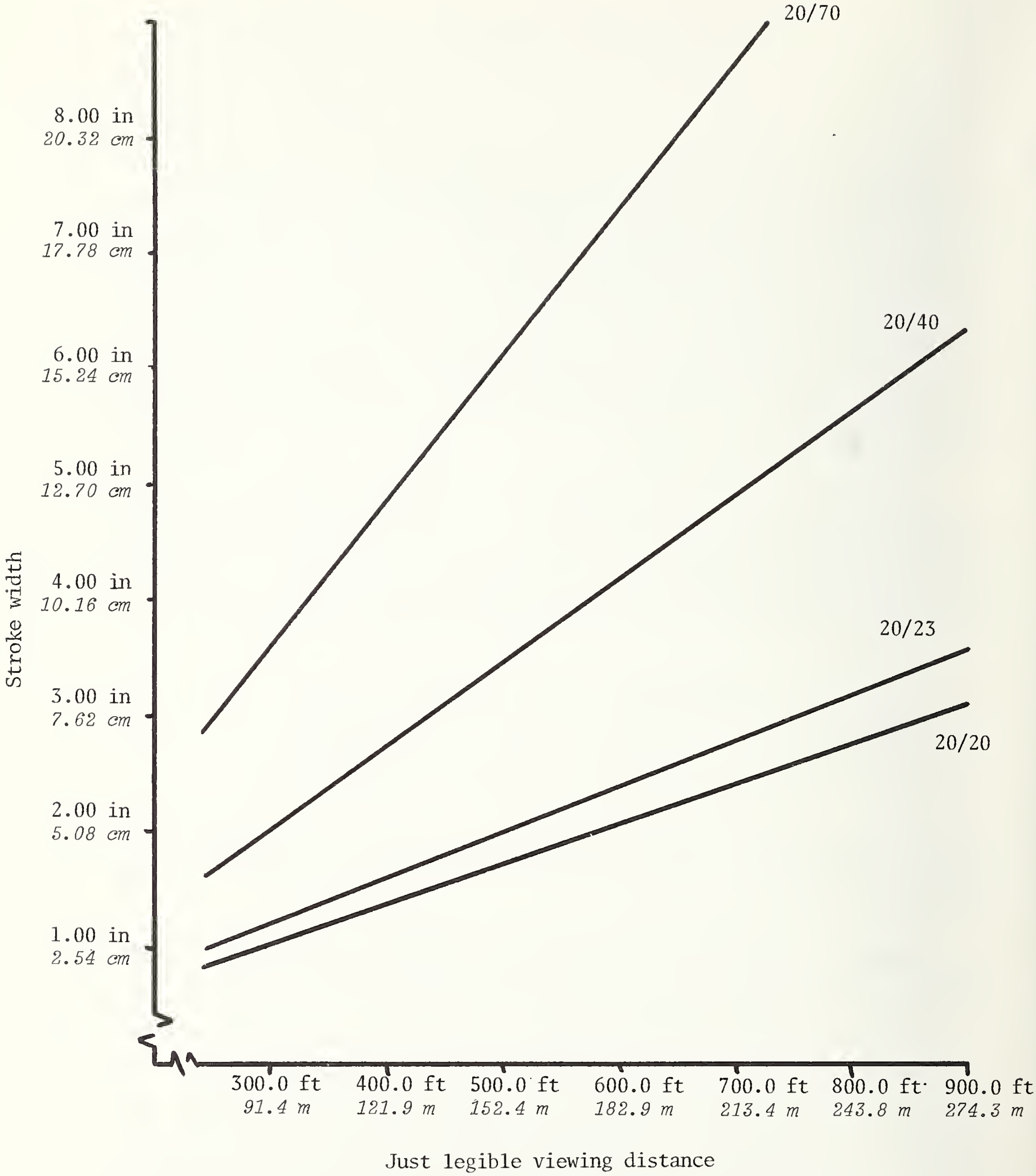

Figure 2. Just legible viewing distance for various stroke widths at four levels of visual acuity (figures based on visual acuity alone, not in context of meaningful sign text).

use of the "Rule of Thumb" for placement of signs with Series E UC only characters rests on the implicit assumption that most drivers have 20/20 vision. In fact, 80% of motorists drive with visual acuity poorer than 20/20 (Dewar, 1973; Forbes, 1965). In several states drivers may operate motor vehicles with uncorrected vision of 20/40 or even 20/70 (King, 1970). Ratios for four different levels of visual acuity are given below for UC/LC (19.9% stroke width) and UC only (17.2% stroke width) Series E characters.

Visual Acuity	Minimum Discernible Visual Angle	Legibility distance per unit of character height: UC/LC characters, stroke width is 19.9% of character height	UC Only characters, stroke width is 17.2% of character height
20/20	1.00 min	57.0 ft/in *6.84 m/cm*	49.3 ft/in *5.92 m/cm* ≈ "Rule of Thumb"
20/23	1.15 min	49.8 ft/in *5.98 m/cm* ≈ "Rule of Thumb"	43.0 ft/in *5.16 m/cm*
20/40	2.00 min	28.8 ft/in *3.46 m/cm*	24.9 ft/in *2.99 m/cm*
20/70	3.50 min	16.3 ft/in *1.96 m/cm*	14.1 ft/in *1.67 m/cm*

2.4 Signings Models

The models considered applicable to this project are those discussed by King (1971) and by Rockwell (1973). Both consider the effect of perpendicular distance from the sign to the roadway (lateral displacement), maximum divergence angle, driver speed, sign width, (length), and number of words.

The lateral displacement partly determines divergence angle. At smaller divergence angles, less lateral eye and head movement is needed to read the sign and foveal vision is not diverted as far from the roadway. The divergence angle increases as the driver moves down the road, from an initial angle, measured at the point where reading begins, to a terminal angle (i.e., maximum divergence angle), measured at the point where reading ends. At any given speed, the terminal divergence angle should be something less than half of the usable visual sector (i.e., the right half of the field). Early work by Hamilton and Thurstone (1937, and summarized by Ewald, 1971) indicated that the usable visual sector, in which detail can be clearly seen, decreases in size with increasing speed. At 30 mph *(48.4 kph)*, the visual sector is 90° wide while at 55 mph *(88.5 kph)* it is reduced to approximately 48°. The minimum size at higher speeds is probably 20° to 30°, the normal limits of eye movement without corresponding head movement.

In addition to its effect on visual sector width, increasing speed also reduces the depth of that sector. At 60 mph *(96.6 kph)* a driver can see details clearly only between 110 and 1400 ft *(33.5 and 426.7 m)* in front of the vehicle (Ewald, 1971). This 110 ft *(33.5 m)* minimum fixes a limit to the closeness of the sign. In other words, there is a minimum distance which must separate drivers from a sign and this minimum increases with increasing speed.

The following parameter values were used in applying the models to the hypothetical signs:

Lateral Displacement -

5 ft *(1.5 m)*, speed limit and similar types of signs are usually positioned at approximately this distance from the pavement.

35 ft *(10.7 m)*, right-of-way signs are generally located 30-50 ft *(9.1-15.2 m)* from the pavement.

80 ft *(24.4 m)*, this is the "average" distance from the pavement to the outermost edge of the right-of-way.

740 ft *(225.6 m)*, the zone protected by the Standards is from the end of the right-of-way to a point 660 ft *(201.2 m)* beyond. 740 ft *(225.6 m)* is 660 ft *(201.2 m)* beyond the "average" right-of-way.

Terminal Divergence Angle -

10°, King (1971) recommends 10° as the maximum angle, but his discussion points out that other researchers favor 15°; both angles are close to the maximum divergence angle expected of drivers who are using only eye movement to scan the visual field in front of the car.

30°, this angle was used since it was empirically determined in eye movement research basic to Rockwell's (1973) paradigm and is close to one-half of the field of view expected of drivers moving at 55-60 mph *(88.5-96.6 kph)*.

40°, this angle approximates the divergence angle between the roadway and the position of the rear-view mirror.

Speed -

80 mph *(128.7 kph)*, the speed for which most Interstate highways have been designed.

60 mph *(96.6 kph)*, though the national speed limit is 55 mph *(88.5 kph)* many drivers are likely to maintain this slightly higher limit.

55 mph *(88.5 kph)*, the national speed limit.

40 mph *(64.4 kph)*, the minimum speed limit on many highways.

Sign Length -

As indicated above, the sign length which made best use of the available 150 ft^2 *(13.9 m^2)* was used for each version of the four-line signs. Required viewing distances are identical for all of the two- and three-line signs because the length of each had to be reduced to 20 ft *(6.1 m)* to conform with the Standards.

Number of Words -

Published research (Forbes, 1939; 1972) emphasizes the desirability of using no more than three or four short, familiar words for best message perception. Since our analysis emphasized the use of "worst case" sign designs, seven words (Miller, 1956) were used as an upper limit.

For "worst case" design purposes, it is important to assume that drivers will be traveling in the leftmost lane when passing the sign. Since rural settings where directional signs are allowed are unlikely to be carrying dense traffic, only three lanes were assumed.

Other factors which affect sign legibility include contrast between the figure and ground (characters and their immediate surround), driver reading habits and search strategy, color and luminance of the sign, atmospheric conditions, and windshield characteristics such as tinting and dirt. These factors were not considered in the analysis.

Each model was used to determine the minimum line-of-sight distance (viewing distance from the driver to the sign) at which reading must start. The distance at which characters on each sign would be legible (a function of visual acuity) can be compared with the minimum line-of-sight distance to determine a sign's adequacy. If the legibility distance is larger than the minimum viewing distance, characters would be legible at the latter distance. If the legibility distance is smaller, the characters would not be adequate at the minimum distance required by the models.

After the minimum viewing distance was determined, the optimum ratio of length to height was used to determine the dimensions of a sign which would satisfy the Rule of Thumb legibility requirements at that distance. These dimensions were obtained as follows:

$$\text{Required Sign Height} = \frac{\text{Viewing distance (from model)}}{50 \text{ ft/in } (6 \text{ m/cm})} \times \text{lines of text and spacings}$$

Both models use the schematic diagram shown in Figure 3. The parameters are:

AB = minimum viewing distance.

AC = distance travelled while reading the sign.

DE = width of roadway (three lanes of traffic).

EF = perpendicular distance from the inner edge of the sign to the outer edge of the roadway (lateral displacement).

FB = one half the sign width (length).

θ (theta) = maximum acceptable angle, which determines the last point where the driver can read the sign (terminal divergence angle).

The equations for both models reduce to the following form:

$$AB = \sqrt{[AC + (DE + EF + FB)\cot\theta]^2 + (DE + EF + FB)^2}$$

The models differ mainly in terms of the assumptions basic to each. In practice, the essential differences are, (1) the amount of time assumed necessary to read the sign, and (2) the terminal angle of regard. King recommends an angle of 10° or less, while Rockwell recommends 30°.

King's discussion of sign size and location is presented as guideline information of use to highway engineers designing legible signs for drivers who are reading such signs while monitoring road traffic in the periphery of their visual field. For this reason, a 10° divergence angle is recommended. Rockwell, instead, presents his model as a description of driver behavior actually observed, and concludes that 30° is the angle at which most drivers stop looking at the sign. In a similar view, King assumes a reasonable reading time based on published research, whereas Rockwell concludes with a longer assumed reading time since observed drivers did not look at the sign during the entire period when it was legible to them.

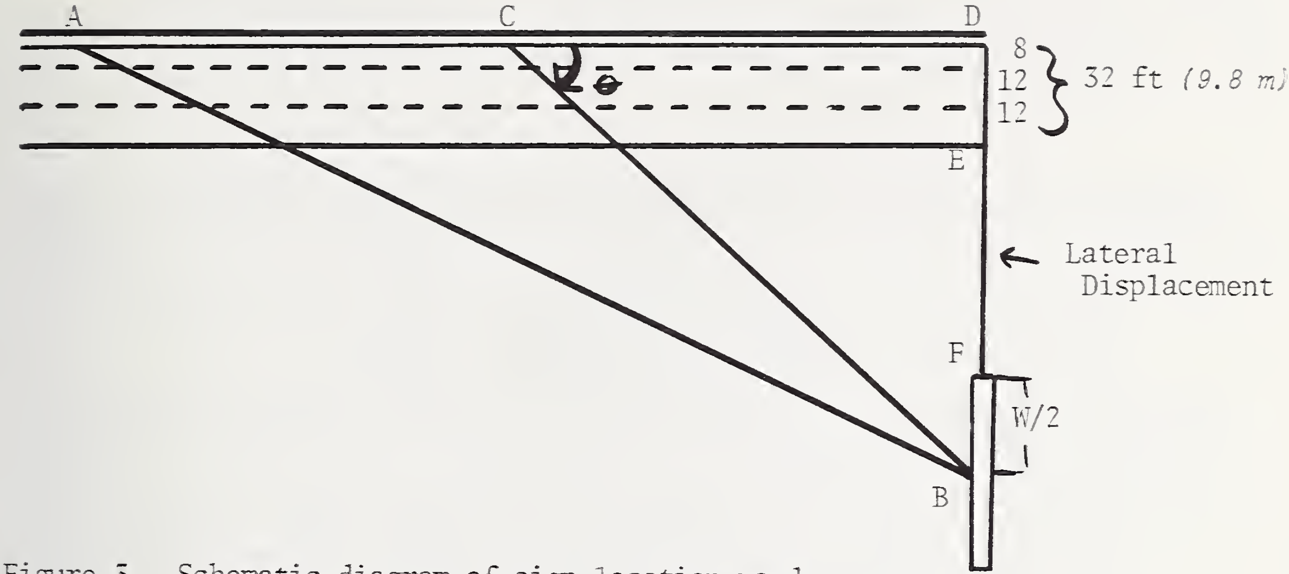

Figure 3. Schematic diagram of sign location used for King's model and Rockwell's model.

Both models can be used for any combination of speed, lateral displacement, sign width, number of words, and terminal divergence angle,* but only the limited number of discrete points described in the previous sections were used in this analysis. The values used were based on "real world" values which closely match situations likely to be encountered in the field.

2.5 Application of Models to Hypothetical Signs

To evaluate the hypothetical signs, answers were sought to these questions:

1. At 80, 60, 55, and 40 miles per hour *(128.7, 96.6, 88.5, and 64.4 kilometers per hour)*, what is the maximum viewing distance at which Standards-conforming signs should be legible?

2. What effect does the lateral displacement from the road have upon the viewing distance?

3. For four-line signs, what is the minimum height, length, and area which would meet the driver's needs, if 50 ft/in *(6 m/cm)* is the visual acuity used? Only four-line signs were used because they made full use of the available area.

3.0 Results

The Standards address five factors related to sign design and placement. These are: (1) maximum sign area of 150 ft^2 *(13.9 m^2)*, (2) length and height each restricted to a maximum of 20 ft *(6.1 m)*, (3) no more than three signs per route, (4) spacing between signs must be at least one mile *(1.6 km)*, and (5) maximum distance from signs to the site is 50 or 75 air miles *(80.5 or 120.7 km)*, depending on the type of road system.

3.1 Problem Areas in the Standards

A review of the Standards and official records showed minimal reference to supporting technical data. For example, no source could be identified to support the one mile *(1.6 kilometer)* spacing between signs, or the restriction of height and length to 20 ft *(6.1 m)*.

A supplementary report from the Commission on Highway Beautification (1975, draft) noted that the 660 ft *(201.2 m)* setback limit was apparently a legislative compromise. In 1955, the Congress had recommended 550 ft *(167.6 m)* in similar highway legislation and later hearings before the Department of Commerce were concluded with a 750 ft *(228.6 m)* recommendation. The present setback of 660 ft *(201.2 m)* is one-eighth of a mile, a furlong, and is apparently not based on highway construction requirements or driver constraints.

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*If the terminal angle of regard exceeds 90°, then the driver will be beyond the sign and must look back at it to finish reading, an impossible situation. Past 90° only the back of the sign is visible if the plane of the sign is perpendicular to the roadway.

Similarly, the 150 ft^2 *(13.9 m^2)* maximum area was adopted over 15 years ago. Its basis is unknown. In a field survey of signs erected next to highways throughout the country (excluding right-of-way signs), FHWA ascertained that over 75% were 150 ft^2 *(13.9 m^2)* or less. Such face validity was apparently used as the basis for continuing the restriction.

As summarized in Appendix B, state standards for directional signs submitted to FHWA for review are essentially in conformance with the Federal regulations. Minor modifications were made on many points, but in terms of sign dimensions and number, all comply with the 131(c) requirements.

3.2 Consultant Conclusions

There was general agreement among the consultants, but with differences of opinion expressed about the specifics of several restrictions. Each consultant stated that a maximum sign size of 150 ft^2 *(13.9 m^2)* was probably too restrictive for all signing situations, and that many factors affect the minimum necessary sign area (e.g., lateral displacement from the roadway, message length, surrounding terrain and traffic density). Similar observations were made concerning character size. The consultants suggested that parameters traditionally used to determine the minimum character size needed for right-of-way signs could just as well be applied to 131(c) type signs, so as to tailor each to the requirements imposed by its intended location. Parameters noted were: visual angle subtended by the image, angle of regard, and traffic density.

No direct comments were received with respect to the number of signs per route. The most direct statement on this point was the suggestion that the "rule of three" concept used in right-of-way highway signing should also be applied to the 131(c) type of signs. This concept requires that three separate warnings be given to drivers prior to each decision point. The one mile *(1.6 km)* spacing was considered to be well above the minimum needed to avoid confusion and distraction. Suggestions were made that if a more different limit is ever adopted it should never be less than 1500 to 2000 ft *(457.2 to 609.6 m)*. One expert also suggested that more than one attraction could be announced at the same sign location, particularly when placed immediately prior to a decision point. No direct comments were made nor any data cited with regard to the distance from the signs to the site.

