Field Studies of Traffic Paints

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SYNOPSIS

THIS PAPER reports a field-performance study of traffic-marking paints. In August 1949 eight experimental sections of paints were installed on various types of pavement surfaces. Eleven paints purchased from leading manufacturers were included in the study. Eight of these were installed as plain paints and also as binders for beads-on-paints, while the other three were of the beads-in paint type. All paints were applied with a self-propelled traffic-line striper (Kelly-Creswell, BP-3) which, except for size, was identical in many respects to those used by the department in actual field operations. Extreme care was used to insure a wet-film thickness of 0.015 in.

The paints were installed in duplicate as transverse lines in accordance with ASTM standard method of conducting road-service tests. For comparative purposes, short sections of longitudinal lines of the reflectorized paints were incorporated in the study. One test section was installed on an abandoned road and subjected to weathering only. A further test section was devoted to a study of various bead types and particle-size gradation.

Performance was evaluated at intervals over an 18-month period. Durability and reflectivity were determined by means of visual inspection, a photographic record and night visibility as measured by the Hunter meter. The paints were rated in order of their performance and on the basis of these studies purchasing specifications were prepared. Approximately 80,000 gal. were purchased and applied in 1950. Despite the severe winter, field forces reported this past spring that the pavement lines on primary roads were in generally good condition and that in many cases only spot work would be necessary until late summer or early fall.

● ACCORDING to provisions in Virginia law, materials purchased with state funds must be secured through competitive bidding from specifications written for those materials. This, of course, is intended to secure the best of available materials at the least cost to the state. Similar provisions are found in the laws of most other states. In the parade of ever improving manufactured products the question arises, however, as to just what constitutes the best of available materials. Costly advertising campaigns by competing manufacturers give conflicting viewpoints as to product superiority. The answer often lies in experimental field studies in which competing products are subjected to conditions similar to those they would be expected to encounter in actual practice. In such a manner it is possible to demonstrate and establish product superiority for particular conditions and to do so independently from manufacturers' claims.

This paper reports a field-performance study of traffic-marking paints conducted in Virginia. In recent years the annual expenditure on traffic paints by the state has amounted to well over $300,000. In considering the magnitude of this item, together with other factors such as an ever-increasing traffic volume and new developments in marking paints, it was found desirable to make a study of currently available paints in order to evaluate them as to their suitability for use on Virginia's highways. Prior to the study, the Virginia Department of Highways had used reflectorized paints only for experimental purposes. A change in policy adopting the use of reflectorized paints on all primary highways necessitated the evaluation of available materials and the development of specifications. The specific purpose of the study was to develop specifications that could be used for purchasing reflectorized traffic marking paints.

DESCRIPTION OF FIELD EXPERIMENTS

For this experiment, 11 paints were purchased from leading manufacturers. Eight of these were installed as plain paints and also as binders for beads-on-paint. The remaining three paints were of the beads-in-paint type. Physical and chemical tests were made on these paints by the Division of Tests of the Virginia Department of Highways and the results are reported in Tables 1 and 2. Drying times determined during field test applications are found in Table 3.

In selecting field test sites, due consideration was given to the location of the test sections so as to include such factors as the type of pavement surface, width and number of traffic lanes, volume of traffic, and climatic conditions. In all, eight experimental locations were selected throughout Virginia. These locations are shown on the map in Figure 1. The locations included highways with pavements of portland-cement concrete, various bituminous plant mixes, and mixed-in-place bituminous surfaces. Average daily traffic volumes ranged from about 2,800 to about 11,000 vehicles with the exception of one section for weathering only, over which no traffic passed.

The eight experimental sections were installed in August 1949 under careful supervision and with ideal weather conditions prevailing. All paints were applied with a self-propelled traffic-line striper (Kelly-Creswell, BP-3) which, except for size, was identical in many respects to those used by the Virginia Department of Highways in regular field operations. The laying of a test stripe is shown in Figure 2. Care was exercised to insure that the paints were handled in accordance with the recommendations of the manufacturers. Extreme care was used to secure a wet-film thickness of 0.015 inches. A film-thickness gauge (Fig. 3) was used in all cases except for beads-in-paint.

