AN INVESTIGATION OF STREAKING ON HIGHWAY TRAFFIC SIGNS

by

R. N. Robertson
Highway Research Engineer

Virginia Highway Research Council
(A Cooperative Organization Sponsored Jointly by the Virginia Department of Highways and the University of Virginia)

Charlottesville, Virginia

May 1974
VHRC 73-R48

SUMMARY

During a night inspection, dark streaks were observed on the faces of many reflectorized highway signs. Although the streaks were not visible during daylight, they substantially reduced the reflectivity of the signs at night. This study was initiated to determine the source of the streaks and to define remedial measures.

An investigation revealed the streaks were caused by a residue of titanium dioxide from the paint on the wooden posts supporting the signs. As the paint deteriorated, the residue was transported down the sign faces by rain, and, subsequently, the titanium dioxide was deposited.

The study concluded that clear coating would remove the streaks on existing signs, and it was recommended that in the future signs be installed with spacers, similar to nylon washers, between the sign panels and the painted posts.

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INTRODUCTION

In Virginia, as in other states, traffic signs are an important element in the highway program. Signs are the most commonly used traffic control device, and they are the oldest method for controlling, safeguarding or expediting the movement of traffic. Signs should be installed only where warranted by facts and field studies, and precautions must be taken to ensure that they are used in compliance with uniform standards.

For a sign to be effective, it should not only be properly installed, but it must be legible at all times. The Virginia Department of Highways requires that all signs be inspected at least twice a year to make certain they are kept in proper position, clean, and legible. During a nighttime sign inspection, dark streaks were observed on the faces of many reflectorized signs. Generally, the streaks were in line with the bolts that secured the signs to the posts. The streaks adversely affected the retroreflective characteristics of the reflective material, thereby reducing the brightness of the sign as shown in Figure 1. During daylight, the streaks were not visible (Figure 2).

This study was initiated to investigate the source of the streaks and, subsequently, report recommendations for remedial measures.

OBJECTIVES

The specific objectives of this project were to:

(1) Analyze the source of the streaks,

(2) determine a method of obliterating the streaks on existing signs, and

(3) define a system of preventing the streaks on future signs.

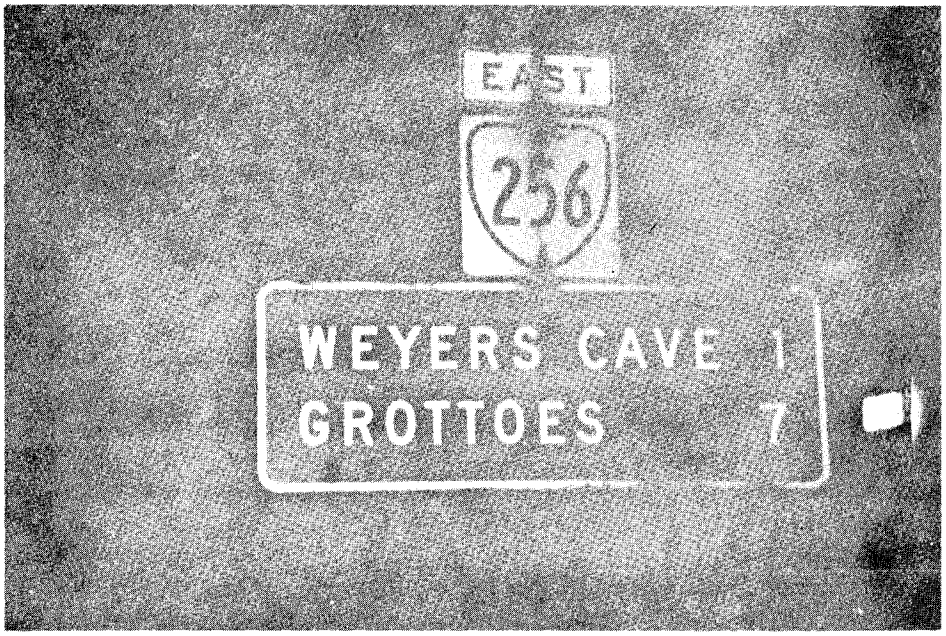

Figure 1. Streaked sign — nighttime.