3.3 Field Site Measurements

Four signs erected in compliance with the Standards were measured to serve as a frame of reference when analyzing the hypothetical signs. Although selected signs did not constitute a statistically representative sample, they did serve as examples of field problems and practices.

The physical measurements of the signs are presented in Table 1. They include the height and length of the sign board; height, width and stroke width of selected characters; and the lateral displacement of the sign. Sign length and the number of words in each sign were used with King's model to determine the maximum viewing distance at which each of these signs should

Table 1

Physical Measurements of Signs and Characters for Four Standards-Conforming Signs
(Photographs of each are presented in Appendix C)

	Sign A (Fig. 14)	Sign B (Fig. 18)	Sign C (Fig. 20)	Sign D (Fig. 16)
Sign height	15.0 ft *4.6 m*	15.0 ft *4.6 m*	15.0 ft *4.6 m*	15.0 ft *4.6 m*
Sign width	10.0 ft *3.0 m*	10.0 ft *3.0 m*	10.0 ft *3.0 m*	10.0 ft *3.0 m*
Lateral displacement (sign to edge of roadway)	82.5 ft *25.1 m*	83.6 ft *25.5 m*	79.8 ft *24.3 m*	79.0 ft *24.1 m*
Percent of available area used	100%	100%	100%	100%
Number of words on sign	7	7	10	8
Character Dimensions				
Largest character	"C" in Caverns	"C" in Caverns	"S" in Skyline	"C" in Caverns
Height/Stroke width	29.0 in/5.5 in *73.66 cm/13.97 cm*	29.0 in/5.0 in *73.66 cm/12.70 cm*	21.0 in/3.0 in *53.34 cm/7.62 cm*	26.0 in/5.5 in *66.04 cm/13.97 cm*
Second largest character	"E" in Caverns	"E" in Caverns	"E" in Skyline	"E" in Exit
Height/Stroke width	22.0 in/ * *55.88 cm/ **	21.0 in/ * *53.34 cm/ **	15.8 in/ * *40.13 cm/ **	18.0 in/3.5 in *45.72 cm/8.89 cm*
Third largest character	"O" in Front	"E" in Drive	"O" in Front	"M" in Mi.
Height/Stroke width	12.0 in/3.0 in *30.48 cm/7.62 cm*	12.0 in/2.5 in *30.48 cm/6.35 cm*	12.0 in/2.5 in *30.48 cm/6.35 cm*	14.5 in/3.0 in *36.83 cm/7.62 cm*

*Measurements not made.

Table 2

Viewing distances required according to King's model, and predicted distances at which the line of largest characters would be legible, using the rule of thumb (50 ft/in, *6 m/cm*) legibility distance ratio.*

	Character Height	Required viewing distance 80 mph *(128.7 kph)*	60 mph *(96.6 kph)*	55 mph *(88.5 kph)*	40 mph *(64.4 kph)*	Rule of thumb (50 ft/in) distance at which measured character would be legible
Sign A	22 in *55.88 cm*	1180 ft *360 m*	1061 ft *323 m*	1031 ft *314 m*	941 ft *287 m*	1100 ft *335 m*
Sign B	21 in *53.34 cm*	1187 ft *362 m*	1067 ft *325 m*	1037 ft *316 m*	947 ft *289 m*	1050 ft *320 m*
Sign C	15.8 in *40.13 cm*	1273 ft *388 m*	1126 ft *343 m*	1089 ft *332 m*	979 ft *298 m*	787 ft *240 m*
Sign D	18 in *45.72 cm*	1196 ft *365 m*	1068 ft *326 m*	1035 ft *315 m*	939 ft *286 m*	900 ft *274 m*

*This 50 ft/in *(6 m/cm)* rule of thumb is only slightly different from the 20/23 visual acuity used to evaluate hypothetical signs (49.8 or 49.3 ft/in; *5.98 or 5.92 m/cm*).

be legible, at several velocities and lateral displacements. These data are presented in Table 2. Also shown in this table is the maximum distance at which the sign characters would be legible, based on 50 ft *(15.2 m)* of viewing distance for every inch *(2.54 cm)* of character height. Signs C and D are not legible at the distance required by King's model, which means that the divergence angle would be greater than 10° before reading was completed.

A variety of signing techniques are shown in Appendix C. Only caverns-related signs were photographed and measured, since other-types of sites in the Washingtion, D.C. area have not yet erected signs under the Standards. Unless located in commercial zones, non-conforming signs for all types of sites are scheduled to be removed by December 1976.

3.4 Sign Size, Legibility, and Theoretical Models

For the hypothetical signs, the 150 ft^2 *(13.9 m^2)* limitation was the binding constraint for the four-line format. The two- and three-line formats were constrained by the maximum 20 ft *(6.1 m)* length allowed. Figure 4 presents the percentage of available area used by each Standards-conforming sign (as reported in Table 3). Table 4 presents the distances at which the fictitious message would be legible on Standards-conforming signs, for four levels of visual acuity.

The distance at which the signs should be legible was determined for each sign using both King's model and Rockwell's model. For each of the four-line signs the five different configurations did not produce substantial differences to such distances. For this reason, the data for only one sign, (configuration D of the four-line signs) are presented in tabular form (Table 5).

Table 6 presents the minimum viewing distances for all two- and three-line signs (each of which was restricted in length to 20 ft *(6.1 m)*. Since theoretically derived viewing distances are based on sign length, such distances for these signs are identical.

The height, length, and area which would be required at the various speeds and placement distances were calculated only for four-line signs because such signs allowed the largest character size within the constraints. The same procedures can be used to calculate these dimensions for any other sign. Figures 5 and 6 illustrate the minimum viewing distance required by the models under several conditions, and the maximum distance at which characters of the hypothetical signs would be legible.

If all of Rockwell's assumptions are accepted, the Standards are not adequate for drivers having normal (20/20) visual acuity, traveling at speeds above 60 mph *(96.6 kph)*. King's model assumes less reading time required, but many of the test signs placed 80 ft or less from the pavement are also not adequate at speeds above 60 mph *(96.6 kph)*. Although it is unlikely that anyone would choose to erect a sign at the limits of the protected zone (660 ft or *201.2 m* beyond the right of way) if a closer position were available, the size of such a sign at that distance would have to be several thousand square feet to be legible, far exceeding the 150 ft^2 *(13.9 m^2)* limit. Tables 7-9 present sign dimensions needed to display legible messages on the UC/LC, 0.75 spacing, four-line sign at various speeds, lateral displacements and divergence angles.

Table 3

Dimensions of "optimum" signs. (Area figures are rounded to the nearest whole ft^2.)

Configuration A - All UC characters, 0.75 spacing.
Configuration B - All UC, 0.75 spacing, destination 1.5 times as large.
Configuration C - All UC, 0.33 spacing.
Configuration D - UC/LC, 0.75 spacing.
Configuration E - UC/LC, 0.75 spacing, destination 1.5 times as large.

	Height	Length	Area	Percentage of available area used
Four-line Signs				
A	8.77 ft *2.67 m*	17.09 ft *5.20 m*	150 ft^2 *13.9 m^2*	100%
B	8.24 ft *2.51 m*	18.19 ft *5.54 m*	150 ft^2 *13.9 m^2*	100%
C	8.02 ft *2.44 m*	18.68 ft *5.69 m*	150 ft^2 *13.9 m^2*	100%
D	8.78 ft *2.65 m*	17.08 ft *5.20 m*	150 ft^2 *13.9 m^2*	100%
E	8.24 ft *2.67 m*	18.18 ft *5.54 m*	150 ft^2 *13.9 m^2*	100%
Three-line Signs				
A	5.15 ft *1.56 m*	20.00 ft *6.09 m*	103 ft^2 *9.6 m^2*	69%
B	4.36 ft *1.32 m*	20.00 ft *6.09 m*	87 ft^2 *8.1 m^2*	58%
C	4.43 ft *1.35 m*	20.00 ft *6.09 m*	89 ft^2 *8.2 m^2*	59%
D	5.23 ft *1.59 m*	20.00 ft *6.09 m*	105 ft^2 *9.8 m^2*	70%
E	4.44 ft *1.35 m*	20.00 ft *6.09 m*	89 ft^2 *8.3 m^2*	60%
Two-line Signs				
A	3.65 ft *1.11 m*	20.00 ft *6.09 m*	73 ft^2 *6.8 m^2*	49%
B	3.36 ft *1.02 m*	20.00 ft *6.09 m*	67 ft^2 *6.2 m^2*	45%
C	3.28 ft *0.99 m*	20.00 ft *6.09 m*	66 ft^2 *6.1 m^2*	44%
D	3.70 ft *1.16 m*	20.00 ft *6.09 m*	74 ft^2 *6.9 m^2*	49%
E	3.42 ft *1.04 m*	20.00 ft *6.09 m*	68 ft^2 *6.3 m^2*	45%

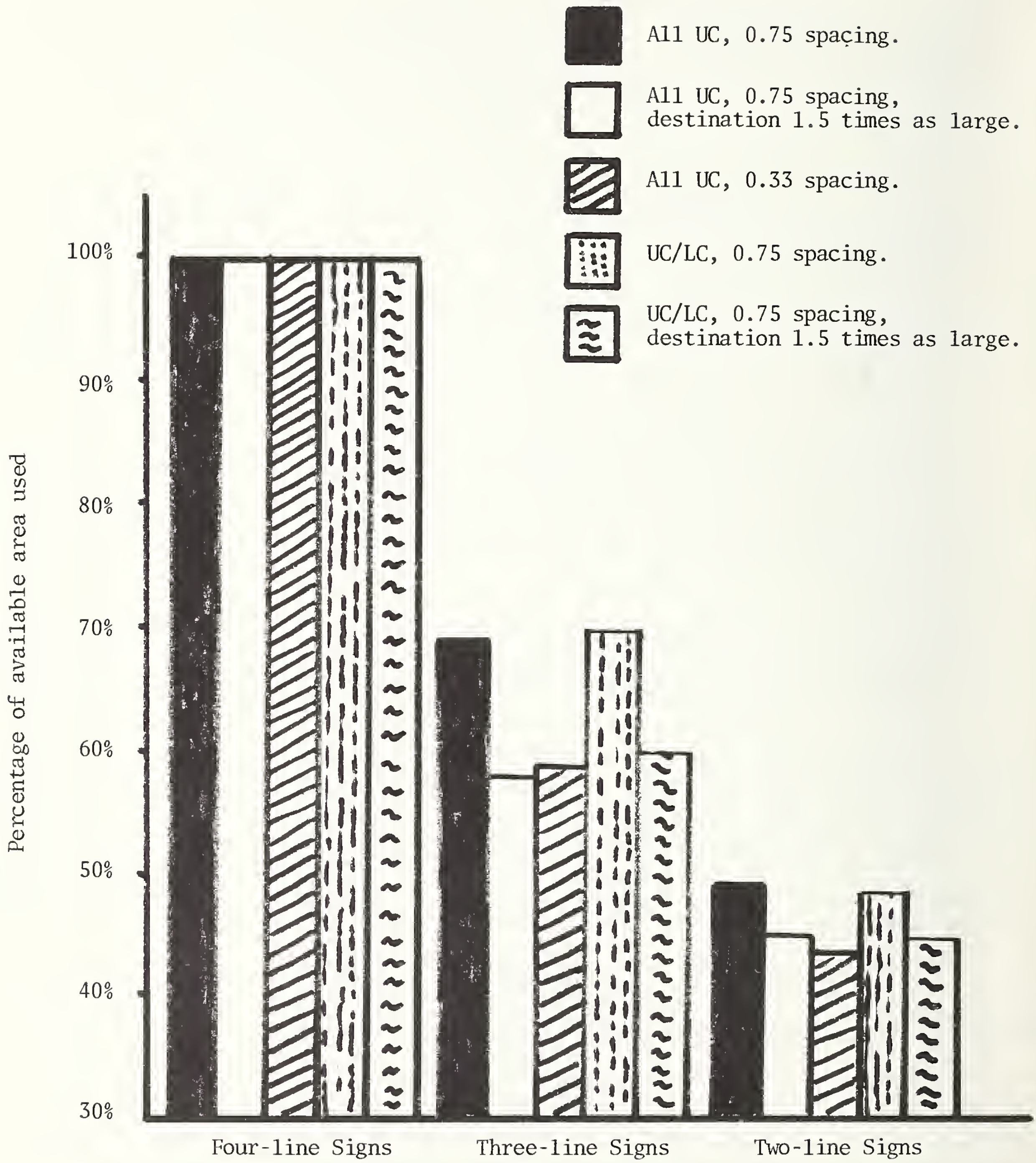

Figure 4. Percentage of available area used by Standards-conforming, hypothetical signs. (From Table 3.)

Table 4

Distances in feet at which the hypothetical "Standards-conforming" signs would be legible, at various levels of visual acuity. (Distances in meters are shown in italics.) Sign configurations A-E are the same as those presented in Table 3.

Four-line Signs

Visual Acuity	A	B	C	D	E
20/20	669	713	731	774	824
	203.9	*217.3*	*222.8*	*235.9*	*251.2*
20/23	584	662	638	677	719
	178.0	*189.6*	*194.5*	*206.3*	*219.2*
20/40	338	360	369	391	416
	103.0	*109.7*	*112.5*	*119.2*	*126.8*
20/70	191	204	209	221	235
	58.2	*62.2*	*63.7*	*67.4*	*71.6*

Three-line Signs

Visual Acuity	A	B	C	D	E
20/20	508	507	508	596	596
	154.8	*154.5*	*154.8*	*181.7*	*181.7*
20/23	443	442	443	521	521
	135.0	*134.7*	*135.0*	*158.8*	*158.8*
20/40	256	256	257	301	301
	78.0	*78.0*	*78.3*	*91.7*	*91.7*
20/70	145	145	145	170	171
	44.2	*44.2*	*44.2*	*51.8*	*52.1*

Two-line Signs

Visual Acuity	A	B	C	D	E
20/20	508	507	507	595	597
	154.8	*154.5*	*154.5*	*181.4*	*182.0*
20/23	443	442	442	520	521
	135.0	*134.7*	*134.7*	*158.5*	*158.8*
20/40	257	256	256	300	302
	78.3	*78.0*	*78.0*	*91.4*	*92.0*
20/70	145	145	145	170	171
	44.2	*44.2*	*44.2*	*51.8*	*52.1*

Table 5

Viewing distances in feet from which a four-line, UC/LC sign having 0.75 interline spacing should be legible, according to two models (King, 1971; Rockwell, 1973). Model-derived distances are shown for various vehicular speeds, lateral displacements, and divergence angles. (Distances in meters are shown in italics.)

10° Divergence Angle

Lateral Displacement		5 ft		35 ft		80 ft		740 ft	
80 mph	King	742	*(226)*	914	*(279)*	1172	*(357)*	4970	*(1515)*
(128.7 kph)	Rockwell	1245	*(379)*	1416	*(432)*	1674	*(510)*	5468	*(1667*
60 mph	King	622	*(190)*	794	*(242)*	1052	*(321)*	4851	*(1479)*
(96.6 kph)	Rockwell	999	*(304)*	1170	*(357)*	1428	*(435)*	5224	*(1592)*
55 mph	King	592	*(180)*	764	*(233)*	1022	*(312)*	4822	*(1470)*
(88.5 kph)	Rockwell	937	*(286)*	1109	*(338)*	1366	*(416)*	5163	*(1574)*
40 mph	King	501	*(153)*	674	*(205)*	933	*(284)*	4732	*(1442)*
(64.4 kph)	Rockwell	752	*(229)*	924	*(282)*	1182	*(360)*	4981	*(1518)*

30° Divergence Angle

Lateral Displacement		5 ft		35 ft		80 ft		740 ft	
80 mph	King	563	*(172)*	618	*(188)*	702	*(214)*	1993	*(607)*
(128.7 kph)	Rockwell	1065	*(325)*	1119	*(341)*	1200	*(366)*	2464	*(751)*
60 mph	King	443	*(135)*	498	*(152)*	583	*(178)*	1883	*(574)*
(96.6 kph)	Rockwell	819	*(250)*	873	*(266)*	956	*(291)*	2232	*(680)*
55 mph	King	413	*(126)*	468	*(143)*	554	*(169)*	1856	*(566)*
(88.5 kph)	Rockwell	758	*(231)*	812	*(247)*	894	*(272)*	2174	*(663)*
40 mph	King	323	*(98)*	380	*(116)*	466	*(142)*	1774	*(541)*
(64.4 kph)	Rockwell	573	*(175)*	628	*(191)*	712	*(217)*	2003	*(611)*

40° Divergence Angle

Lateral Displacement		5 ft		35 ft		80 ft		740 ft	
80 mph	King	538	*(164)*	577	*(176)*	637	*(194)*	1614	*(492)*
(128.7 kph)	Rockwell	1041	*(317)*	1078	*(329)*	1136	*(346)*	2069	*(631)*
60 mph	King	418	*(127)*	458	*(140)*	520	*(158)*	1510	*(460)*
(96.6 kph)	Rockwell	795	*(242)*	833	*(254)*	891	*(272)*	1843	*(562)*
55 mph	King	388	*(118)*	428	*(130)*	490	*(149)*	1484	*(452)*
(88.5 kph)	Rockwell	733	*(223)*	771	*(235)*	830	*(253)*	1787	*(545)*
40 mph	King	299	*(91)*	340	*(104)*	403	*(123)*	1408	*(429)*
(64.4 kph)	Rockwell	549	*(167)*	588	*(179)*	648	*(198)*	1623	*(495)*

Table 6

Viewing distances in feet from which two and three-line signs should be legible, according to two models (King, 1971; Rockwell, 1973). Model-derived distances are shown for various vehicular speeds, lateral displacements, and divergence angles. (Distance in meters shown in italics.)