The paints were installed at each test section in duplicate as transverse lines in

TABLE 1

PHYSICAL TESTS ON TRAFFIC ZONE PAINTS

Test	Paint Numbers										
	1	2	3	4	5	6	7	8	9	10	11
Viscosity - No.3 Ford Cup (Sec.)	119	39	54	121	71	53	51	40			
Viscosity - Stormer (K.U.)	93	75	76	89	86	75	77	71	90	124	91
Weight per gal.	12.25	13.85	12.15	12.65	14.00	13.45	13.20	11.70	14.80	14.9	14.5
Drying Time, Min. (Laboratory)	10	15	12	90	45	35	80	25	30	20	120
Elasticity - 1/4 in. Rod	Very Poor	Good	Poor	Good	Good	Good	Poor	Slight Failure			
Elasticity - 1/8 in. Rod	Very Poor	Good	Very Poor	Slight Failure	Good	Slight Failure	Poor	Poor			

TABLE 2

CHEMICAL TESTS ON TRAFFIC ZONE PAINTS

Test	Paint Numbers										
	1	2	3	4	5	6	7	8	9	10	11
Pigment	59.37	62.05	57.39	60.11	61.34	64.57	60.32	51.75	67.28	69.12	67.41
Vehicle	40.63	37.95	42.61	39.89	38.66	35.43	39.68	48.25	32.72	30.88	32.59
Nonvolatile in Vehicle	35.10	35.73	42.20	46.40	45.78	35.51	38.84	39.83	41.05	34.75	46.76
TiO_2	16.64	5.31	15.13	22.61	6.25	15.58	9.38	28.20	32.17	17.63	58.81
ZnO	5.18	40.83	None		38.76	9.20	1.94	20.09	22.68	5.44	None
ZnS	None	9.47	None		9.77		11.65	None	None	None	None
$BaSO_4$	None	21.98	None	None	22.06	None	38.70	None	None	None	None
Insoluble	68.54	19.43	49.89	9.29	19.93	22.80	15.16	33.84	29.27	64.51	35.13
CaO	0.60									0.50	
MgO	3.64									4.56	
$CaCO_3$			26.80	63.01		47.14	19.40	14.24	11.42		1.98
$MgCO_3$			4.76	2.90		3.73	0.86	3.70	3.46		2.68
Loss on Ignition	6.36									6.90	
Impurities and Undetermined		2.98	3.42	2.19	3.23	1.55	2.91		1.00	0.46	1.40

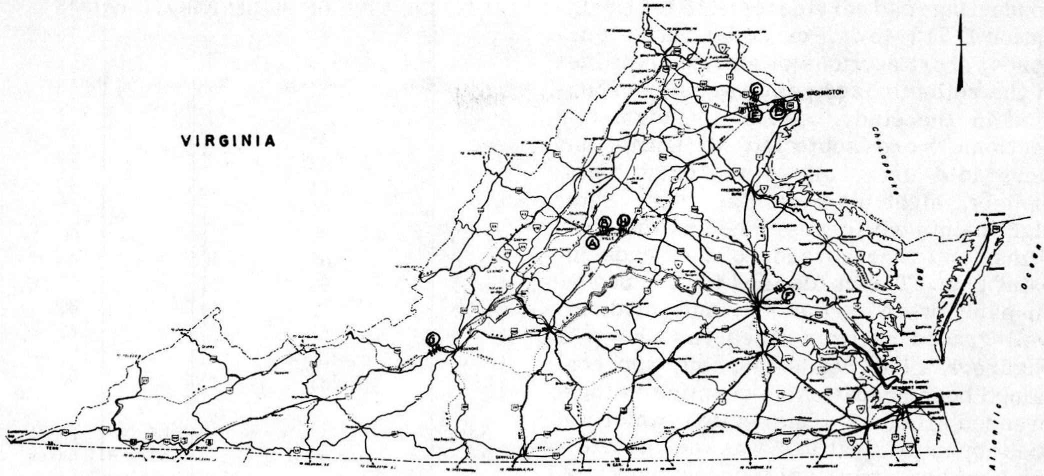

Figure 1. Location of experimental paint sections.