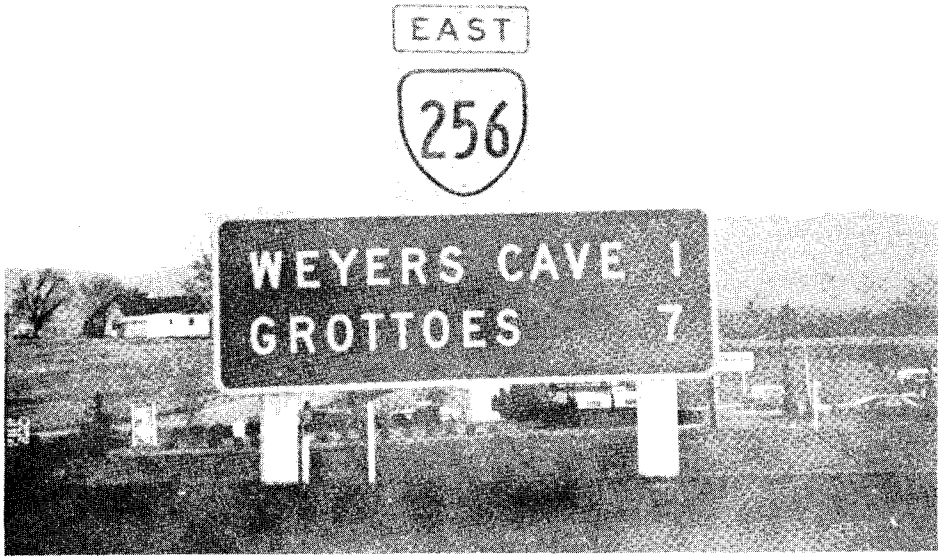

Figure 2. Streaked sign — daytime.

SELECTION OF TEST SIGNS

To obtain an insight into the magnitude of the problem, a statewide survey was conducted. The Highway Department's district traffic engineers were requested to report locations of streaked signs and to furnish a copy of the installation and maintenance records for the respective signs. Reports were received from various sections of the state, however, the problem appeared to be more severe in the Fredericksburg and Staunton Districts than elsewhere.

All of the reported signs were located on primary highways and interstate ramps where installation standards required the placement of signs on wooden posts. The posts were painted white with Number 10 paint (oil base) in accordance to the Department's specifications. Furthermore, the streaks were more predominant on signs that had been in place for four or more years than on newer ones. The orientation of the signs in relation to the sun did not appear to affect the degree of streaking, and there were no visible variations in the streaks on signs from the different parts of the state. No problems were encountered with the metal-post mounted signs on the interstate system.

The four signs selected for analysis are shown in Figure 3. The details relative to the location, placement, installation date, mounting hardware, maintenance, and characteristics of each sign are in Appendix A.

ANALYSIS

The analysis for this study included laboratory and field tests. Laboratory tests were conducted to determine the source of the streaks and define an ultimate solution, while the field analysis dealt mainly with interim remedial measures.

Laboratory Analysis

Preliminary investigations indicated that the streaks were caused by a residue from the painted posts and/or the mounting hardware. All test signs, except the Route 687 sign, were mounted to the wooden posts with aluminum bolts and nuts, with fiber washers installed between the bolt heads and faces of the signs. The attachment details are shown in Figure 4.

Field observations revealed the fiber washer had deteriorated and thus the sign panel was not attached firmly against the post. However, the washers were determined not to be a source of the streaks as they were not used on the streaked Route 687 sign. Through an elimination process, the cause of the streaks was traced to the paint on the post, and the 3M Company agreed to conduct a chemical analysis of the paint residue on the test signs.

The analysis revealed that the residue was titanium dioxide, the white pigment in oil base and latex paints. As the paint weathered and aged, it deteriorated, rain carried the residue down the post to the top of the sign or through a bolt hole, and then along the sign face, leaving the deposit of titanium dioxide.

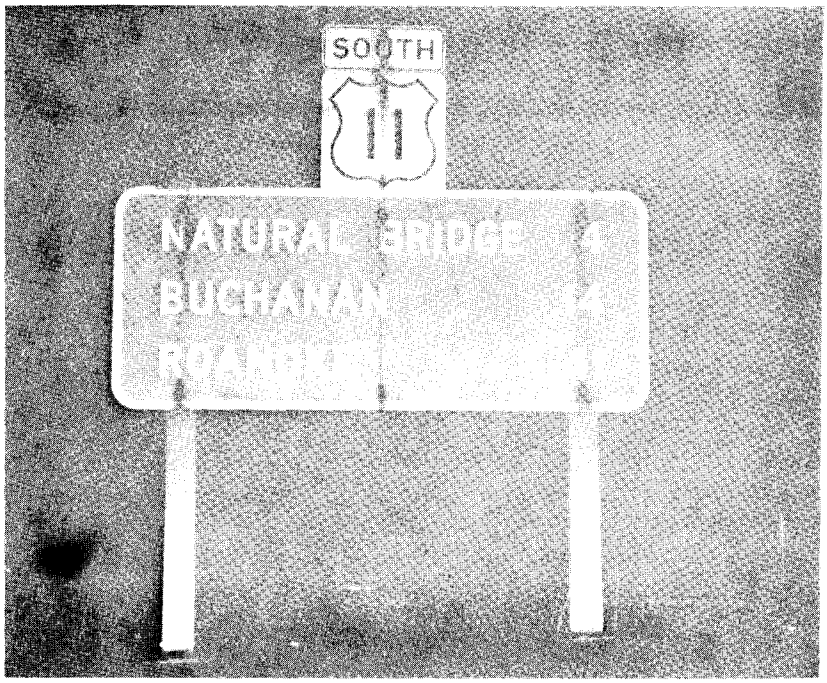

Figure 3. Test signs.