10° Divergence Angle

Lateral Displacement		5 ft		35 ft		80 ft		740 ft	
80 mph	King	750	*(299)*	922	*(281)*	1180	*(360)*	4979	*(1518)*
(128.7 kph)	Rockwell	1253	*(382)*	1424	*(434)*	1682	*(513)*	5476	*(1669)*
60 mph	King	630	*(192)*	802	*(244)*	1061	*(323)*	4860	*(1481)*
(96.6 kph)	Rockwell	1007	*(307)*	1178	*(359)*	1436	*(438)*	5233	*(1595)*
55 mph	King	600	*(183)*	772	*(235)*	1031	*(314)*	4830	*(1472)*
(88.5 kph)	Rockwell	945	*(288)*	1117	*(340)*	1375	*(419)*	5172	*(1576)*
40 mph	King	510	*(155)*	682	*(208)*	941	*(287)*	4741	*(1445)*
64.4 kph)	Rockwell	761	*(232)*	933	*(284)*	1191	*(363)*	4989	*(1521)*

30° Divergence Angle

Lateral Displacement		5 ft		35 ft		80 ft		740 ft	
80 mph	King	566	*(172)*	620	*(189)*	704	*(215)*	1996	*(608)*
(128.7 kph)	Rockwell	1068	*(326)*	1122	*(342)*	1203	*(367)*	2467	*(752)*
60 mph	King	446	*(136)*	501	*(153)*	586	*(179)*	1886	*(575)*
(96.6 kph)	Rockwell	822	*(251)*	876	*(267)*	958	*(292)*	2235	*(681)*
55 mph	King	416	*(127)*	471	*(144)*	556	*(170)*	1858	*(566)*
(88.5 kph)	Rockwell	760	*(232)*	815	*(248)*	897	*(273)*	2177	*(664)*
40 mph	King	326	*(99)*	382	*(117)*	469	*(143)*	1777	*(542)*
(64.4 kph)	Rockwell	576	*(176)*	631	*(192)*	715	*(218)*	2006	*(611)*

40° Divergence Angle

Lateral Displacement		5 ft		35 ft		80 ft		740 ft	
80 mph	King	540	*(165)*	579	*(177)*	639	*(195)*	1616	*(493)*
(128.7 kph)	Rockwell	1043	*(318)*	1080	*(329)*	1138	*(347)*	2071	*(631)*
60 mph	King	420	*(128)*	460	*(140)*	522	*(159)*	1512	*(461)*
(96.6 kph)	Rockwell	797	*(243)*	835	*(254)*	893	*(272)*	1845	*(562)*
55 mph	King	390	*(119)*	430	*(131)*	492	*(150)*	1486	*(453)*
(88.5 kph)	Rockwell	735	*(224)*	773	*(236)*	832	*(254)*	1789	*(545)*
40 mph	King	301	*(92)*	342	*(104)*	405	*(124)*	1410	*(430)*
(64.4 kph)	Rockwell	551	*(168)*	590	*(180)*	650	*(198)*	1625	*(495)*

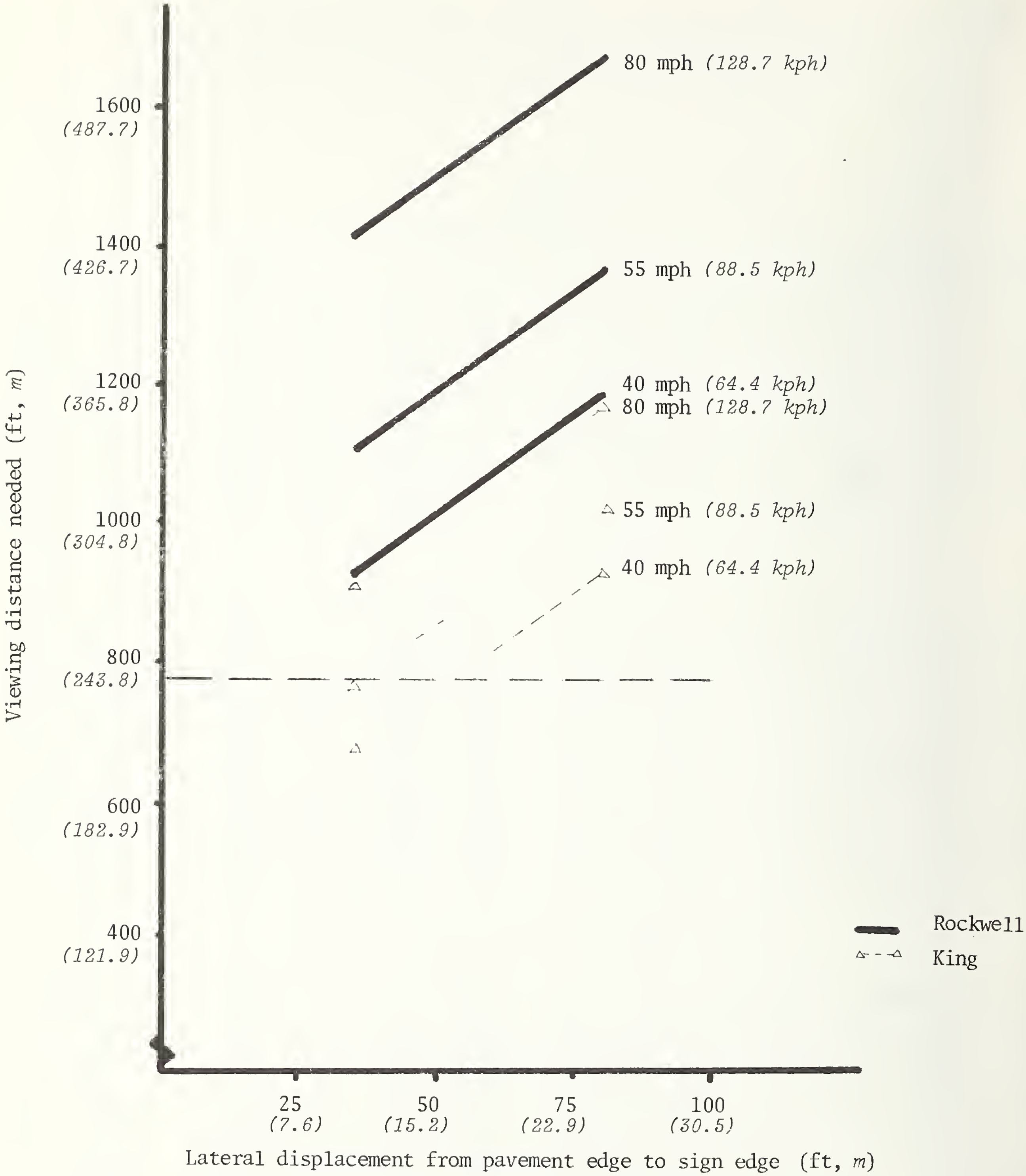

Figure 5. Viewing distance needed to read characters on a four-line sign, UC/LC characters, 0.75 interline spacing, at a 10° divergence angle at various lateral displacements. The horizontal dotted line is the distance at which the characters on the four-line sign would be legible to stationary viewers of 20/20 visual acuity. (From Table 5.)

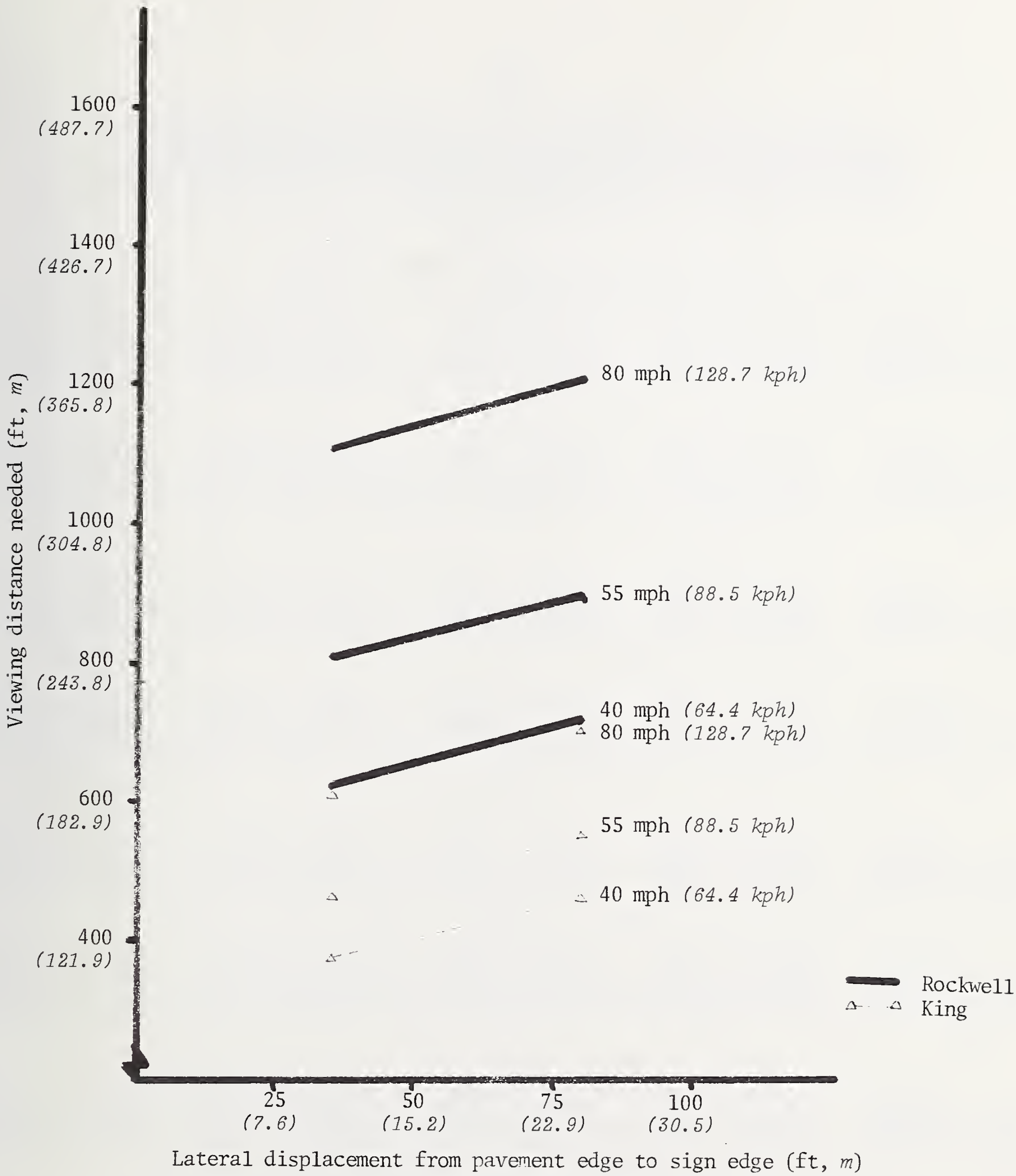

Figure 6. Viewing distance needed to read characters on a four-line sign, UC/LC characters, 0.75 interline spacing, at a 30° divergence angle at various lateral displacements. The horizontal dotted line is the distance at which the characters on the four-line sign would be legible to stationary viewers of 20/20 visual acuity. (From Table 5.)

Table 7

Sign dimensions in feet needed to display the four-line, UC/LC, 0.75 interline spacing sign to drivers of 20/23 visual acuity, at a 10° divergence angle, at various vehicular speeds and lateral displacements. (Dimensions in meters are shown in italics.)

			10° Divergence Angle							
Lateral Displacement			5 ft		35 ft		80 ft		740 ft	
80 mph *(128.7 kph)*	King	Height	9.58	*(2.92)*	11.80	*(3.60)*	15.14	*(4.61)*	64.20	*(19.57)*
		Length	18.64	*(5.68)*	22.96	*(7.00)*	29.46	*(8.98)*	124.92	*(38.08)*
		Area	179	*(16.6)*	271	*(25.2)*	446	*(41.4)*	8020	*(745.0)*
	Rockwell	Height	16.08	*(4.90)*	18.29	*(5.57)*	21.62	*(6.59)*	70.63	*(21.53)*
		Length	31.29	*(9.54)*	35.59	*(10.85)*	42.07	*(12.82)*	137.43	*(41.89)*
		Area	503	*(46.7)*	651	*(60.5)*	910	*(84.5)*	9707	*(901.8)*
60 mph *(96.6 kph)*	King	Height	8.03	*(2.45)*	10.25	*(3.12)*	13.59	*(4.14)*	62.66	*(19.10)*
		Length	15.62	*(4.76)*	19.94	*(6.08)*	26.44	*(8.06)*	121.92	*(37.16)*
		Area	125	*(11.7)*	204	*(19.0)*	359	*(33.4)*	7640	*(709.7)*
	Rockwell	Height	12.90	*(3.93)*	15.11	*(4.61)*	18.44	*(5.62)*	67.48	*(20.57)*
		Length	25.10	*(7.65)*	29.40	*(8.96)*	35.88	*(10.94)*	131.30	*(40.02)*
		Area	324	*(30.1)*	444	*(41.3)*	662	*(61.5)*	8860	*(823.1)*
55 mph *(88.5 kph)*	King	Height	7.64	*(2.33)*	9.86	*(3.01)*	13.20	*(4.02)*	62.28	*(18.98)*
		Length	14.87	*(4.53)*	19.19	*(5.85)*	25.68	*(7.83)*	121.18	*(36.94)*
		Area	114	*(10.6)*	189	*(17.6)*	339	*(31.5)*	7547	*(701.1)*
	Rockwell	Height	12.10	*(3.69)*	14.32	*(4.36)*	17.65	*(5.38)*	66.69	*(20.33)*
		Length	23.54	*(7.17)*	27.86	*(8.49)*	34.34	*(10.47)*	129.77	*(39.55)*
		Area	285	*(26.5)*	399	*(37.1)*	606	*(56.3)*	8654	*(804.0)*
40 mph *(64.4 kph)*	King	Height	6.48	*(1.98)*	8.70	*(2.65)*	12.04	*(3.67)*	61.13	*(18.63)*
		Length	12.61	*(3.84)*	16.93	*(5.16)*	23.43	*(7.14)*	118.95	*(36.26)*
		Area	82	*(7.6)*	147	*(13.7)*	282	*(26.2)*	7271	*(675.5)*
	Rockwell	Height	9.72	*(2.96)*	11.94	*(3.64)*	15.27	*(4.65)*	64.33	*(19.61)*
		Length	18.91	*(5.76)*	23.23	*(7.08)*	29.71	*(9.06)*	125.17	*(38.15)*
		Area	184	*(17.1)*	277	*(25.8)*	454	*(42.2)*	8052	*(748.1)*

Table 8

Sign dimensions in feet needed to display the four-line, UC/LC, 0.75 interline spacing sign to drivers of 20/23 visual acuity, at a 30° divergence angle, at various vehicular speeds and lateral displacements. (Dimensions in meters are shown in italics.)

			30° Divergence Angle							
Lateral Displacement			5 ft		35 ft		80 ft		740 ft	
80 mph (128.7 kph)	King	Height	7.27	*(2.22)*	7.98	*(2.43)*	9.06	*(2.76)*	25.75	*(7.85)*
		Length	14.15	*(4.31)*	15.53	*(4.73)*	17.63	*(5.37)*	50.10	*(15.27)*
		Area	103	*(9.6)*	124	*(11.5)*	160	*(14.8)*	1290	*(119.9)*
	Rockwell	Height	13.76	*(4.19)*	14.45	*(4.40)*	15.51	*(4.73)*	31.83	*(9.70)*
		Length	26.77	*(8.16)*	28.12	*(8.57)*	30.18	*(9.20)*	61.94	*(18.88)*
		Area	368	*(34.2)*	406	*(37.8)*	468	*(43.5)*	1972	*(183.2)*
60 mph (96.6 kph)	King	Height	5.72	*(1.74)*	6.44	*(1.96)*	7.53	*(2.30)*	24.32	*(7.41)*
		Length	11.13	*(3.39)*	12.53	*(3.82)*	14.65	*(4.47)*	47.32	*(14.42)*
		Area	64	*(5.9)*	81	*(7.5)*	110	*(10.3)*	1151	*(106.9)*
	Rockwell	Height	10.58	*(3.22)*	11.28	*(3.44)*	12.34	*(3.76)*	28.83	*(8.79)*
		Length	20.59	*(6.28)*	21.95	*(6.69)*	24.01	*(7.32)*	56.10	*(17.10)*
		Area	218	*(20.2)*	248	*(23.0)*	296	*(27.6)*	1617	*(150.3)*
55 mph (88.5 kph)	King	Height	5.33	*(1.62)*	6.05	*(1.84)*	7.15	*(2.18)*	23.97	*(7.31)*
		Length	10.37	*(3.16)*	11.77	*(3.59)*	13.91	*(4.24)*	46.64	*(14.22)*
		Area	55	*(5.1)*	71	*(6.6)*	99	*(9.2)*	1118	*(103.9)*
	Rockwell	Height	9.79	*(2.98)*	10.49	*(3.20)*	11.55	*(3.52)*	28.09	*(8.56)*
		Length	19.05	*(5.81)*	20.41	*(6.22)*	22.47	*(6.85)*	54.66	*(16.66)*
		Area	187	*(17.3)*	214	*(19.9)*	260	*(24.1)*	1535	*(142.6)*
40 mph (64.4 kph)	King	Height	4.17	*(1.27)*	4.90	*(1.49)*	6.02	*(1.83)*	22.91	*(6.98)*
		Length	8.11	*(2.47)*	9.53	*(2.90)*	11.71	*(3.57)*	44.58	*(13.59)*
		Area	34	*(3.1)*	47	*(4.3)*	70	*(6.6)*	1021	*(94.9)*
	Rockwell	Height	7.41	*(2.26)*	8.11	*(2.47)*	9.19	*(2.80)*	25.87	*(7.89)*
		Length	14.42	*(4.40)*	15.78	*(4.81)*	17.88	*(5.45)*	50.34	*(15.34)*
		Area	107	*(9.9)*	128	*(11.9)*	164	*(15.3)*	1302	*(121.0)*

Table 9

Sign dimensions in feet needed to display the four-line, UC/LC, 0.75 interline spacing sign to drivers of 20/23 visual acuity, at a 40° divergence angle, at various vehicular speeds and lateral displacements. (Dimensions in meters are shown in italics.)