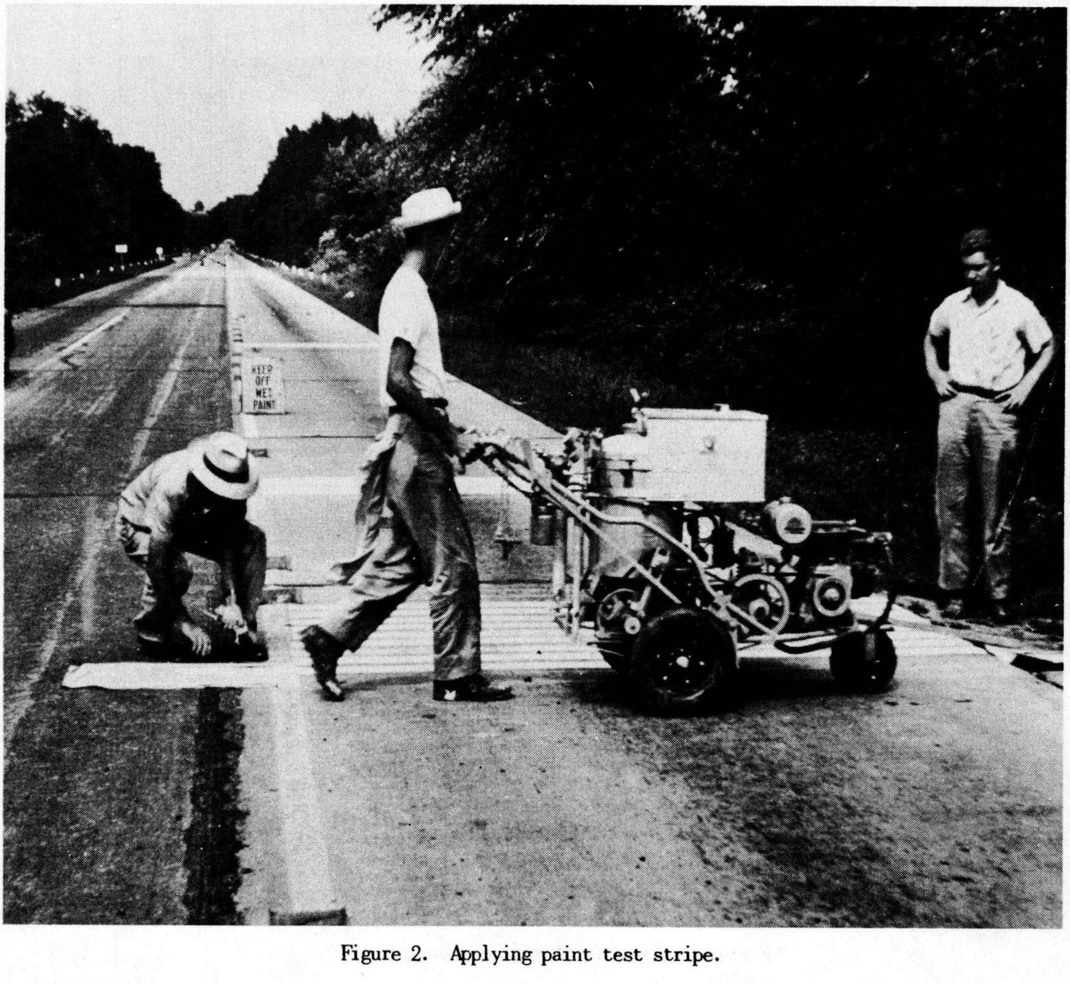

Figure 2. Applying paint test stripe.

accordance with ASTM standard method of conducting road service tests (ASTM Designation D 713-46). For comparative purposes, short sections of longitudinal lines of the reflectorized paints were incorporated in the study. Six of the eight test sections were subjected to traffic and were laid using all of the paint types; namely, eight plain paints, these same eight paints with beads placed on their wet films, and three brands of the beads-in-paint type. The beads used for the beads-on-paint were glass and had medium, well-graded particle sizes, as shown in Figure 4. The beads-in-paint type contained bead gradation as supplied in these branded products. One section, which was also open to traffic, was devoted to a study of bead-material types and particle-size gradation. Plastic beads of one gradation and glass beads of fine, medium well-graded, and coarse particle sizes

TABLE 3

DRYING TIME OF REFLECTORIZED PAINTS

Paint No.	Average *min.*	Maximum *min.*	Minimum *min.*
1	45	75	25
2	43	75	30
3	74	165	45
4	91	120	60
5	99	150	60
6	65	105	45
7	96	170	50
8	79	140	30
9	65	105	40
10	31	55	25
11	163	250	90

Note: Drying time shown is time for paint lines to become thoroughly dry. In all cases this time is longer than that required to prevent picking up by traffic. Values were determined after application of paint at each test section.

Figure 3. Wet-film-thickness gauge in use.