An independent paint company (not a present supplier) was requested to review the Department's specifications for Number 10 (oil base) and Number 11 (waterbase or latex) paints, and to determine if the amount of titanium dioxide could be reduced. (The specifications are in Appendix B.) The review concluded that the paints specified by the Department were very good and no changes were recommended. It appears that titanium dioxide is the best known whiting agent, because it chalks little, and a decrease in quantity would reduce the white appearance. It was also reported that latex paints were superior to the oil base paints and, therefore, the company suggested a greater use of latex paint on wooden posts. Furthermore, the company's representative expressed much concern about the Department's repainting program. He was of the opinion that, with latex paints now available, the practice of repainting sign posts every one or two years was unnecessary.

Since a reduction in the titanium dioxide content would adversely affect the quality of paint and the appearance of the sign post, an alternate solution was sought. A simple, and perhaps the most practical, approach is to separate the sign panel and the painted post with a spacer such as a washer (Figure 5), so as to allow the rain to transport the paint residue along the post behind the sign. The spacer should be a non-biodegradable material to ensure the sign panel will be held firmly against the post at all times. Another reason for using the spacers is that the chemical reaction between the aluminum sign panel and the paint would be alleviated. It was reported that whenever these two materials are in contact, a reaction takes place and the result is a rapid deterioration of the paint.

Field Analysis

Intuitively, one would surmise that the streaking would be a statewide problem, as the paint is purchased and distributed from a central warehouse. However, the preliminary survey indicated that the problem was more severe in some districts than it was in others. In an effort to resolve an interim solution for the many streaked signs along the highways, the sign maintenance programs of several districts were reviewed.

In all districts, signs on the interstate and primary highways were washed periodically; however, several districts had not adopted a uniform clear coating program.* Furthermore, a comprehensive review of the maintenance records for the signs used in this study revealed they had not been clear coated. A large green information sign, shown in Figure 6, was selected for experimentation. The left third of the sign was washed and clear coated in accordance with the reflective sheeting manufacturer's instructions. The middle third was only washed and no maintenance was performed on the right third. The results are shown in Figure 7.

A comparison of Figures 6 and 7 reveals that washing did not improve the appearance of the sign (center section), however, the clear coating removed the streaks and restored the reflectivity (left section).

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*"Clear coating" is an application of finishing clear, similar to shellac, to the sign face to restore reflection and increase durability.

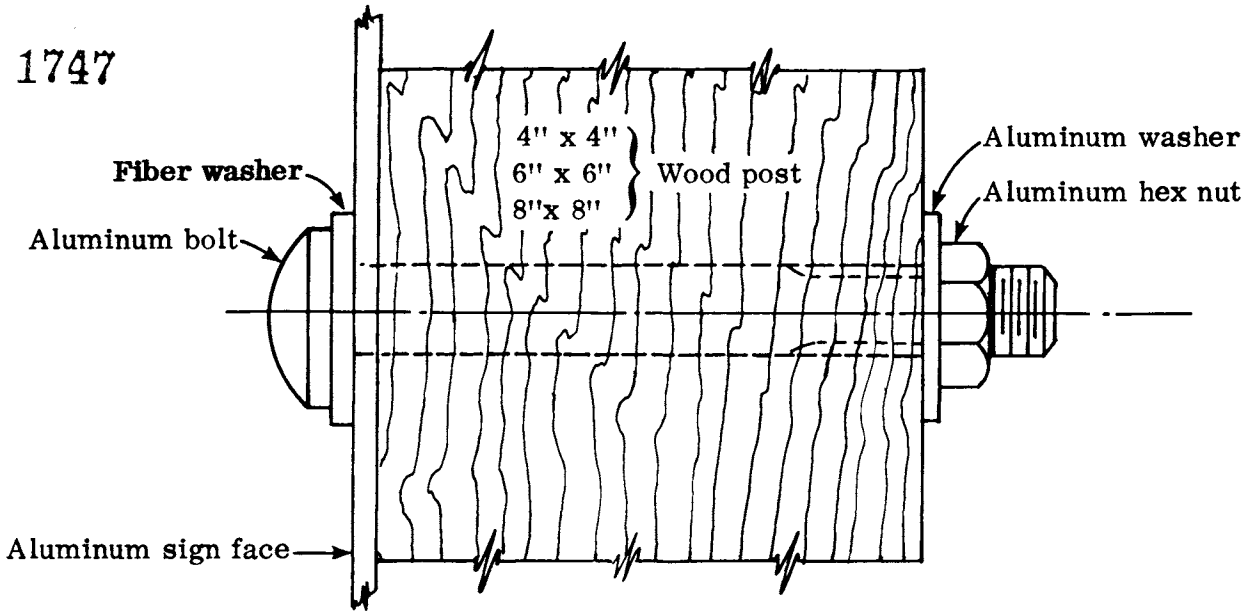

Figure 4. Sign attachment details.