40° Divergence Angle

Speed	Sign	Lateral Displacement	5 ft		35 ft		80 ft		740 ft	
80 mph *(128.7 kph)*	King	Height	6.95	*(2.12)*	7.46	*(2.27)*	8.23	*(2.51)*	20.84	*(6.36)*
		Length	13.52	*(4.12)*	14.52	*(4.43)*	16.01	*(4.88)*	40.57	*(12.37)*
		Area	94	*(8.7)*	108	*(10.1)*	132	*(12.2)*	846	*(78.6)*
	Rockwell	Height	13.44	*(4.10)*	13.93	*(4.25)*	14.67	*(4.47)*	26.72	*(8.14)*
		Length	26.15	*(7.97)*	27.11	*(8.26)*	28.54	*(8.70)*	51.99	*(15.85)*
		Area	351	*(32.7)*	378	*(35.1)*	419	*(38.9)*	1389	*(129.1)*
60 mph *(96.6 kph)*	King	Height	5.41	*(1.65)*	5.92	*(1.80)*	6.71	*(2.05)*	19.50	*(5.94)*
		Length	10.53	*(3.21)*	11.52	*(3.51)*	13.06	*(3.98)*	37.94	*(11.56)*
		Area	57	*(5.3)*	68	*(6.3)*	88	*(8.1)*	740	*(68.7)*
	Rockwell	Height	10.27	*(3.13)*	10.76	*(3.28)*	11.51	*(3.51)*	23.81	*(7.26)*
		Length	19.98	*(6.09)*	20.94	*(6.38)*	22.40	*(6.83)*	46.33	*(14.12)*
		Area	205	*(19.1)*	225	*(20.9)*	258	*(24.0)*	1103	*(102.5)*
55 mph *(88.5 kph)*	King	Height	5.02	*(1.53)*	5.53	*(1.69)*	6.33	*(1.93)*	19.17	*(5.84)*
		Length	9.77	*(2.98)*	10.76	*(3.28)*	12.32	*(3.76)*	37.30	*(11.37)*
		Area	49	*(4.6)*	60	*(5.5)*	78	*(7.3)*	715	*(66.4)*
	Rockwell	Height	9.47	*(2.89)*	9.96	*(3.04)*	10.72	*(3.27)*	23.09	*(7.04)*
		Length	18.43	*(5.62)*	19.38	*(5.91)*	20.86	*(6.36)*	44.93	*(13.69)*
		Area	175	*(16.2)*	193	*(17.9)*	224	*(20.8)*	1037	*(96.4)*
40 mph *(64.4 kph)*	King	Height	3.86	*(1.18)*	4.39	*(1.34)*	5.21	*(1.59)*	18.18	*(5.54)*
		Length	7.51	*(2.29)*	8.54	*(2.60)*	10.14	*(3.09)*	35.37	*(10.78)*
		Area	29	*(2.7)*	37	*(3.5)*	53	*(4.9)*	643	*(59.7)*
	Rockwell	Height	7.09	*(2.16)*	7.59	*(2.31)*	8.37	*(2.55)*	20.97	*(6.39)*
		Length	13.80	*(4.21)*	14.77	*(4.50)*	16.29	*(4.97)*	40.80	*(12.44)*
		Area	98	*(9.1)*	112	*(10.4)*	136	*(12.7)*	856	*(79.5)*

For all practical purposes, eye movement (without head movement) is not expected of drivers past the center of their rear view mirror. While this angle is dependent upon many factors, 40° is a reasonable average. Using a terminal divergence angle of 40° for King's model, most Standards-conforming signs could be read at most speeds - unless located far from the edge of the right-of-way.

4.0 Discussion

4.1 Problem Areas

Available records did not explain the rationale for adopting the current limits in the Standards, and state codes do not differ significantly from the provisions spelled out in the 131(c) regulations. Thus, it was necessary to consider the specific objections raised by the National Caves Association (NCA) and other potential problems raised by research results to evaluate the adequacy of the Standards.

NCA objections to the Standards were primarily concerned with the size and number of signs allowed. In place of existing restrictions, a 700% increase in total area (doubling the number of signs allowed and increasing the area of each to 600 ft^2 *(55.7 m^2)*) was proposed. Rather than react directly to these proposed changes, the approach taken in this project was to objectively determine sign dimensions adequate for the field environment expected. Aspects of the Standards considered potential problems and subject to examination were sign dimensions, spacing between signs, and the number of signs allowed per route.

4.2 Development of Theoretical Tests

Since official records did not explain the rationale used to select the values for these variables, and since the available literature did not directly address the specific points in the Standards, it was necessary to use design paradigms originally developed for right-of-way signs to evaluate our hypothetical, "worst case" examples.

Figure 4 illustrates the importance of properly arranging messages to make best use of the available area, i.e., a four-line Standards-conforming sign constrained only by an area limit, would be legible at the required viewing distance, though two- and three-line versions of the same message would be of inadequate character height since they were constrained more severly by the length limit. So long as maximum limits on height and length are in the Standards, their influence is greatly affected by the sign format used.

Addressing a separate issue, Tables 5 and 6 present data which can be used to judge the adequacy of signs conforming to the existing dimensional restrictions. Listed in these tables are the sign dimensions needed to display the Schmillingrass Caverns message at the model-derived viewing distances, to drivers of 20/23 visual acuity.

As shown in Tables 7-9, for many conditions signs must be larger than 150 ft^2 *(13.9 m^2)* to meet the requirements of each model. As speed and lateral displacement increase, Standards-conforming signs become more and more inadequate. However, if signs are located 35-80 ft *(10.7-24.4 m)* from the pavement and the angle of regard is assumed to be 30°, many Standards-conforming signs are adequate. For example, at the minimum speed (40 mph, *64.4 kph)*, the minimum lateral displacement (5 ft, *1.5 m*), and at the largest divergence angle (40°), a sign of less than 30 ft^2 *(2.8* m^2*)* would be adequate to meet King's assumptions, and a sign of 98 ft^2 *(9.1* m^2*)* would meet Rockwell's assumptions. However, at 80 mph *(128.7 kph)*, 740 ft *(225.6 m)* from the edge of the pavement, and using a 10° divergence angle, the same sign would have to be several thousand square feet.

Specific values must be assumed for the essential parameters of speed, lateral displacement, divergence angle, and visual acuity if the data from these tables are to be used to determine in what way and to what extent the standards are adequate or inadequate.

The sign size required at the outermost edge of the protected zone is far in excess of 150 ft^2 *(13.9* m^2*)*. Few businesses would be likely to choose such a distant placement if a closer position were available, but it can be concluded that signs of 150 ft^2 *(13.9* m^2*)* are not adequate at all points within the protected zone. If the size restriction is to be maintained, a shorter, maximum setback distance within the protected zone should be adopted, or a range of sizes be defined for various lateral displacements.

The data illustrate the importance of visual angle in sign design. Signs which meet the optimum length/height ratio increase in area as they are placed farther from the roadway. The effect is comparable to projecting an image on a screen. When close, the image is small, and it increases in size as the screen is moved farther away. Though the actual size of the image on the screen changes, the visual angle which that image subtends at the viewer's eye is constant. If the Standards placed a restriction on the size of the visual angle which the sign could subtend, signs placed at all distances from the roadway would all present the same image size to a viewer. As an alternative to an absolute size regulation, a maximum visual angle specification would seem to be consistent with intent of the 150 ft^2 *(13.9* m^2*)* restriction currently in the Standards.

To insure that the text on each sign is legible (a need not directly addressed in the current Standards), the visual angle which the stroke width of characters must subtend should also be specified. If this change was coupled to a maximum visual angle for the sign itself, signs would be of uniform impact because their images would be of a constant apparent size, and the individual characters would be legible.

4.3 Limitations of the Models

These paradigms were selected and used because they presented illustrative examples of the parameters which must be considered in evaluating the Standards. As previously described, the essential differences between the models are the reading times assumed and the maximum divergence angles recommended. Both models were originally developed primarily for right-of-way signs; as the lateral displacement becomes large the models are not entirely adequate because the orientation of the sign itself becomes a major factor. It must be emphasized that no models were located which specifically addressed the highway signing situations covered by the Standards, and to that extent the viewing distances, character sizes, and sign dimensions could be expected to change if a more appropriate model were used instead.

4.4 Conclusions and Recommendations

Some parts of the Standards should be modified, to better meet the needs of drivers in the variety of field situations likely to be encountered when reading signs.

1. Directional sign Standards should require individual characters to be legible at the minimum visual acuity levels specified in state driver licensing regulations. For ease of use by highway engineers, this can be specified as a ratio of viewing distance/character height. The proper ratio would depend on the stroke width of the type of characters used.

2. Restricting the physical dimensions of signs may constrain those sites seeking to display long-named items of information. Instead, restrictions should limit the visual angle subtended by the sign in the horizontal and vertical directions. This would mean that signs placed close to the road would be smaller than those placed further away, that both would be of the same apparent size to the viewer, and that justifications for large signs would be based only on legibility needs of drivers.

3. No material was located to support a change to the present proximity limits between directional signs and interchanges or exits; to the number of signs allowed, or to the maximum distance from sign location to site location.

4. In terms of motorists' needs, the one mile *(1.6 km)* spacing between signs is adequate. Consultants recommended no change, but cautioned that this distance never be reduced to less than 1500-2000 ft *(457.2-609.6 m)*.

In the process of studying deficiencies and improvements to the Standards, the consultants made several other observations which merit consideration.

1. The current Standards include no "break away" requirements. In the interest of safety, signs covered by 131(c) regulations and located less than 80 ft *(24.4 m)* from the pavement should also comply with the break away requirements imposed on right-of-way signs.

2. Many developed cavern sites are located in close proximity to one another, due to the geological make-up of the area and ease of access for tourists. Motorists would be aided if right-of-way signs were used to announce the type of activity accessible from an exit (see Figures 21 and 22).

3. Effective, attention-getting signs of reasonable size are possible if standard shapes or colors are used. However, their use would require public education - more than a minor problem.

4. Consultants suggested that perhaps a priority of sign placement, indpendent of right-of-way, should be adopted. With this system of priorities, drivers could search specific areas of the visual field for driving information signs, without constantly scanning for signs over the entire area in front of the vehicle. For example, information signs could be located 35-50 ft *(10.7-15.2 m)* into the right-of-way, or overhead, and caverns-type directional signs could be located in the same position or at some other standard distance, such as 80 ft *(24.4 m)*.

4.5 Recommended Research

As noted several times in this report, most of the literature reviewed for this project was not directly applicable to the problems under study. To remedy this situation, several areas of research should be pursued.

1. The legibility of signs erected outside the right-of-way has not been sufficiently examined. More field testing is needed.

2. Laboratory experiments involving humans often yield data which are inconsistent with field results. As an example, the Janesville field study (National Advertising Company, undated report) determined that a 42 ft/in *(5.04 m/cm)* legibility distance/character height ratio was necessary for signs to be legible, whereas simulation studies had yielded a 50 ft/in *(6 m/cm)* ratio. Had the simulation-derived figures been used without field testing, all signs would have been too small for their intended placement. Field validation of laboratory studies and theoretical models is essential.

3. More data are needed on drivers' visual abilities. The proper ratio of viewing distance to character height is not firmly established, and the maximum terminal divergence angle has not been identified. Not only do they depend upon visual acuity and speed but also the familiarity of the message to be perceived and the type of characters used. Much work also needs to be done on the gestalt of highway sign perception - especially in terms of familiarity, driver attention and motivation, and driver expectancies and stereotyped responses. The visual acuity assumptions relate to such a gestalt, and could explain why words can be read on a highway sign at longer distances than would be predicted for a particular visual acuity level, even though some of the letters are not clearly discerned.

4. Better data are needed to define the "actual" static and dynamic visual acuity of the driving population. Many states require only a static visual acuity examination, and then only at the time of initial license application. Drivers whose vision has deteriorated over time may be operating at levels far below the tested level.

5. Much sign design is based upon assumed driver information needs. Proper design requires a better understanding of such needs: What level of information do drivers obtain prior to departure, what feedback is expected along the way, and what details are assumed to be announced prior to arrival? No research was identified by this project which could define the specific information drivers require or when they require it.

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APPENDIX A

Sign Design Guidelines

"Schmillingrass Caverns," was used to illustrate sign design principles. It used the same number of characters and spaces as the longest, real destination name previously studied by FHWA to respond to the question of the Standards' adequacy (FHWA Correspondence #To-21, 1974). For purposes of illustration and model testing the following assumptions were met for the various configurations of "Schmillingrass Caverns" signs. These design considerations were adapted from guidelines presented in Standard Alphabets for Highway Signs (1972 reprint of 1966 edition), from The Manual of Uniform Traffic Control Devices for Streets and Highways (1971), and from information obtained directly from Mr. Travis Brooks, FHWA, Office of Traffic Operations.

1. Character Height, Width and Stroke Width.

   - Stroke width to height ratios for Series E letters and numbers were used (Standard Alphabets, 1966).

   - Character widths employed maintained the same ratio to character height as was specified for 10 in *(25.4 cm)* high Series E characters.

   - Characters were not restricted to standard sizes. Rather characters that utilized all available height on the sign were used, e.g., 15.02 in *(38.15 cm)*.

   - Loop heights of lowercase (LC) characters in a given line were set at 0.75 the height of the uppercase (UC) characters in that line.

   - For signs having two sizes of UC characters, the larger was 1.5 times the height of the smaller.

2. Spacing Between Characters and Words.

   - Spacing between characters maintained the ratios specified in Standard Alphabets for spacing between 10 in *(25.4 cm)* characters.

   - Spacing between words on the SCHMILLINGRASS CAVERNS line equals the width of a fictitious UC "C" plus the spacing to the left and right of that "C".

3. Spacing to Side Borders.

   - Spacing from the first character of the longest line to the left vertical border, and spacing from the last character to the right border were each set equal to the height of the UC characters on that longest line.

4. Interline Spacing

   - The distance from the top border to the first line equalled 0.75 of the height of UC characters in that line.

   - For configurations A and D, interline spacing was 0.75 UC character height.

   - For configurations B and E, interline spacing was 0.75 the height of the first "S" in Schmillingrass.

   - For configuration C, interline spacing was 0.33 character height (Kindersley, 1966).

   - Spacing to the bottom border was 0.75 the height of the UC characters. (This differs slightly with guidelines in the Manual on Uniform Traffic Control Devices, but was assumed for ease of computation.)

5. Line Length

   - Only the length of the longest line was calculated since all other lines will fall within the same limits.

6. Sign Height was determined as the sum of the number of lines of text, interline spacings, and text-to-border spacings (expressed as proportions of character height).

7. Punctuation

   - No periods were used after abbreviations.

Widths of Characters, Spaces and Resultant Lines of Text for Four Configurations of "Schmillingrass Caverns," Widths Expressed as Proportions of Uppercase Character Heights

UC/LC line	Character (or space)	UC only line
1.000	Border to 1st Character	1.000
.797	S	.797
.313		.206
.633	C	.797
.413		.206
.663	H	.797
.513		.258
1.054	M	.922
.513		.258
.188	I	.172
.513		.258
.188	L	.734
.513		.206
.188	L	.734
.513		.206
.188	I	.172
.513		.258
.640	N	.797
.400		.258
.633	G	.797
.513		.258
.484	R	.797
.200		.206
.633	A	1.000
.375		.206
.633	S	.797
.233		.206
.633	S	.797
1.000	Last character to border	1.000
15.08	Subtotal[1]	15.10
1.209	Space between words	1.209
.797	C	.797
.350		.137
.633	A	1.000
.375		.068
.742	V	.906
.263		.206
.633	E	.734
.413		.206
.484	R	.797
.313		.258
.640	N	.797
.375		.258
.633	S	.797
1.000	Last character to border	1.000
22.94	Total[2]	23.27

Total Width of Line	
[1]SCHMILLINGRASS	15.10
[1]Schmillingrass	15.08
[2]SCHMILLINGRASS CAVERNS	23.27
[2]Schmillingrass Caverns	22.94

Appendix B

Summary of State Standards for Directional Signs

Table 10 presents a summary of pertinent provisions in various state codes regarding directional signs. The first ten states listed had previously submitted their codes to FHWA in accordance with provisions in Section 21.4, Paragraph (f) (3) of the Standards. As part of the preparation for field site measurements, those states near the Washington, D.C. area which had not yet submitted their codes were asked to provide regulations applicable to similar types of signs.

The entries in the first line of Table 10 are from Part 21, Section 21.2 and 21.4 of the Standards. All entries of "standard" mean that the State Code essentially replicates the Part 21 requirements for that point. FHWA responses to provisions less restrictive than the National Standards were not studied for this project. Because cell entries are only brief summaries, it will be necessary to refer to the State Code to clarify some specific provisions, e.g., the Number of Signs entry for Nebraska. Maryland has special provisions for directional signs, so the comments below relate to the remaining twelve states whose Codes were examined.