TABLE 4

PHYSICAL TESTS ON BEADS

Sample	Rounds %	Index Refraction	Average Breaking Load (on 20 - 30 Mesh Spheres) *lb.*	Beads *type*
3	24.0	1.46	Mash Flat at 10 lb.	Plastic
4	78.8	1.54 to 1.56	Too small to test	Glass
5	74.6	1.54 to 1.56	46.7	Glass
6	82.4	1.54 to 1.56	39.6	Glass

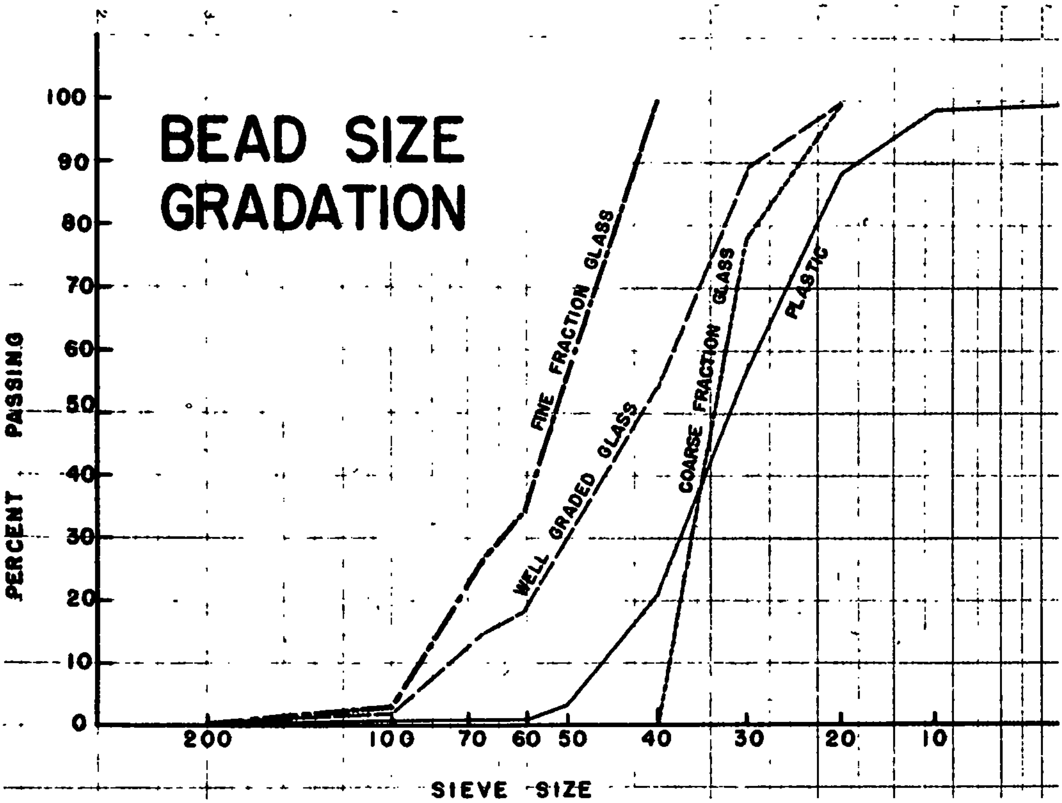

Figure 4. Gradation of beads used for beads-on-paint.

were installed here. Physical tests were made on the beads and typical results are given in Table 4. The particle-size gradations of various typical brands of beads are shown in Figure 4. In addition, one section was placed on an abandoned bituminous pavement and was subjected to weathering only. A general view of a test section open to traffic is illustrated by Figure 5.

TEST DATA

The performance of all test sections was evaluated at intervals over an 18-month period. Two performance properties, durability and reflectivity, were given primary consideration. Durability was determined by visual inspection and was also recorded photographically. To reduce bias in ratings, all observations and photographs were made by the same men throughout the period of study.' Values were recorded as percent failure of the lines.

Reflectivity was measured by means of a Hunter night-visibility meter (Fig. 6), which operates in a manner that makes it possible to simulate reflectance under conditions of night driving. Approximately

Figure 5. General view of a paint test section.

20,000 reflectance readings were taken during the study.

As the data were collected and analyzed, it became evident that the performance of the various paints was dependent upon such variables as pavement type and texture, lane width, number of lanes, volume and type of traffic, and climatic conditions. However, the order of paint ratings was nearly the same for all sections. For this reason, the durability and reflectivity performances as reported here represent the averages of all the test sections.