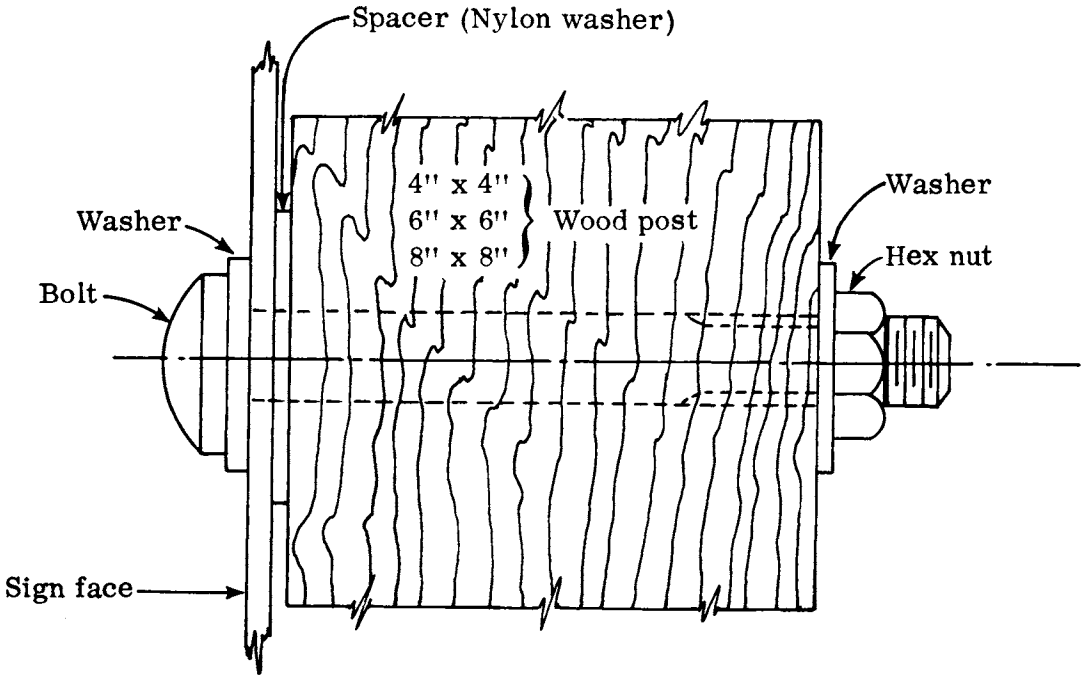

Figure 5. Proposed sign attachment details.

Figure 6. Test sign — "original" condition.

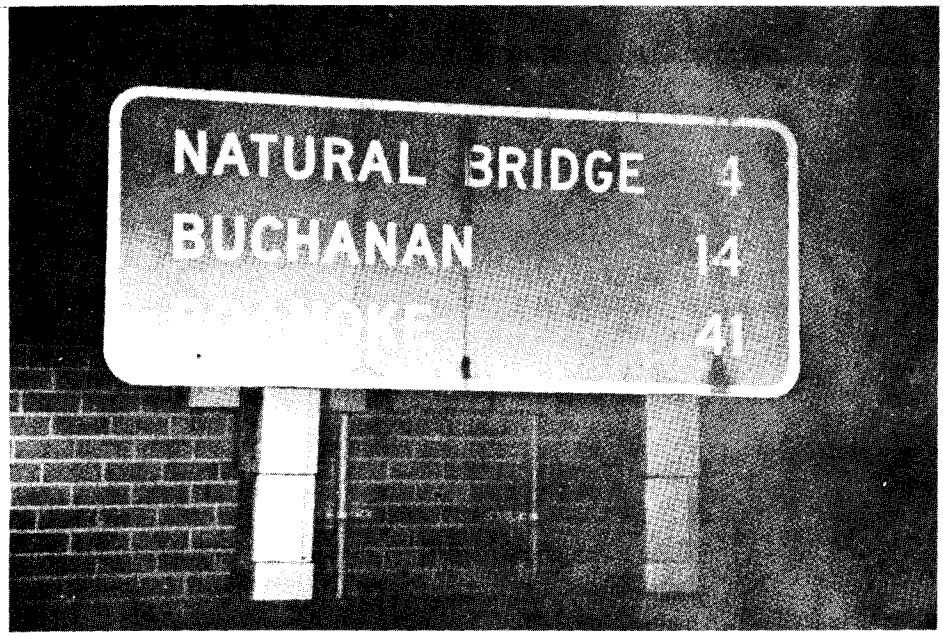

Figure 7. Test sign — "after" condition.

Retroreflective measurements were obtained on each section of the sign by a modified Gardner Portable Reflectometer. Prior to each series of measurements, the reflectometer was calibrated to a white standard reflectance plate to yield a meter reading of 19% at the retroreflection setting of the instrument. Readings were taken randomly across the sign, and no readings were taken where the sensing area of the meter was superimposed on the message and border. A summary of the measurements recorded for the test sign is presented in Table 1.

As shown in Table 1, there was a statistical difference in the retroreflective characteristics of the clear coated section of the sign when compared to the original condition; however, washing did not "statistically" restore the brightness.