Distance from Right-of-Way (R-O-W, within 660 ft *(201.2 m)* of the nearest edge of R-O-W on Interstate (IS) and Federal-aid Primary System (P) and which are visible from the main traveled way of the system).

- 8 states meet or exceed the Standards.
- 3 states have not specified requirements.
- 1 state refers to locations adjacent to and visible from the main traveled way of IS and P.

Size (maximum: Area 150 ft^2; Height 20 ft; Length 20 ft; *or Area 13.9* m^2; *Height 6.1 m; Length 6.1 m).*

- All twelve states comply with the Standards.

Moving (signs which move or have any animated parts are prohibited).

- 7 states meet the Standards (one of these mentions P but not IS).
- 5 states have not specified requirements.

Spacing

a. (2,000 ft *(609.6 m)* minimum distance from an interchange or intersection at grade along IS or other freeways.)

   - 10 states meet the Standards (3 of these have other restrictions).
   - 1 state specified 100 ft *(30.5 m)* minimum from an intersection on any route or road.
   - 1 state specified 500 ft *(152.4 m).*

b. (2,000 ft *(609.6 m)* minimum distance from a rest area, parkland, or scenic area.)

- 8 states meet the Standards with respect to Federal-aid primary (1 of these does not mention IS).
- 1 state did not specify this requirement.
- 3 states specified 500 ft *(152.4 m)*.

c. (Separation of at least one mile *(1.6 kilometers)* from other directional signs facing same direction of travel.)

- 9 states meet the Standards (1 of these does not mention IS).
- 1 state specified 0.5 mile *(0.8 kilometers)*.
- 2 states mention shorter distances but are unclear as to how they relate to the Standards.

Number of Signs (Not more than three directional signs for same activity facing same direction along a single route to the activity.)

- 11 states meet the Standards (1 of these does not mention IS).
- 1 state does not permit commercial signs along IS.

Distance from Activity (Signs to be within 75 air miles *(120.7 kilometers)* along IS; within 50 air miles *(80.5 kilometers)* along P).

- 10 states meet the Standards (1 of these does not specify air miles and 1 requires signs to be within 5 air miles *(8 kilometers)* of the advertised activity).
- 2 states did not specify for IS (1 of these also did not specify for P).

Content (Message limited to identification of the attraction and directional information (mileage, route number, or exit numbers).)

- 9 states meet the Standards.
- 3 states not clearly specified.

Table 10. State Directional Sign Specification Summary

State, Date of Code	Distance from R-O-W	Size (maximum) Area (ft^2)	Height (ft)	Length (ft)	Moving	Lighting	Spacing: Minimum distance From intersection etc.	Minimum distance From Rest area, etc.	Separation
DOT Part 21 Section 21.2, 21.4 1/17/69	660 ft of Interstate and Federal-aid primary system and visible from main traveled way	150	20	20	Do not move and have no animated or moving parts	Stable, shielded, do not improve vision, do not interfere with traffic signal, device, sign	2000 ft on Interstate system or other freeway	2000 ft from rest area, parkland, scenic area	At least 1 mile between signs facing same direction of travel
Illinois 7/11/72	Standard	Standard	Standard	Standard	Standard	Standard	Standard, except for addition of "weigh" station	Standard	Standard
Indiana 3/3/72	Standard	Standard	Standard	Standard	Standard	Standard	Standard	Standard	Standard
Iowa No date	No non-complying, directional signs shall be visible from Interstate, freeway primary, or primary highway.	Standard	Standard	Standard	Not specified	Not specified	Standard	Standard	Standard
Mississippi 10/1/72	[1]Not indicated (see remarks)	Standard	Standard	Standard	Not specified	Standard	Standard	Standard	Standard
Missouri 3/16/72	Standard	Standard	Standard	Standard	Standard	Standard	Standard	Standard	Standard
Nebraska No date	Not specified	Standard	Standard	Standard	Not specified	Essentially standard	No sign within 100 ft of intersection on any route or road	Not specified	Minimum of 250 ft from any Class IV-A or IV-B[1] sign
Utah No date	Adjacent to and visible from main traveled way of IS and P	Standard	Standard	Standard	Standard	Standard	500 ft	500 ft	1/2 mile apart facing same direction
Virginia 10/29/70	Standard	Standard	Standard	Standard	Not specified	Standard	Standard	Standard	Standard
Wisconsin 1971	Standard	Standard	Standard	Standard	Standard	Standard	Standard	Standard	Standard
Wyoming 1971	Not specified	Standard	Standard	Standard	Not specified	Not specified	2000 ft from interchange or intersection or[1] 500 ft of interchange, intersection, safety, rest areas on IS or P with full access control	500 ft of public parks, playgrounds, scenic areas, cemetaries[2]	IS - 500 ft of existing off-premise sign[2] P - 300 ft of existing off-premise sign[2] All signs facing same direction of travel, at least one mile apart[3]
Ohio	Standard	Standard	Standard	Standard[1]	Standard	Standard	2000 ft of freeway interchange or 500 ft of non-froeway interchange	Standard[1]	Standard[1]
New Jersey 7/74	Standard	Standard	Standard	Standard	Standard	Standard	2000 ft, limited access highway; 500 ft, Non-limited access highway	2000 ft, limited access highway; 500 ft non-limited access highway	Standard
Maryland 7/1/68	NO PROVISION FOR DIRECTIONAL SIGNS								

Table 10. State Directional Sign Specification Summary (continued)

State, Date of Code	Number of Signs	Distance from Activity		Content	Remarks
		Interstate	Primary		
DOT Part 21 Section 21.2, 21.4 1/17/69	Not more than 3 signs for same activity facing same direction of travel along a single route to activity	Within 75 air miles	Within 50 air miles	Identification and directional information. No words, phrases, pictorial, photographic material descriptive of activity of envisions	Column entries for states are noted as "standard" when they essentially duplicate Section 21.2 or 21.4
Illinois 7/11/72	Standard	Standard	Standard	Standard	
Indiana 3/3/72	Standard	Standard	Standard	Standard	
Iowa No date	Standard	Standard	Standard	Standard	
Mississippi 10/1/72	Standard	Standard	Standard	Standard	[1]No indication of distance or visual criteria provided in SOP MND-09-06-00-000 pp. 6-11
Missouri 3/16/72	Standard	Standard	Standard	Standard	
Nebraska No date	Maximum 1 sign per mile per activity 1-5 miles from corporate or activity limits, none over or under that. Also, not more than 3 signs for same activity facing same direction of travel along a single route to activity (non-commercial).	Not specified	Not specified	Not specified but illustrations indicate that some message is acceptable	Data are for informational signs to public places owned and operated by Federal, State, or local governmental subdivisions, i.e., Class IV-A. Not clear as to status of private directional signs. [1]Class IV-B are local government or civic organization signs.
Utah No date	Standard	Within 5 air miles	Within 5 air miles	Essentially standard	
Virginia 10/29/70	Standard	Standard	Standard	Standard	
Wisconsin 1971	Standard	Standard	Standard	Standard	
Wyoming 1971	Standard	Standard	Standard	Not specified but context seems to imply identification and direction only	[1]This distinction is not clear as cited. [2]It is not clear if this applies to directional signs. [3]Relationship of this specification is not clear.
Ohio 4/5/72	Not specified[1]	Not specified	Standard	Standard	[1]Specified for Federal-aid primary highways without mention of Interstate highways
New Jersey 7/74	Standard	Within 75 miles, Limited access highway Within 50 miles, Non-limited access highway		Standard	[1]Not specified as air miles
Maryland 7/1/68					

APPENDIX C

Photographs and location maps
of field signs

Figure 7. #View of Harpers Ferry Caverns sign located in West Virginia just south of Bolivar, West Virginia on US Route 340.

Figure 8. #Close-up view of sign in Figure 7.

#Does not comply with 131(c) Standards.

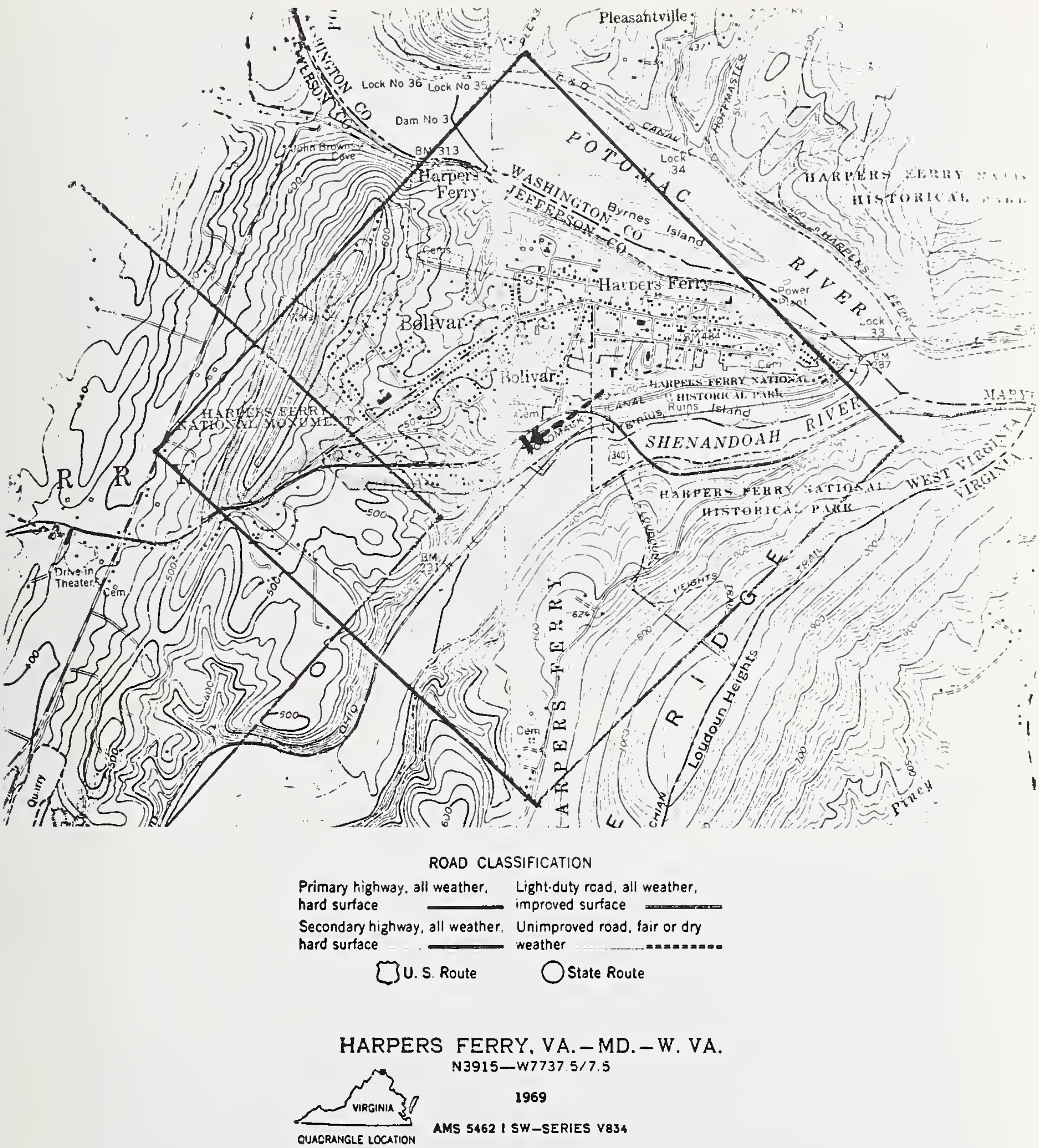

Figure 7A. Approximate location of Harpers Ferry Caverns sign located in West Virginia on US Route 340 just south of Bolivar, West Virginia (see Figures 7 and 8).

Figure 9. #View of Harpers Ferry Caverns sign located in West Virginia on US Route 340, approximately one mile (1.6 kilometers) east of Halltown, West Virginia.

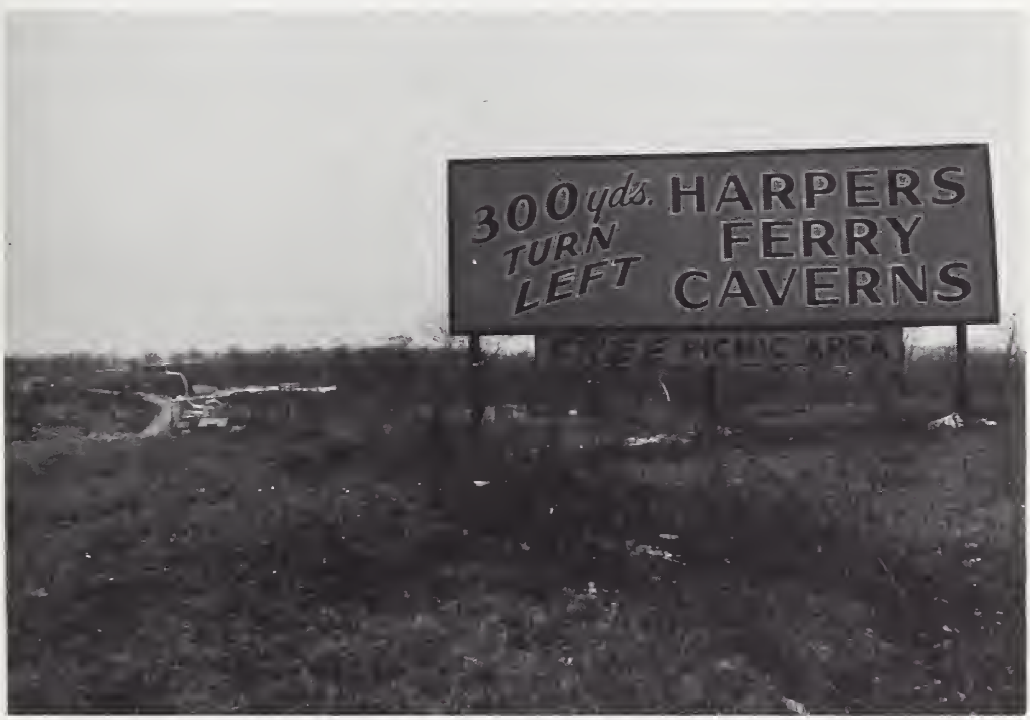

Figure 10. #Close-up view of sign in Figure 9.

#Does not comply with 131(c) Standards.

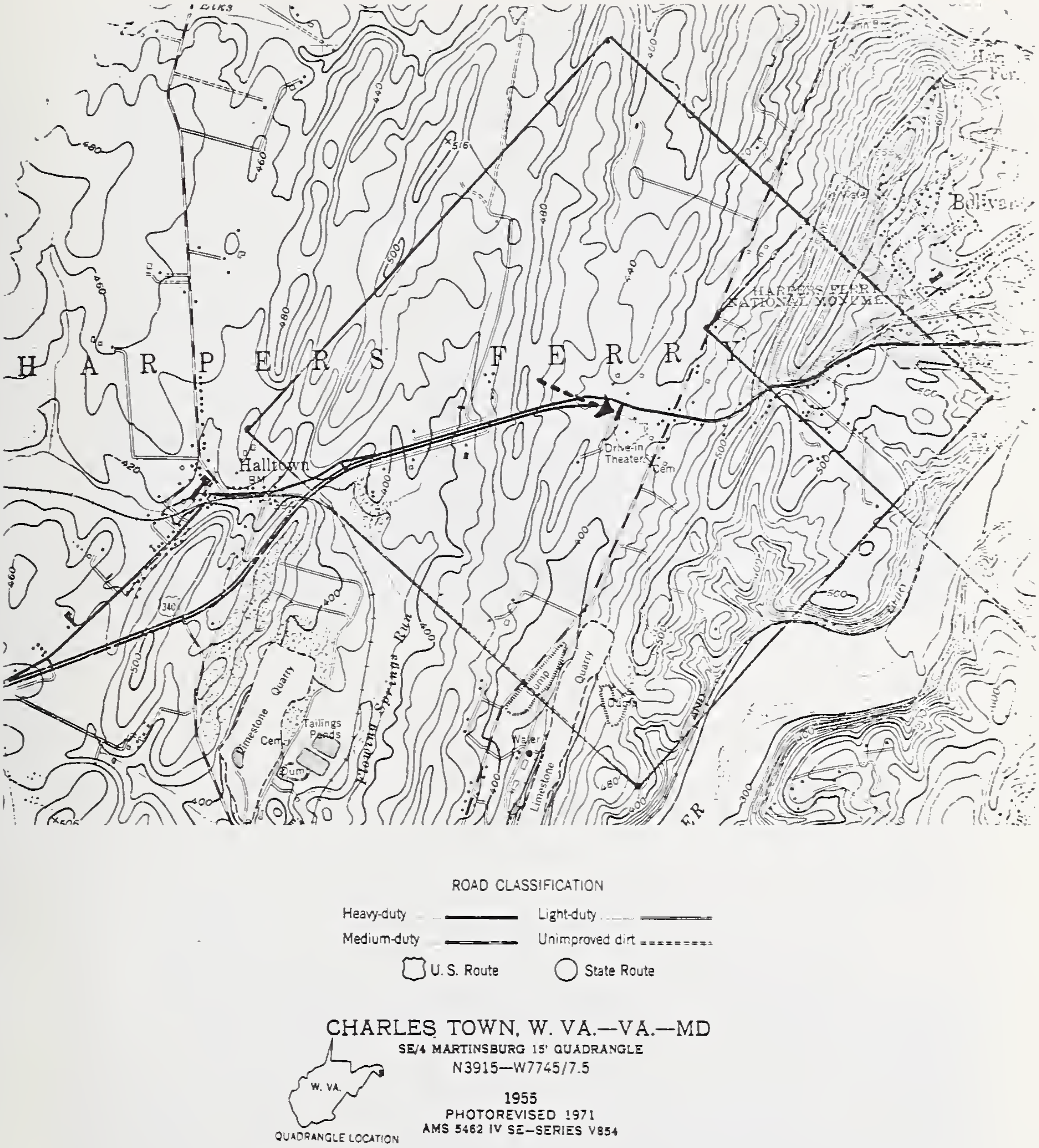

Figure 9A. Approximate location of Harpers Ferry Caverns sign located in West Virginia on US Route 340, one mile (1.6 kilometers) east of Halltown, West Virginia (see Figures 9 and 10).