Durability

The data for failure of the lines in the six regular test sections is summarized in Table 5. From these values, the average failure of the transverse reflectorized lines is illustrated in Figure 7. It is at once evident that some paints withstood traffic wear much better than others. While the order of the paints as plotted on the graph was determined by ranking at age 545 days, it is noted that relative positions would be approximately the same

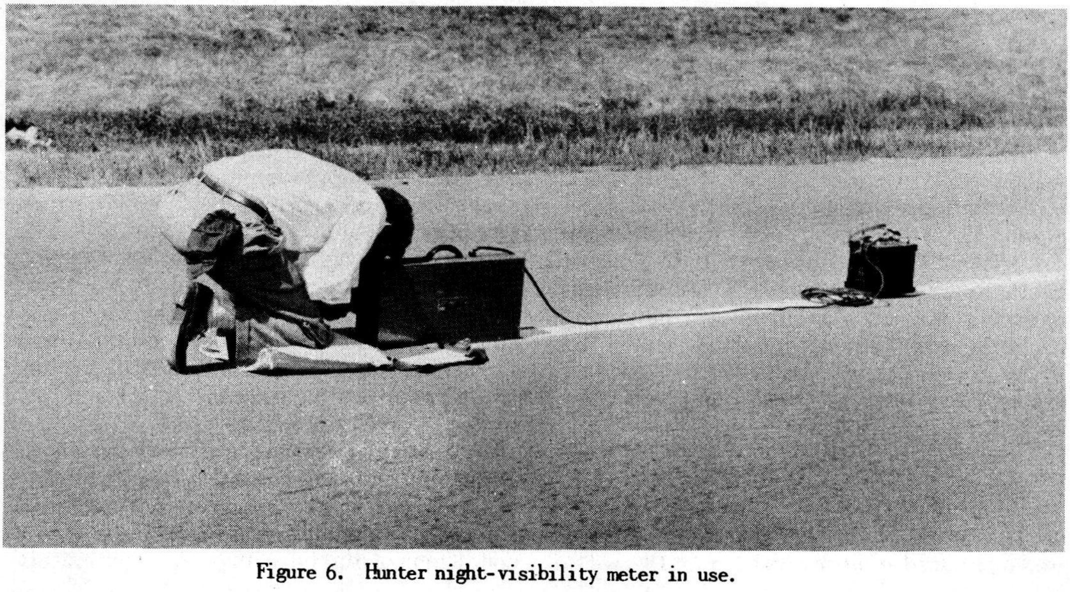

Figure 6. Hunter night-visibility meter in use.

TABLE 5

FAILURE OF TRAFFIC LINES ON SECTIONS B, C, D, E, F AND G AS DETERMINED BY VISUAL INSPECTION

Type Paint	Reflectorized									
Type Lines	Transverse									
Age Days	138		297		381		476		545	
Paint No	%	Range	%	Range	%	Range	%	Range	%	Range
1	13	3-20	42	22-75	55	35-80	69	45-95	79	60-98
2	13	2-25	35	25-45	54	40-75	71	45-90	84	60-98
3	16	10-25	48	30-65	71	40-92	79	45-98	88	60-100
4	6	1-15	15	5-35	25	15-40	35	20-55	50	30-90
5	5	0-15	14	5-27	26	15-35	38	25-55	52	35-80'
6	9	3-15	29	20-40	39	25-45	52	40-70	66	50-95
7	7	3-15	24	10-40	35	20-55	46	30-65	63	35-90
8	4	1-10	16	2-40	28	10-55	40	20-65	54	30-90
9	4	1-10	24	6-50	37	15-75	51	25-90	61	30-95
10	18	5-35	50	30-85	57	40-95	74	45-100	86	60-100
11	8	1-25	24	5-45	36	15-75	49	25-90	59	30-98
Avg (1-8)	9		28		42		54		67	
Avg (1-11)	9		29		42		55		67	

Type Paint	Reflectorized									
Type Lines	Longitudinal									
Age Days	138		297		381		476		545	
Paint No	%	Rng	%	Range	%	Range	%	Range	%	Range
1	6	1-12	31	8-60	43	25-75	59	35-85	79	45-98
2	6	0-15	32	8-45	44	25-60	73	40-98	86	50-100
3	9	1-20	46	18-60	64	35-100	81	40-98	89	50-100
4	2	0-5	10	2-20	14	5-25	25	10-60	39	20-98
5	2	0-6	11	1-22	21	5-30	32	10-55	48	25-98
6	7	0-15	20	3-40	29	15-30	42	20-80	60	25-100
7	7	1-20	28	12-40	38	25-55	54	35-90	71	50-100
8	2	0-5	15	2-35	25	10-50	37	15-65	59	25-100
9	3	0-10	17	6-40	33	15-65	46	25-100	58	30-100
10	10	0-20	48	20-95	61	40-96	73	50-100	90	70-100
11	6	1-15	23	5-45	31	15-65	43	20-98	48	25-100
Avg (1-8)	5		24		35		50		66	
Avg (1-11)	5		25		37		51		66	