TABLE 1

Summary of Retroreflective Measurements and Statistical Comparisons

Statistical Parameters	Original Readings	Washed			Clear Coated		
		Readings	"t" test	Significance	Readings	"t" test	Significance
Sample Size	26	25			25		
Mean	9.35	9.68			10.94		
Standard Deviation	1.36	1.31	0.87	No	0.46	4.88	Yes

$\alpha = 0.01$

CONCLUSIONS

The following conclusions are based on the findings of this study:

1. The streaks were caused by a residue of titanium dioxide, the white pigment in paint, which was transported down the sign face by rain. The deposit reduced the reflective characteristics of the sheeting and thereby adversely affected the brightness of the sign.

2. The fiber washers used between the bolt heads and the sign face deteriorated with age. This allowed the sign panel to come loose from the post and thus, provided an opening through which the titanium dioxide residue was transported to the sign face.

3. There was a chemical reaction between the aluminum sign panel and the paint on the post that caused the paint to break down and resulted in excessive chalking and in titanium dioxide deposits.

4. The Department's specifications covering the signpost paint are adequate and a reduction in the titanium dioxide content would adversely affect the quality of the paint and the appearance of the painted post.

5. In most areas, signposts are repainted every one or two years. The paints presently used should provide a longer service life, thereby making this procedure unnecessary.

6. Washing a sign with soap and water did not remove the titanium dioxide residue nor did it restore the reflectivity in the streaked areas.

7. Clear coating did remove the streaks and improve the brightness of the sign. The statistical "Student t" test revealed that the application of a coating of finishing clear did "significantly" restore the reflectivity of the sign.

RECOMMENDATIONS

The conclusions of this study indicate that the streaks adversely affected the appearance and effectiveness of traffic signs in Virginia. Streaked signs do not adequately serve the motoring public and they are a discredit to the Department's sign program. In an effort to alleviate these problems, the following recommendations are offered for consideration:

1. It is recommended that the use of fiber washers be discontinued. The deterioration of these washers contributes to the streaking problem. It is suggested that instead the Department use washers made from a non-biodegradable material, such as the nylon washers supplied with high intensity reflective sheeting. Furthermore, nylon washers may be used universally as they do not create a chemical reaction with either galvanized steel, aluminum, or paint.

2. Although the paints (oil base and latex) used by the Department are acceptable, an evaluation should be conducted to determine which one has the superior performance characteristics. In recent years latex paints have increased in popularity, however, there are no data to substantiate their effectiveness on signposts.

3. In order to remove the streaks and restore the brightness, it is recommended that the existing signs be clear coated in accordance with the reflective sheeting manufacturer's instructions.

4. On future sign installations, it is recommended that the sign panel be offset from the painted post with a spacer similar to a nylon washer approximately $1\frac{1}{2}$ inches in diameter and 1/8 inch thick. This arrangement will keep the aluminum from contacting the paint and eliminate the chemical reaction (which breaks down the paint) between the two. Furthermore, the rain transporting the paint residue can continue down the post rather than going down the sign face.

5. The repainting of signposts every one or two years may not be necessary, especially with the quality paints now available. It is recommended that this program be evaluated and guidelines be established for this important maintenance activity.

ACKNOWLEDGMENTS

The author gratefully acknowledges the interest and cooperation of J. L. Thomas, district traffic engineer of the Staunton District, in the initiation of this research.

Appreciation is extended to W. P. Youngblood of the 3M Company and W. L. Kump of the William Armstrong Smith Company for their contributions of time, effort, and data. Without their cooperation, completion of the study would have been impossible.

Sincere appreciation is expressed to the following traffic engineers for surveying their respective districts for streaked signs: N. E. Hood, Bristol; L. C. Taylor II, Salem; B. C. Pierce, Lynchburg; F. L. Isbell, Richmond; B. B. Goodloe, Suffolk; R. W. Wallace, Fredericksburg; and J. W. Nicholson, Culpeper.

Finally acknowledgment is given to J. P. Mills, Jr., state traffic and safety engineer; W. C. Nelson, Jr., traffic engineer; and John Shelor, traffic technician, for their support in this study.

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1. Manual on Uniform Traffic Control Devices, Federal Highway Administration, U. S. Department of Transportation, 1971.

2. Paint Manual, Corps of Engineers, Department of the Army, July 1956.

3. "Sign Maintenance Field Manual", 3M Company, St. Paul, Minn.