Figure 11. #Luray Caverns sign typical of many such signs erected prior to Standards spaced about 0.5 miles (0.8 kilometers) apart along highways in the area. This sign is located on US Route 340, approximately one mile (1.6 kilometers) west of Gaylord, Virginia. The sign in Figure 12 is barely visible in this photograph in the lower left corner, right side of highway.

Figure 12. #Luray Caverns sign located on US Route 340 just past the sign in Figure 11.

=Does not comply with 131(c) Standards.

ROAD CLASSIFICATION

Primary highway, all weather, hard surface ——— Light-duty road, all weather, improved surface ———

Unimproved road, fair or dry weather ==========

U. S. Route ◯ State Route

BERRYVILLE, VA. – W. VA.

QUADRANGLE LOCATION

N3907.5—W7752.5/7.5

1968
PHOTOREVISED 1972
AMS 5462 III NW—SERIES V834

Figure 11A. Approximate locations of Luray Caverns signs located one mile (1.6 kilometers) west of Gaylord, Virginia on US Route 340 (see Figures 11 and 12).

Figure 13. #Endless Caverns sign located in New Market, Virginia at intersection of US Route 211 and 11.

Figure 14. *Close-up view of Skyline Caverns sign located approximately two miles (3.2 kilometers) south of Stephens City, Virginia on I-81.

#Does not comply with 131(c) Standards.
* Complies with 131(c) Standards.

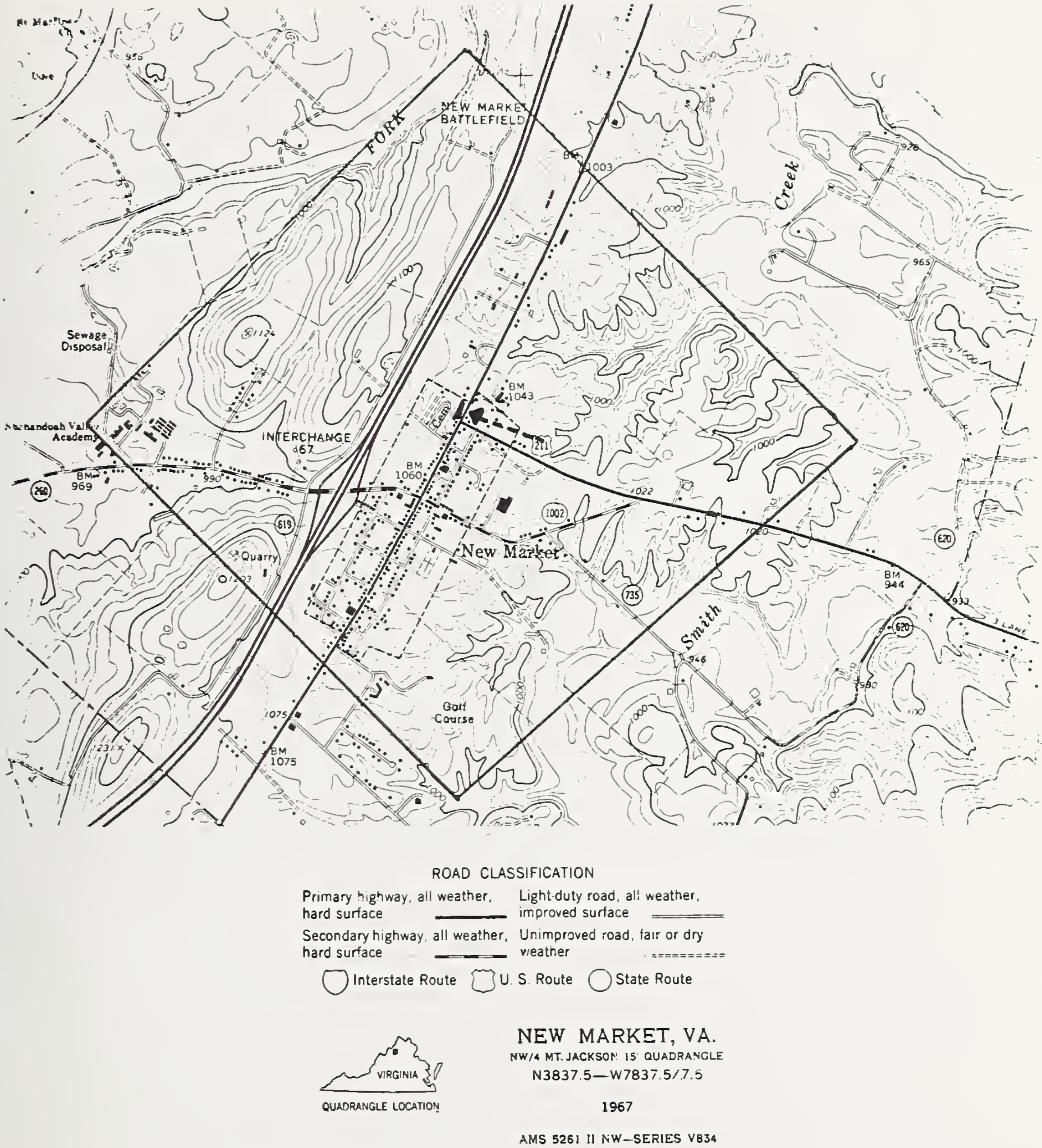

Figure 13A. Location of Endless Caverns sign on US Route 11 in New Market, Virginia (see Figure 13).

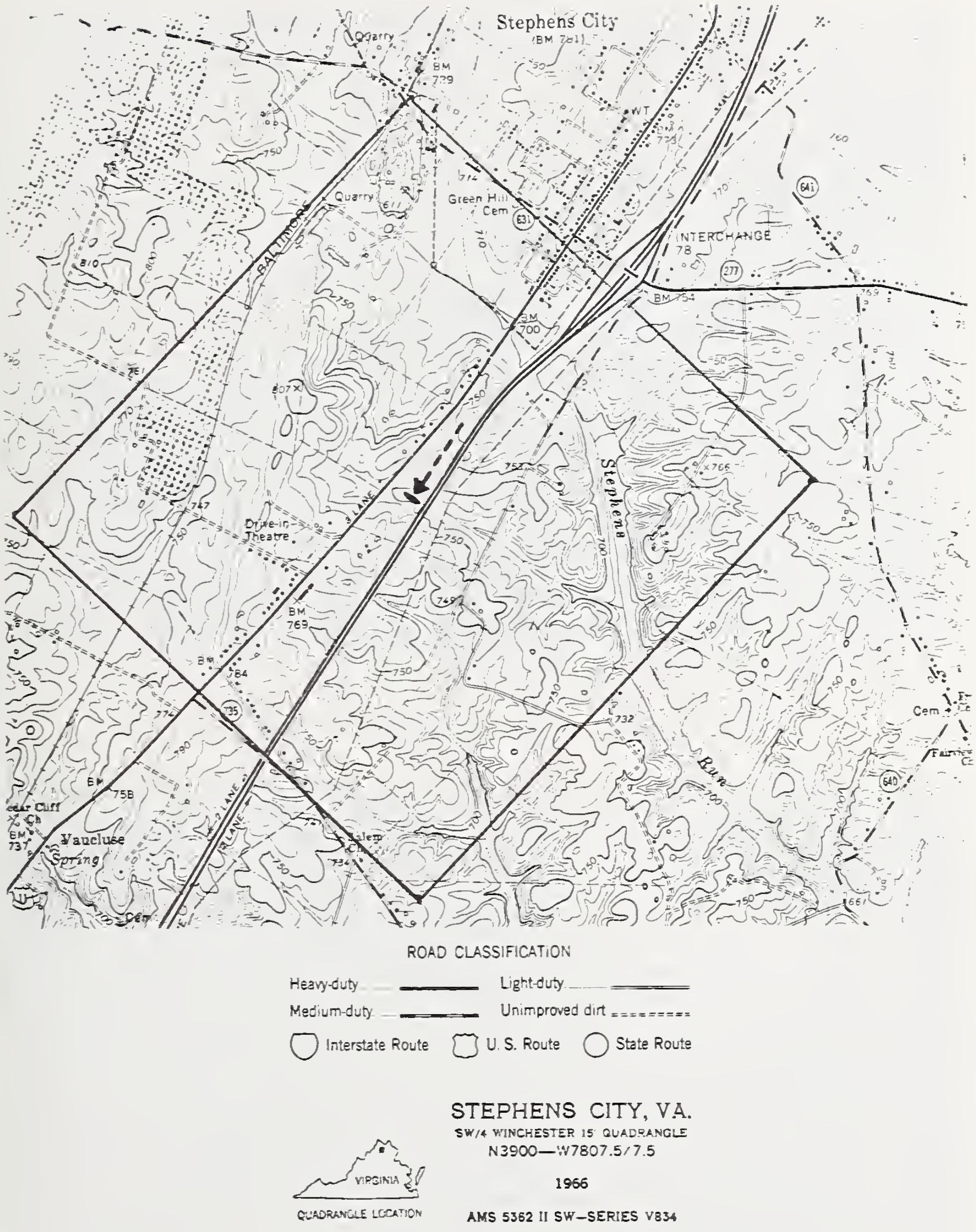

Figure 14A. Approximate location of Skyline Caverns sign located two miles (3.2 kilometers) south of Stephens City, Virginia on I-81 (see Figure 14).

Figure 15. *Road-side view of Endless Caverns sign located on I-81 approximately 0.5 miles (0.8 kilometers) south of Mauzy, Virginia. (Sign is located among trees in upper right-hand corner of photograph. Apparently erected in 1971.)

Figure 16. *Close-up view of sign in Figure 15. (Trees in front of sign, blocking view in Figure 15 are behind photographer.)

*Complies with 131(c) Standards.

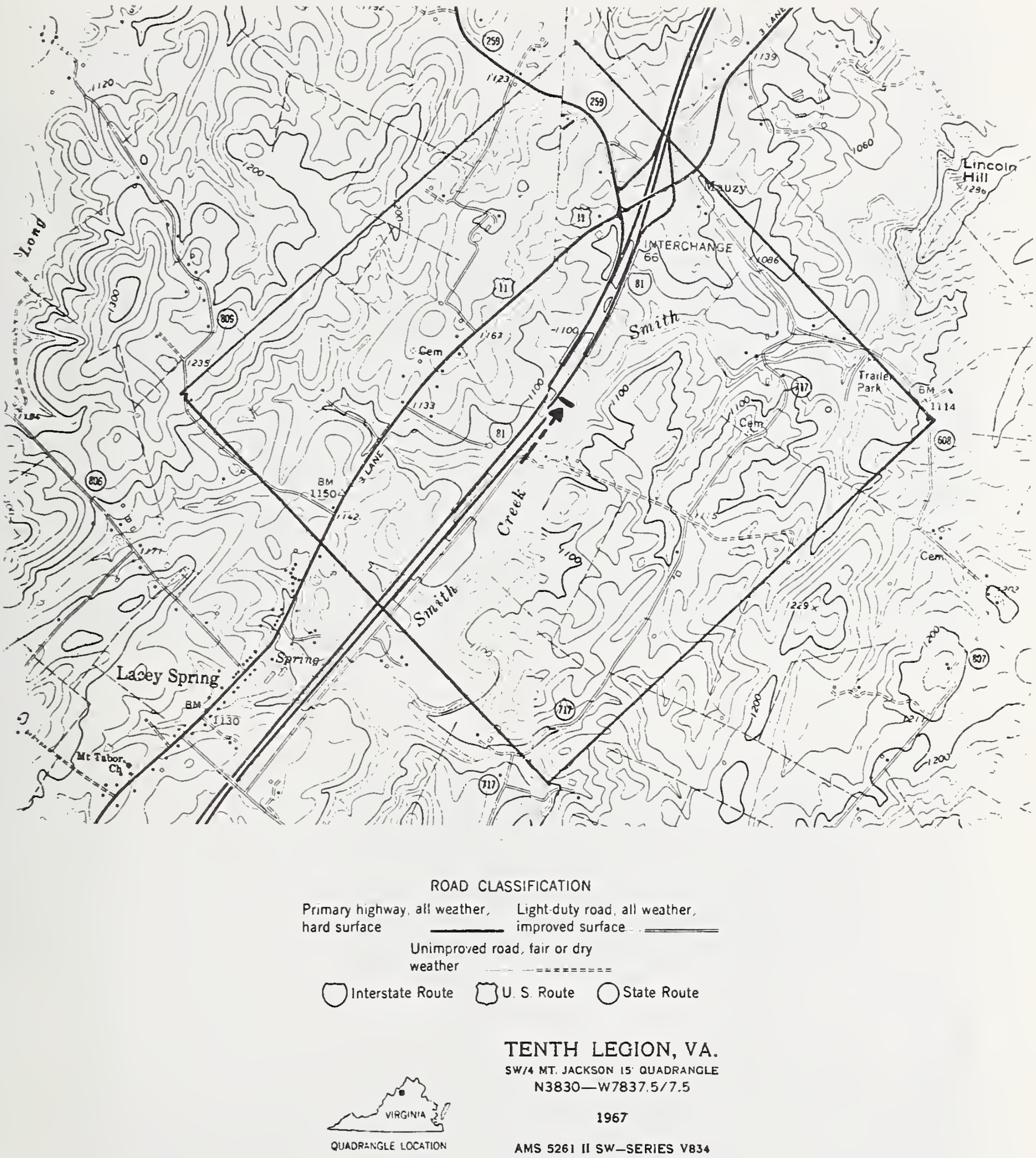

Figure 15A. Approximate location of Endless Cavern sign located 0.5 miles (0.8 kilometers) south of Mauzy, Virginia on I-81 (see Figures 15 and 16).

Figure 17. *Close-up view of Skyline Caverns sign located approximately one mile (1.6 kilometers) northeast of Middletown, Virginia on I-81.

Figure 18. *Road-side view of sign in Figure 17. (Note close proximity to state-erected mileage sign.)

*Complies with 131(c) Standards.

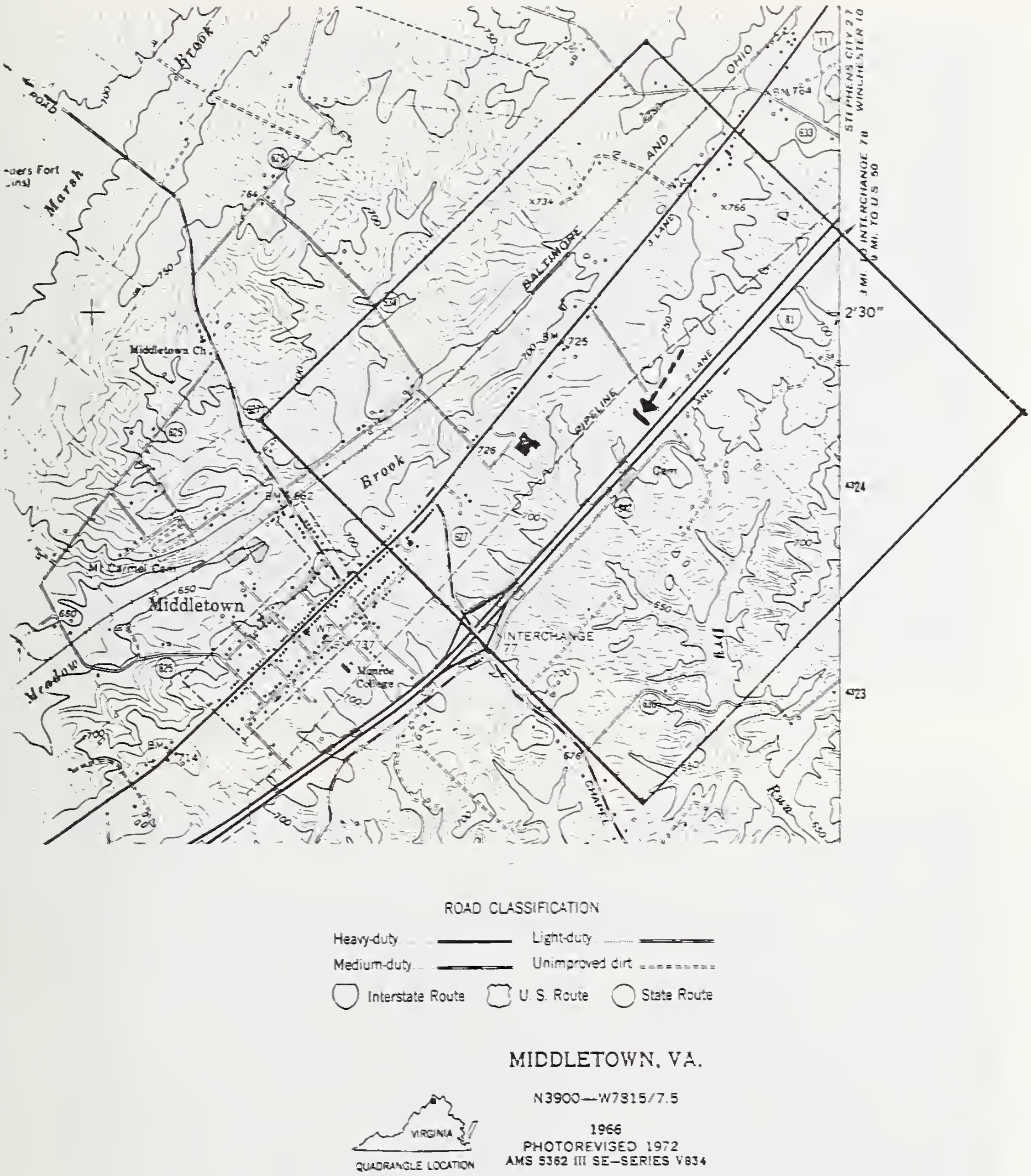

Figure 17A. Approximate location of Skyline Caverns sign located on I-81, one mile (1.6 kilometers) northeast of Middletown, Virginia (see Figures 17 and 18).