Type Paint	Nonreflectorized									
Type Lines	Transverse									
Age Days	138		297		381		476		545	
Paint No	%	Rng	%	Range	%	Range	%	Range	%	Range
1	14	1-50	59	25-90	63	30-95	75	35-100	84	50-100
2	11	1-25	40	30-75	60	30-85	73	35-95	84	60-100
3	17	8-30	50	5-85	68	30-90	77	35-98	84	50-100
4	10	1-25	23	5-50	35	15-70	45	25-80	57	40-95
5	9	1-28	25	5-50	38	20-75	48	30-80	61	45-95
6	11	2-20	36	20-50	46	30-75	58	35-90	68	50-98
7	11	3-22	34	15-60	46	30-80	57	35-90	71	50-98
8	6	1-10	26	7-60	36	15-80	46	25-90	56	30-98
9										
10										
11										
Avg (1-8)	11		37		49		60		71	
Avg (1-11)										

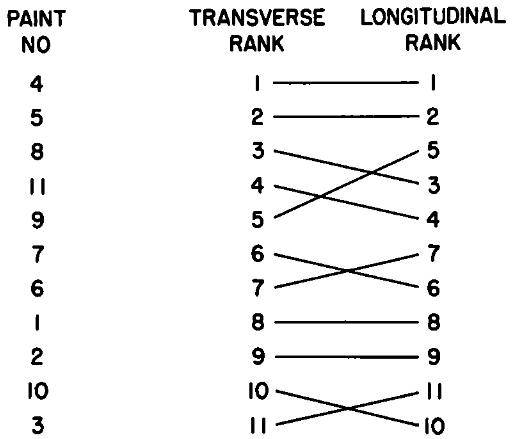

Figure 6(a). Rank correlation of transverse and longitudinal lines rated for durability.

at earlier ages. The several paints on the left would be judged to have superior durability properties, with Paint 4 ranking best. Further examination of the data for reflectorized longitudinal lines and non-reflectorized transverse lines pointed out that in addition to No. 4, Paints 5, 8, 9, and 11 gave a good account of themselves with respect to durability. It is interesting to examine the correlation of relative performance of the transverse and longitudinal test lines. Previous to the experiment, some doubt had been expressed by persons not familiar with testing techniques as to the validity of accelerated tests (such as carried out in the ASTM transverse line method) to determine performance of longitudinal lines as used in actual practice. In Figure 6(a) the paints have been listed in order of durability for the transverse lines at age 545 days. The corresponding rank for the durability of the longitudinal lines are listed in the column at the right in the figure.

The rank-correlation coefficient computed from this data (Spearman's method) is equal to 0.95. Rank-correlation coefficients for transverse and longitudinal performance for durability and reflectance under various other conditions ranged from 0.88 to 0.98. This indicates that good correlation exists between accelerated transverse-line paint tests and longitudinal-line performance under ordinary traffic exposure.

Figures 8, 9, 10, 11, 12, and 13 show the progressive failure of transverse stripes at one of the test sections.