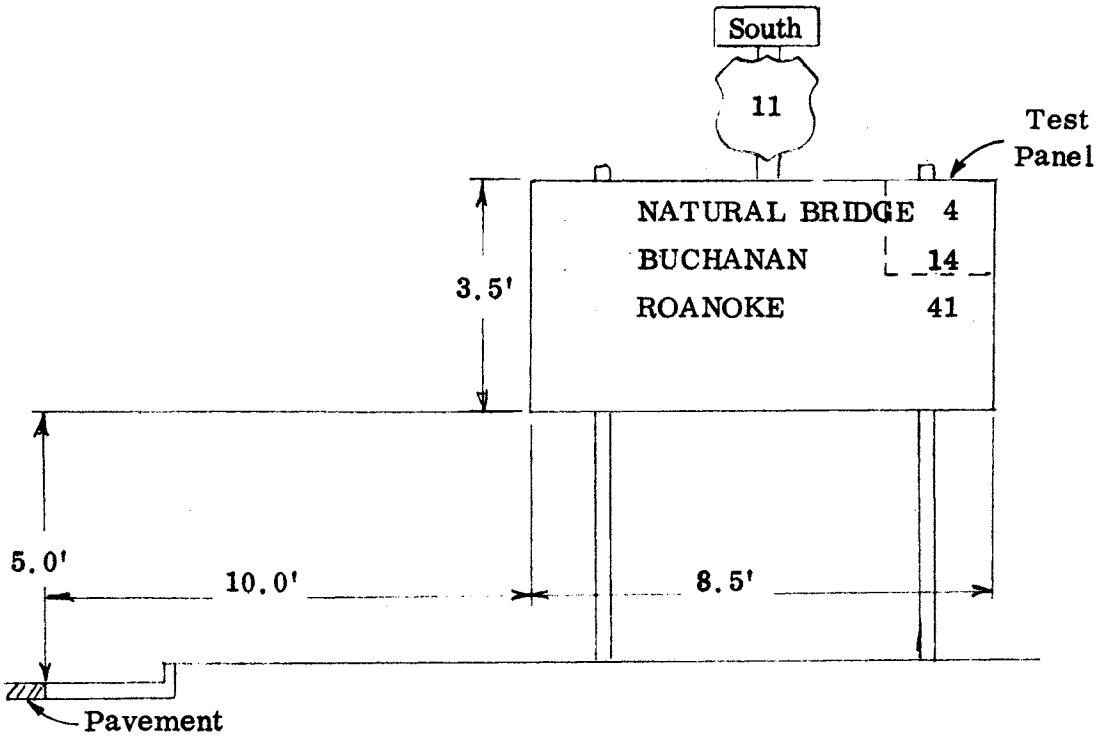
4. Virginia Manual on Uniform Traffic Control Devices, Traffic and Safety Division, Virginia Department of Highways, Richmond, Virginia, 1971.