Figure 19. *Road-side view of Skyline Caverns sign located on I-66, approximately three miles (4.8 kilometers) south of Reliance, Virginia.

Figure 20. *Close-up view of sign in Figure 19.

*Complies with 131(c) Standards.

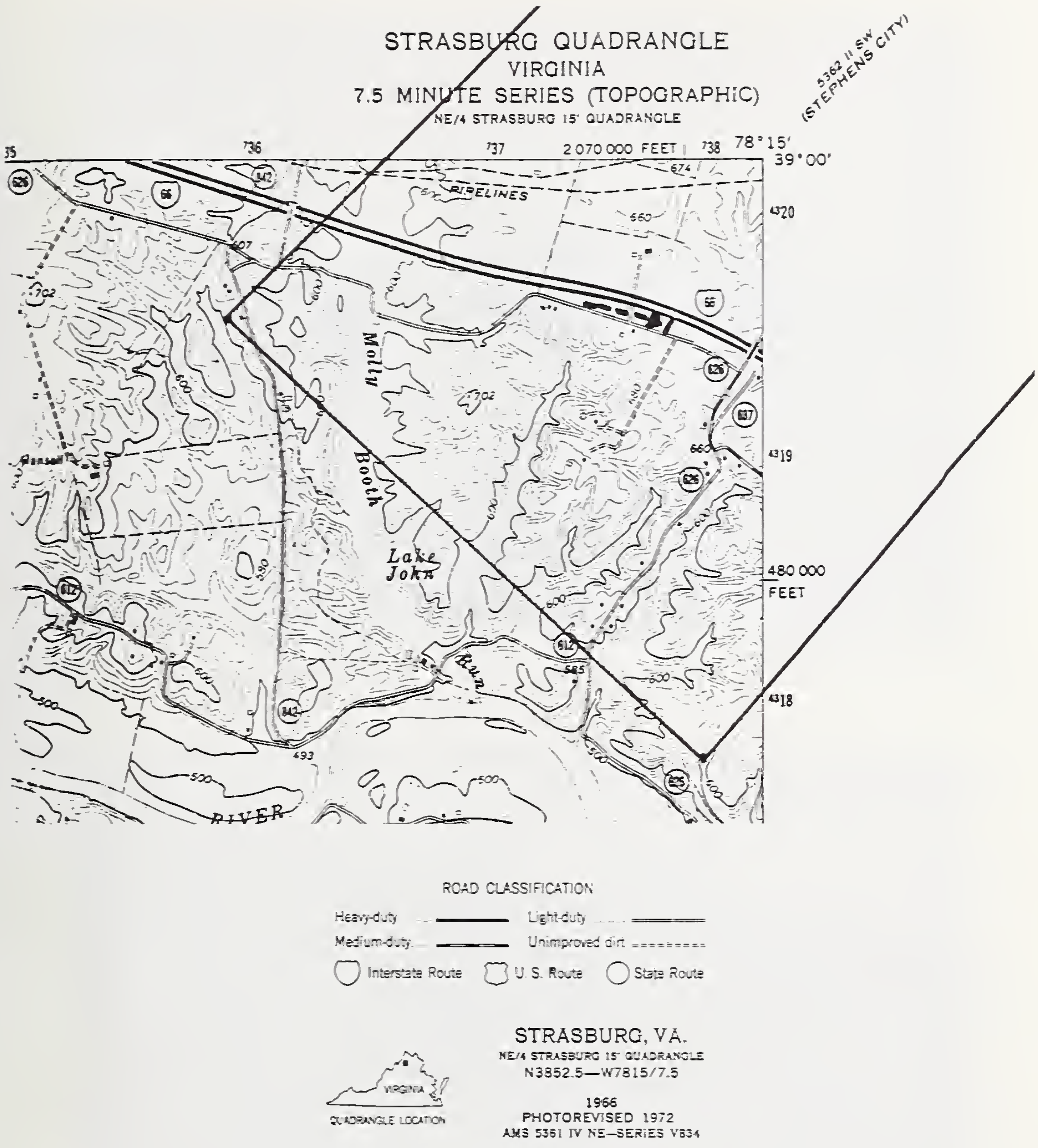

Figure 19A. Approximate location of Skyline Caverns sign located on I-66, three miles (4.8 kilometers) south of Reliance, Virginia (see Figures 19 and 20).

Figure 21. @Right-of-way sign for "Caverns" located on US Route 340, approximately 0.5 miles (0.8 kilometers) north of Luray, Virginia.

Figure 22. @Right-of-way sign for "Caverns" located just off Route 211, approximately 0.25 miles (0.4 kilometers) south of Luray Caverns.

@State-erected right-of-way sign for caverns destination.

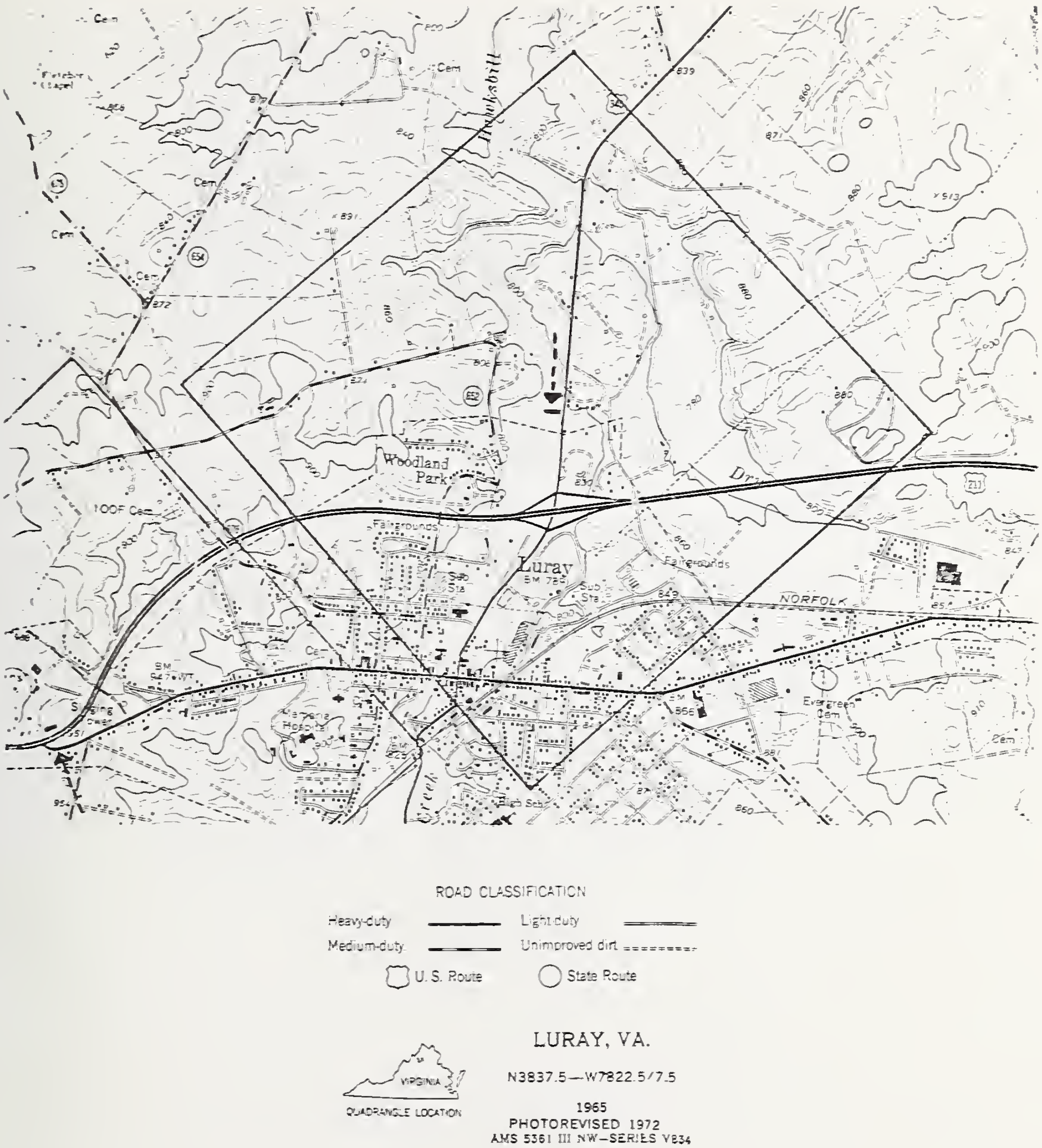

Figure 21A. Approximate location of right-of-way sign for "Caverns" located on US Route 340, 0.5 miles (0.8 kilometers) north of Luray, Virginia (see Figure 21).

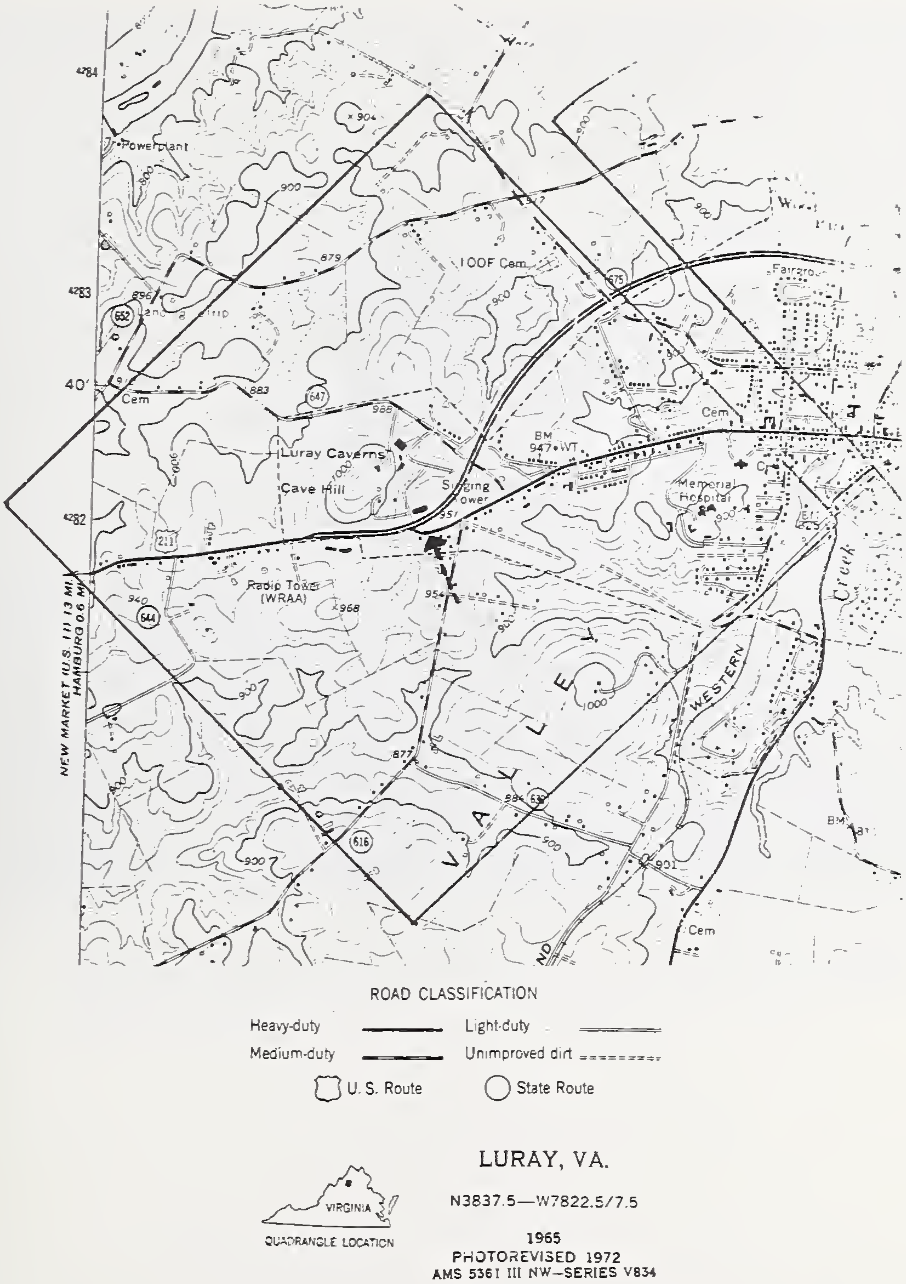

Figure 22A. Approximate location of right-of-way sign for "Caverns" located just off US Route 211, 0.25 miles (0.4 kilometers) south of Luray Caverns (see Figure 22).

Figure 23. @Right-of-way sign for Shenandoah Caverns located on I-81, approximately 1.25 miles (2 kilometers) east of Quicksbury, Virginia. (Similar sign at Route 730 Exit.)

@State-erected right-of-way sign for caverns destination.

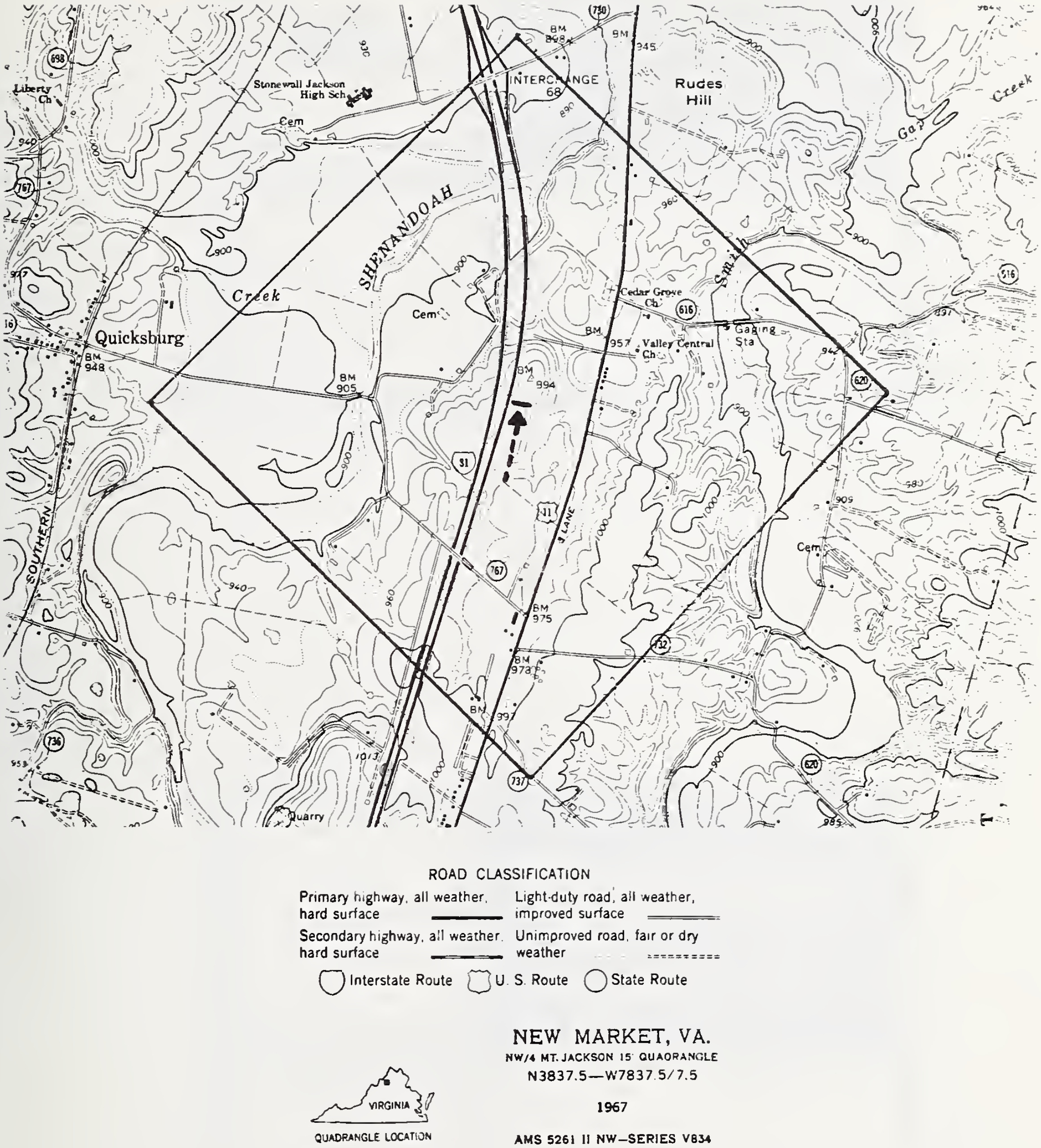

Figure 23A. Approximate location of right-of-way sign for Shenandoah Caverns located on I-81, 1.25 miles (2 kilometers) east of Quicksburg, Virginia (see Figure 23).