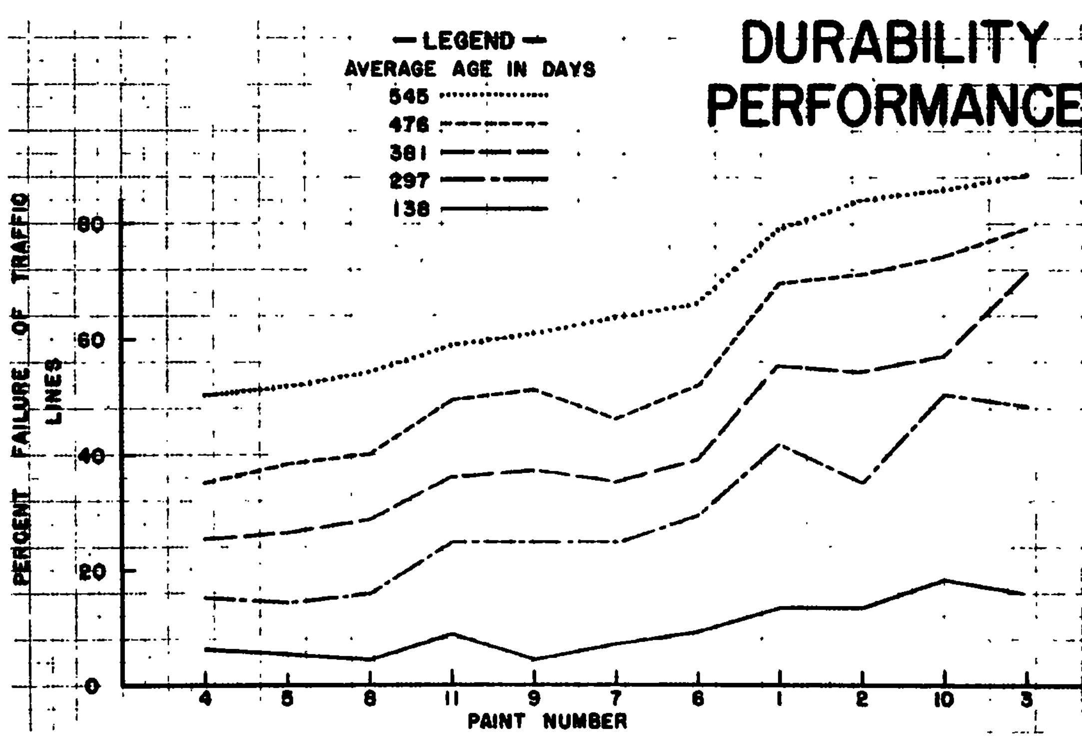

Figure 7. Average failure of transverse reflectorized traffic lines.

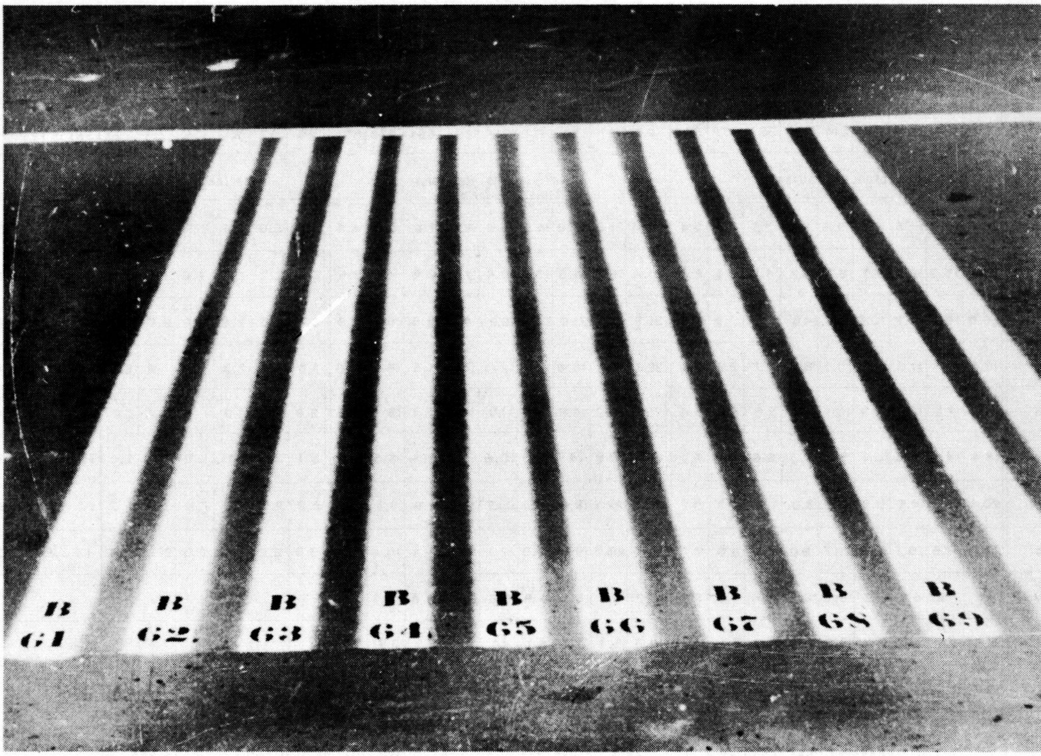

Figure 8. Test Section B at age one day. Note: Section B is on Route 250 in Albemarle County. It is a Type F-1 Paint Mix and carried an average daily traffic of 2,800 vehicles during the test.