APPENDIX A

DETAILS ON SIGNS ANALYZED

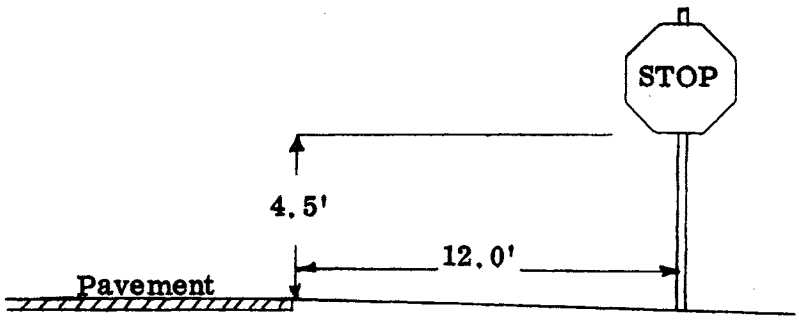
TEST SIGN NUMBER 1

1755

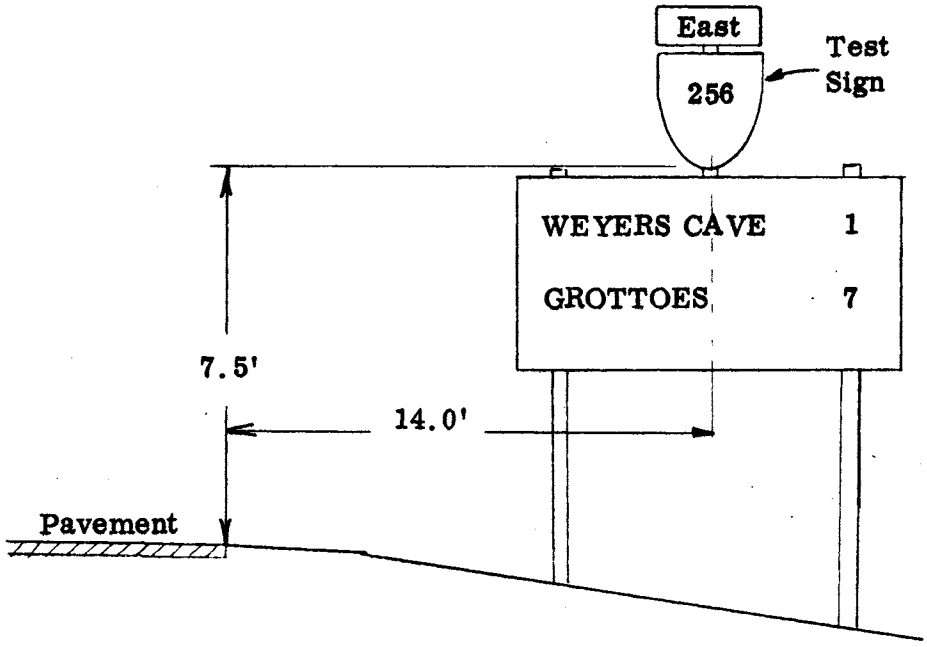


Location — SBL Route 11 just south of Route 81 (Fancy Hill Interchange) in Rockbridge County, Virginia
Direction Facing — North
1972 Traffic Volumes (ADT) — 1,720 Passenger Cars and Pickups
55 Trucks
40 Tractor Trailers and Buses
1,815 Total
Installation Date — May 1965
Maintenance — Washed several times but no record of dates.
Mounting — On wooden post with aluminum bolts and nuts and fiber washers.
Characteristics — Dark streaks showed on the sign in line with the bolts during nighttime. These streaks were not visible during the day.

TEST SIGN NUMBER 2

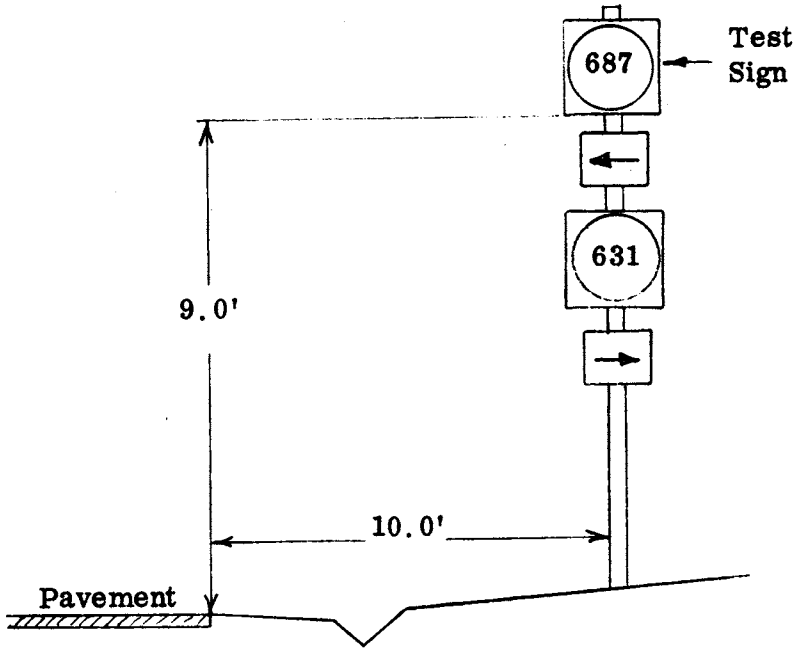


Location — Ramp from NBL Route 81 to Route 256, Augusta County, Virginia
Direction Facing — South
Installation Date — August 1967
Maintenance — Washed several times but dates not recorded.
Mounting — On wooden post with aluminum bolts and nuts and fiber washers.
Characteristics — A dark streak showed on the sign in line with the bolts during the hours of darkness. During the day it was not visible except for a small spot under the lower bolt where the transparent red paint had deteriorated.



Location — Eastbound Lane Route 256 just east of Route 81 in Augusta County, Virginia
Direction Facing — West
1972 Traffic Volumes (ADT) — 2,560 Passenger Cars and Pickups
270 Trucks
75 Tractor Trailers and Buses
2,905 Total
Installation Date — August 1967
Maintenance — Washed several times but no record of dates.
Mounting — On wooden post with aluminum bolts and nuts and fiber washers.
Characteristics — A dark streak showed on the sign in line with the bolts during the hours of darkness. However, during the day the streak was not visible.

TEST SIGN NUMBER 4



Location — SBL Route 1 just north of Route 631 near Stafford County Courthouse in Stafford County, Virginia
Direction Facing — North
1972 Traffic Volumes (ADT) — 10,400 Passenger Cars and Pickups
335 Trucks
230 Tractor Trailers and Buses
10,965 Total
Installation Date — July 1969
Maintenance — No records to indicate any maintenance.
Mounting — On wooden post with galvanized lag bolts (no washers).
Characteristics — During the hours of darkness there was a dark streak, approximately the width of the post, beginning at the top and continuing down the face of the sign. The streak was not visible in daylight.

APPENDIX B

VIRGINIA DEPARTMENT OF HIGHWAYS PROVISIONS FOR NUMBER 10 PAINT

Sec. 239.06 No. 10 Paint, Exterior, White — No. 10 paint is a white paint for signs, buildings, posts and other exterior surfaces. It shall have good brushing properties and when applied to a smooth vertical surface shall dry within the specified time to a smooth oil gloss finish free from sags, streaks and objectionable brush marks. It shall have the following composition:

	Percent by Weight	
	Minimum	Maximum
Pigment	61	—
Titanium dioxide, Type I	14	16
35% Leaded zinc oxide (co-fumed)	49	51
Magnesium silicate	34	36
Vehicle	—	39
Raw linseed oil	58	60
Heat bodied linseed oil (W to Z-2)	16	18
Mineral spirits and driers	—	25

The paint shall have the following physical properties:

	Minimum	Maximum
Drying time, hours	—	16
Weight per gallon, lbs.	14.1	—
Fineness of grind	4	—
Viscosity, K. U.	78	85

VIRGINIA DEPARTMENT OF HIGHWAYS
SPECIAL PROVISIONS FOR 6-15-72C
NUMBER 11 PAINT, ACRYLIC EMULSION, EXTERIOR WHITE

DESCRIPTION - This specification covers a modified acrylic emulsion paint for application to exterior wood and masonry surfaces, which may be used in lieu of No. 10 paint.