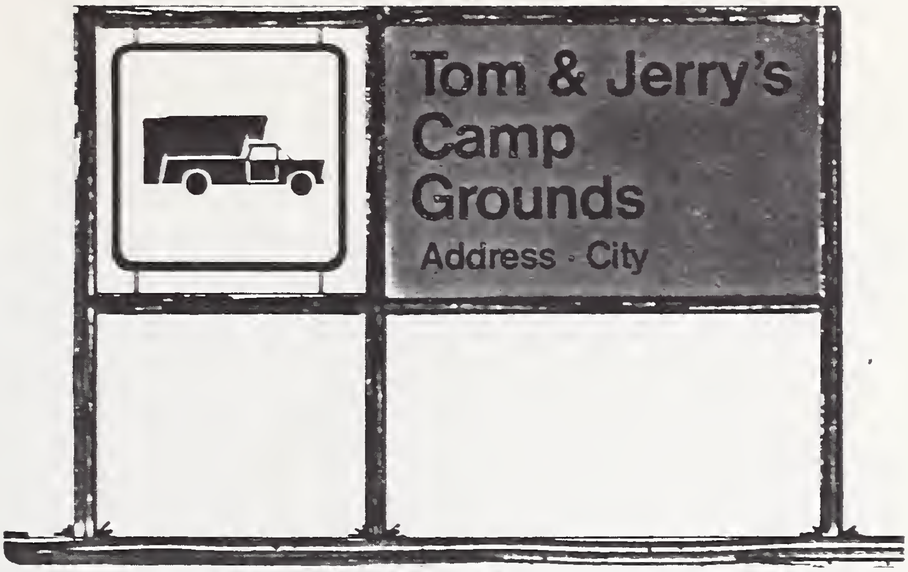

Figure 24

Figure 25

APPENDIX D

Consultant Vitae

Dr. Theodore W. Forbes

Dr. Forbes is Professor of Psychology and research advisor, Highway Traffic Safety Center at Michigan State University. He teaches graduate courses in Engineering Psychology and carries on human factor research under the Division of Engineering Research. He obtained his A.B. and M.S. from Oberlin College and his Ph.D. from Ohio State University in fields of applied and experimental psychology and was a Fellow at the Harvard Traffic Bureau and a staff member of the Yale Traffic Bureau. He has authored research reports in a variety of fields, including Traffic Sign Legibility, Driver Judgments and Responses, Human Factors in Traffic Flow Theory, Drowsiness in Driving, Air Photo Traffic Data, and Effects of Tunnel Conditions on Driving Behavior. He performed some of the earliest human engineering research in connection with highway sign studies at the Yale Bureau of Highway Traffic. He is a member of a number of scientific and professional societies in human factor and engineering fields.

Example publications include:

Forbes, T.W. A method for analysis of the effectiveness of highway signs. Journal of Applied Psychology, 1939, XXIII, No. 6, 669-684.

Forbes, T.W. Highway sign luminance, contrast, visibility and legibility. Presented at: 7th IRF World Meeting, Munich, West Germany, October 16, 1973.

Forbes, T.W., Pain, R.F., Fry, J.P., Jr & Joyce, R.P. Effect of sign position and brightness on seeing simulated highway signs. Highway Research Record, 1967, 164, 29-37.

Forbes, T.W., Pain, R.F., Joyce, R.P. & Fry, J.P. Jr. Color and brightness factors in simulated and full-scale traffic sign visibility. Highway Research Record, 1968, 216, 55-65.

Forbes, T.W., Snyder, T.E., and Pain, R.F. A study of traffic sign requirements II. An annotated bibliography, Michigan State University, East Lansing, Michigan, 1964, 65.

Forbes, T.W., Snyder, T.E., and Pain, R.F. Traffic sign requirements I. Review of factors involved. Previous studies and needed research. Highway Research Record, 1965, 70, 48-56.

Dr. Slade F. Hulbert

Dr. Hulbert has been a research psychologist with UCLA since 1952. Since that time he has been active in: Human Factors research in transportation systems, Engineering Education, and Psychological Behavior Theories. He has had extensive experience consulting in these areas with numerous national, state, and local governmental agencies.

He has authored and co-authored several textbook chapters and 40 research articles and reports having to do with driver behavior.

Dr. Hulbert is a Fellow of the Human Factors Society of America and recipient of the Society's 1972 A.R. Lauer Award; Fellow of the Institute of Traffic Engineers; a member of the American Psychological Association; Sigma Xi; Training Committee of the Society of Automotive Engineers; Driving Simulation Committee and Bicycle Committee of the Transportation Research Board of the National Academy of Sciences and Engineering; Panel on Human Error in Maritime Accidents, Maritime Research Board; Research Advisor to the National Joint Committee for Uniform Traffic Control Devices; Consultant to the National Highway Traffic Safety Administration, U.S. Department of Transportation; and is a Licensed Psychologist in the State of California.

Example publications include:

Beers, J., and Hulbert, S. Research and development of the changeable message concept of freeway traffic control, Highway Research Board Special Report, July 1972, 129.

Burg, A., and Hulbert, S. Dynamic visual acuity as related to age, sex, and static acuity, Journal of Applied Psychology, 1961, 45(2), 111-116.

Hulbert, S.F. Evaluation of highway destination signs, Proceedings, Seventh California Street and Highway Conference, University of California, Berkeley, 1955, 122-124.

Hulbert, S.F., and Burg, A. Predicting the effectiveness of highway signs, Highway Research Board Bulletin, 1962, 324, 1-11.

Hulbert, S.F., and Burg, A. Human factors in transportation systems, Systems Psychology, (K.B. DeGreene, Ed.), McGraw-Hill, 1970, 471-509.

Schoppert, D.W., Moskowitz, K., Hulbert, S.F., and Burg, A. Some principles of freeway directional signing based on motorist's experiences, Highway Research Board Bulletin, 1960, 244, 30-87.

Dr. L. Ellis King

Dr. King has pursued the practical application of laboratory and field data to highway signing and lighting problems. Previous work has included analysis of the ability of drivers to process graphic, directional and driving information and other nonverbal messages. He holds B.S.C.E. and M.S.C.E. degrees in transportation engineering from North Carolina State University and the D.Eng. degree from the University of California at Berkeley and was Director of the Transportation Systems Program at West

Virginia University from 1971 to 1973. Now an Associate Professor of Civil and Environmental Engineering at the University of Colorado at Denver and Associate Director of the Center for Urban Transportation Studies, he was awarded a Walter L. Huber Civil Engineering Research Prize by the American Society of Civil Engineers in 1973.

Recent publications include:

King, L.E. Recognition of symbol and word traffic signs, Journal of Safety Research National Safety Council (accepted for publication).

King, L.E. A laboratory comparison of symbol and word roadway signs, Traffic Engineering & Control, London, February 1971, 12(10), 518-520.

King, L.E. Highway lighting - design for luminance, Traffic Engineering, February 1973, 43(5), 32-33, 50.

King, L.E., and Campbell, R.E. The traffic conflicts technique applied to rural intersections, Accident & Prevention, December 1970, 2(3), 209-221.

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National Standards for Directional and Other Official Signs

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
BUREAU OF PUBLIC ROADS

WASHINGTON, D.C 20591

FEBRUARY 1969

Title 23—HIGHWAYS

Chapter I—Bureau of Public Roads, Department of Transportation

PART 21—NATIONAL STANDARDS FOR DIRECTIONAL AND OTHER OFFICIAL SIGNS

The purpose of this amendment is to add a new Part 21—National Standards for Directional and Other Officials Signs—to chapter I of title 23 of the Code of Federal Regulations. The new part will include all national standards established under section 131(c)(1) of title 23, United States Code.

Section 303(a) of the Highway Beautification Act of 1965 (Public Law 89–285) requires public hearings to be held in each State by the Secretary before issuing standards necessary to carry out section 131 of title 23, United States Code. Notice of the public hearings was published in the FEDERAL REGISTER on January 28, 1966 (31 F.R. 1162).

Pursuant to this notice, public hearings were conducted in each State, the District of Columbia, and Puerto Rico.

Based on the testimony received at the 52 public hearings which were held, draft standards were developed. The draft standards were given wide circulation among the outdoor advertising industry, roadside councils, garden clubs, State highway departments, and other interested groups. Comments thereon were evaluated and given full consideration in the preparation of the proposed standards.

On January 10, 1967, proposed national standards for directional and official signs were reported to Congress by the Secretary in accordance with section 303(b) of the Highway Beautification Act of 1965, and printed as Senate Document No. 6, 90th Congress, first session.

Thereafter proposed standards were distributed to the States, the District of Columbia, and Puerto Rico, and other interested parties for comment.

A review of the proposed national standards and all additional comments and recommendations submitted as a result of the distribution has been completed with all such pertinent matter, recommendations and comments having been fully considered and evaluated.

The national standards added by this amendment are minimum standards. They have been developed in cooperation with the States and other interested organizations, groups, and individuals.

In consideration of the foregoing, Chapter I of title 23, Code of Federal Regulations is amended by adding a new Part 21, "National Standards for Directional and Other Official Signs" as set forth below, effective February 25, 1969.

This amendment is made under authority of sections 131 and 315 of title 23, United States Code, section 6(a)(1)(H) of the Department of Transportation Act (Public Law 89–670, 80 Stat. 931), and the delegation of authority contained in Part 1 of the Regulations of the Office of the Secretary of Transportation (49 CFR 1.4(c)).

Issued in Washington, D.C., on January 17, 1969.

LOWELL K. BRIDWELL,
Federal Highway Administrator.

Sec.
21.1 Purpose.
21.2 Application.
21.3 Definitions.
21.4 Standards for directional signs.
21.5 State standards.

AUTHORITY: The provisions of this Part 21 issued under secs. 131 and 315 of title 23, U.S.C., sec. 6 (a)(1)(H), Department of Transportation Act (Public Law 89–670, 80 Stat. 931); delegation of authority to 49 CFR 1.4(c).

§ 21.1 Purpose.

(a) In section 131 of title 23, United States Code, Congress has declared that:

(1) The erection and maintenance of outdoor advertising signs, displays, and devices in areas adjacent to the Interstate System and the primary system should be controlled in order to protect the public investment in such highways, to promote safety and recreational value of public travel, and to preserve natural beauty.

(2) Directional and other official signs and notices, which signs and notices shall include, but not be limited to, signs and notices pertaining to natural wonders, scenic and historical attractions, which are required or authorized by law, shall conform to national standards authorized to be promulgated by the Secretary, which standards shall contain provisions concerning the lighting, size, number and spacing of signs, and such other requirements as may be appropriate to implement the section.

(b) The standards in this part are issued as provided in section 131 of title 23, United States Code.

§ 21.2 Application.

The following standards apply to directional and other official signs and notices which are erected and maintained within 660 feet of the nearest edge of the right-of-way of the Interstate and Federal-aid primary system, and which are visible from the main traveled way of the system. These standards do not apply to directional and other official signs erected on the highway right-of-way.

§ 21.3 Definitions.

For the purpose of this part—

(a) "Sign" means an outdoor sign, light, display, device, figure, painting, drawing, message, placard, poster, billboard, or other thing which is designed, intended, or used to advertise or inform, any part of the advertising or informative contents of which is visible from any place on the main traveled way of the Interstate or Federal-aid primary highway.

(b) "Main traveled way" means the through traffic lanes of the highway, exclusive of frontage roads, auxiliary lanes, and ramps.

(c) "Interstate system" means the National System of Interstate and Defense Highways described in section 103(d) of title 23, United States Code.

(d) "Primary system" means the Federal-aid highway system described in section 103(b) of title 23, United States Code.

(e) "Erect" means to construct, build, raise, assemble, place, affix, attach, create, paint, draw, or in any other way bring into being or establish.

(f) "Maintain" means to allow to exist.

(g) "Scenic area" means any area of particular scenic beauty or historical significance as determined by the Federal, State, or local officials having jurisdiction thereof, and includes interests in land which have been acquired for the restoration, preservation, and enhancement of scenic beauty.

(h) "Parkland" means any publicly owned land which is designated or used as a public park, recreation area, wildlife or waterfowl refuge or historic site.

(i) "Federal or State law" means a Federal or State constitutional provision or statute, or an ordinance, rule, or regulation enacted or adopted by a State or Federal agency or a political subdivision of a State pursuant to a Federal or State constitution or statute.

(j) "Visible" means capable of being seen (whether or not legible) without visual aid by a person of normal visual acuity.

(k) "Freeway" means a divided arterial highway for through traffic 1 full control of access.

(l) "Rest area" means an area or site established and maintained within or adjacent to the highway right-of-way by or under public supervision or control for the convenience of the traveling public.

(m) "Directional and other official signs and notices" includes only official signs and notices, public utility signs, service club and religious notices, public service signs, and directional signs.

(n) "Official signs and notices" means signs and notices erected and maintained by public officers or public agencies within their territorial or zoning jurisdiction and pursuant to and in accordance with direction or authorization contained in Federal, State, or local law for the purposes of carrying out an official duty or responsibility. Historical markers authorized by State law and erected by State or local government agencies or nonprofit historical societies may be considered official signs.

(o) "Public utility signs" means warning signs, informational signs, notices, or markers which are customarily erected and maintained by publicly or privately owned public utilities, as essential to their operations.

(p) "Service club and religious notices" means signs and notices, whose erection is authorized by law, relating to meetings of nonprofit service clubs or charitable associations, or religious services, which signs do not exceed 8 square feet in area.

(q) "Public service signs" means signs located on school bus stop shelters, which signs—

(1) Identify the donor, sponsor, or contributor of said shelters;

(2) Contain safety slogans or messages, which shall occupy not less than 60 percent of the area of the sign;

(3) Contain no other message;

(4) Are located on school bus shelters which are authorized or approved by city, county, or State law, regulation, or ordinance, and at places approved by the city, county, or State agency controlling the highway involved; and

(5) May not exceed 32 square feet in area. Not more than one sign on each shelter shall face in any one direction.

(r) "Directional signs" means signs containing directional information about public places owned or operated by Federal, State, or local governments or their agencies; publicly or privately owned natural phenomena, historic, cultural, scientific, educational, and religious sites; and areas of natural scenic beauty or naturally suited for outdoor recreation, deemed to be in the interest of the traveling public.

(s) "State" means any one of the 50 States, the District of Columbia, or Puerto Rico.

§ 21.4 Standards for directional signs.

The following apply only to directional signs:

(a) *General.* The following signs are prohibited:

(1) Signs advertising activities that are illegal under Federal or State laws or regulations in effect at the location of those signs or at the location of those activities.

(2) Signs located in such a manner as to obscure or otherwise interfere with the effectiveness of an official traffic sign, signal, or device, or obstruct or interfere with the driver's view of approaching, merging, or intersecting traffic.

(3) Signs which are erected or maintained upon trees or painted or drawn upon rocks or other natural features.

(4) Obsolete signs.

(5) Signs which are structurally unsafe or in disrepair.

(6) Signs which move or have any animated or moving parts.

(7) Signs located in rest areas, parklands or scenic areas.

(b) *Size.* (1) No sign shall exceed the following limits:

(i) Maximum area—150 square feet.
(ii) Maximum height—20 feet.
(iii) Maximum length—20 feet.

(2) All dimensions include border and trim, but exclude supports.

(c) *Lighting.* Signs may be illuminated, subject to the following:

(1) Signs which contain, include, or are illuminated by any flashing, intermittent, or moving light or lights are prohibited.

(2) Signs which are not effectively shielded so as to prevent beams or rays of light from being directed at any portion of the traveled way of an Interstate or primary highway or which are of such intensity or brilliance as to cause glare or to impair the vision of the driver of any motor vehicle, or which otherwise interfere with any driver's operation of a motor vehicle are prohibited.

(3) No sign may be so illuminated as to interfere with the effectiveness of or obscure an official traffic sign, device, or signal.

(d) *Spacing.* (1) Each location of a directional sign must be approved by the State highway department.

(2) No directional sign may be located within 2,000 feet of an interchange, or intersection at grade along the Interstate System or other freeways (measured along the Interstate or freeway from the nearest point of the beginning or ending of pavement widening at the exit from or entrance to the main traveled way).

(3) No directional sign may be located within 2,000 feet of a rest area, parkland, or scenic area.

(4) (i) No two directional signs facing the same direction of travel shall be spaced less than 1 mile apart;

(ii) Not more than three directional signs pertaining to the same activity and facing the same direction of travel may be erected along a single route approaching the activity;

(iii) Signs located adjacent to the Interstate System shall be within 75 air miles of the activity; and

(iv) Signs located adjacent to the Primary System shall be within 50 air miles of the activity.

(e) *Message content.* The message on directional signs shall be limited to the identification of the attraction or activity and directional information useful to the traveler in locating the attraction, such as mileage, route numbers, or exit numbers. Descriptive words or phrases, and pictorial or photographic representations of the activity or its environs are prohibited.

(f) *Selection methods and criteria.* (1) Privately owned activities or attractions eligible for directional signing are limited to the following: natural phenomena; scenic attractions; historic, educational, cultural, scientific, and religious sites; and outdoor recreational areas.

(2) To be eligible, privately owned attractions or activities must be nationally or regionally known, and of outstanding interest to the traveling public.

(3) Each State shall develop specific selection methods and criteria to be used in determining whether or not an activity qualifies for this type of signing. A statement as to selection methods and criteria shall be furnished to the Secretary of Transportation before the State permits the erection of any such signs under section 131(c) of title 23, United States Code, and this part.

§ 21.5 **State standards.**

This part does not prohibit a State from establishing and maintaining standards which are more restrictive with respect to directional and other official signs and notices along the Federal-aid highway systems than these national standards.

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