MATERIALS - Materials shall be as specified herein. Material not specified shall be subject to all the provisions of this specification. The paint shall be free of materials which would be toxic to personnel under normal conditions of use.

(a) Composition - (By weight based on the percentage in the whole paint)

	% Min.	- Max.
Titanium Dioxide	19	- 21
Zinc Oxide	3	- 5
Silicates	15	- 17
Acrylic Resin Solids	15	- 17
Soya Isophtalic Alkyd Resin	2	- 5
Water, Additives and Stabilizers	40	- 42

(b) Tolerances - A maximum and minimum percentage of each ingredient required is allowed for manufacturing and analytical error. This tolerance shall not be considered as allowing the manufacturer freedom to adjust percentages to the lowest or highest allowed because of cost factors. He shall maintain production to meet the average of the percentages required.

(c) Ingredient Specifications -

Titanium Dioxide	Fed. Spec. TT-P-442 B Type III
Zinc Oxide	Fed. Spec. TT-P-463 A Type I
Acrylic Resin	100% Straight Acrylic Polymer dispersed in water, with the minimum amounts of necessary additives such as emulsifiers, pigment-dispersants, anti-foaming agents, and preservatives. Water and additives shall be calculated in the formula as "Acrylic Resin Solids".
Soya Isophthalic Alkyd Resin	Long Oil Soya Isophthalic Alkyd containing a minimum of 80% Soya Oil.

(d) Physical Requirements -

Weight/gallon-pounds	11 min.
Fineness of Grind	4 min.
Viscosity-Krebs Units	75 - 85
Set to touch	30 minutes - max.
Recoat time	4 hours - max.
Daylight directional reflectance (.005 inch wet film thickness), percent.	87
Dry opacity contrast ratio (.005 in wet film thickness)	0.98 min.

(e) Condition in Container - The paint shall mix readily with a minimum of foaming to a smooth, homogenous state free from lumps and coarse particles. In a fresh opened container there shall be no rusting of the container and no offensive, disagreeable, or putrid odor.

(f) Freeze-Thaw Stability - When tested as specified in Federal Specification TT-P-19b the paint shall show no coagulation, or flocculation and no decrease in wet abrasion resistance.

(g) Heat Stability - When tested as specified in Federal Specification TT-P-19b the paint shall show no coagulation, flocculation, or discoloration and shall not exceed the maximum viscosity requirement.

(h) Storage Stability - After 30 days storage in three quarters filled, closed container, the paint shall show no skinning, livering, curdling, hard settlement, or caking that cannot be readily remixed to a smooth, homogenous state. (Containers delivered to the job or for storage shall be full. The above is for testing only.)

(i) Brushing Properties - The paint shall brush easily and shall have good flowing, leveling, and spreading characteristics.

(j) Recoating Properties - Upon recoating the painted surface and after two hours of air drying under standard laboratory conditions, the paint film shall show no irregularity. There shall be no picking up or rolling up of the previous coat.

(k) Appearance - The paint shall dry to a uniform, smooth appearance. There shall be no flashings; the laps and brush marks shall not be conspicuous.

(l) Fungus Resistance - When tested as specified in Federal Specification TT-P-19b the paint shall show no fungus growth.

INTENDED USE, APPLICATION AND SURFACE PREPARATION -

(a) Use - This paint is intended for brush or roller application to exterior wood and masonry surface, which have been properly prepared.

(b) Surface Preparation - On previously painted surfaces as much loose material and chalk as possible must be removed by wire brushing and wash down with water before painting.
Masonry may be painted after the washing operation while still damp.
Where staining may be a problem, such as on redwood, a good stain resistant primer must be used.
On other surfaces no primer is generally necessary.
Two coats are required for best durability.

(c) Application - For best results directions must be followed. Surfaces shall be clean and free of mildew or scaling paint. Glossy surfaces shall be dulled with wire brush or other means. Sand blast surfaces previously coated with cement-based water paints. DO NOT ADD PAINT THINNER OR OIL COLORS. THIN ONLY WITH WATER. This type of paint may be thicker than oil base paints, but in most cases no addition of water is required. Use water as a thinner very sparingly. Paint only when temperature is 50°F or higher. Stir well and apply with roller or nylon brush. Do not use a bristle brush. Do not spread to thin. Allow 4 hours between coats. Clean tools and brushes with water or soapy water.