Reflectivity

Reflectance measurement of the paints comprised an important phase of the study. The summary values for reflectance measurements are found in Table 7. Certain typical paints with respect to their reflectivity are represented graphically in Figure 14. It was the opinion of some observers that in order for a paint line to give a satisfactory night reflectance, a minimum Hunter meter reading of 10 is required. The problem of establishing minimum reflectance requirements is worthy of further study. All of the plain paints gave uniformly low reflectance readings and decreased gradually with time. The beads-in-paint type decreased in reflectivity for a few months and then increased somewhat as the beads became exposed. One of the three paints tested of the beads-in-paint type gave reflectance values 25 percent higher than the curve shown in Figure 14.

A typical beads-on-paint type, as shown in Figure 14, began with a high reflectance which decreased with age, but which maintained a Hunter reading of 10 at the end of one year. The fourth curve shown in Figure 14 is representative of two of the beads-on-paint type which initially had very-high reflectance properties but which rapidly decreased until reflectivity approached that of plain paint. It was noted that these two paints had poor elastic properties and that apparently the beads were removed from the surface with usage.

Bead Test Section

Some typical reflectance curves for the test section devoted to a study of beads are shown in Figure 15. Reference is made to Figure 4 and to Table 4. It is seen that particle-size gradation of the glass beads appears to have definite influence on their reflectance. The coarse fraction of glass beads (100 percent passing the No. 20 sieve and zero percent passing the No. 40 sieve) produced relatively high reflectance initially, while the fine fraction (100 percent passing the

TABLE 7

SUMMARY OF NIGHT REFLECTANCE READINGS SECTIONS-B, C, D, E, F, AND G

Type Line	Reflectorized Transverse									Reflectorized Longitudinal									Nonreflectorized								
Age Days	24	57	81	114	214	297	381	472	*554	24	57	81	114	214	297	381	*472	*554	24	57	81	114	214	297	381	*472	*554
Paint No	Reflectance Readings									Reflectance Readings									Reflectance Readings								
1	26 5	19 9	14 6	11 9	9 2	6 6	3.5	3 8	3 4	25 3	21 5	16 0	14 0	10 6	8 9	7 5	5 0	4 3	3 3	3 0	2 4	1 9	2 1	2 4	1 2	1 6	2 5
2	19 6	15 7	12.8	9.7	8.3	6.2	4 1	3 4	2 5	21 4	18.3	14 5	13 2	10 4	7 6	2 8	4 9	2 6	2 6	2 2	1 6	1 6	1 8	2 0	1 0	1 4	2 3
3	26 5	19 1	14.7	10.6	6.8	4.8	2.5	2 9	2 4	31 9	24.9	21 0	15.0	6 2	4.8	2.5	5.8	3.4	3 1	2 5	2 2	1 9	2 0	2.0	1 0	1 5	2 4
4	18.4	13.1	11 6	11 7	10 3	8.9	7 1	8.8	8 6	22 5	18.1	15 6	14 7	12 3	13 0	11 5	14 0	10.5	3.5	2 9	2 3	1 9	1 8	2 2	1 1	2 2	2 4
5	18.6	17 2	13.0	10.9	10 1	10.2	9.8	8 2	6 4	22.0	18 2	14 8	13.8	11 0	11 1	12 1	13 6	8 3	2 8	2.3	1 6	1 6	1 7	2.0	1 1	1 5	2 4
6	18 4	14 8	12 5	10 1	9 2	7 3	6 6	6 5	6.2	21.8	15.9	14 8	13 0	10 6	10.1	8 4	9 5	7 9	3 1	2 3	2 1	1 7	1 7	2 0	1 1	1 5	3 1
7	20.4	17 2	14 9	11 2	11 1	8 3	7 4	6 3	5 2	26 3	22.2	19 4	16 1	11 7	9 4	8 9	9 3	5 2	3 2	2 5	2 0	1 8	1.8	1 9	1 1	1 5	2 8
8	23.5	17 5	15 1	12 3	11 7	9.0	6 8	8.0	7 7	29 4	23.3	19 0	17 0	12 1	11 2	11 4	15.6	12 3	3.5	2 6	2 3	2 0	2 2	2.4	1 1	2 1	2 5
9	5 7	4.8	4 5	4 3	6 2	6.4	6 4	7 8	7 0	6 9	5 5	5 6	4 8	5 8	8.1	8 5	12 4	10 4									
10	8 3	6.4	5 5	4 1	3 9	3 9	2 2	3 1	2 4	10 3	8 4	6 3	6 1	4.4	6 9	5 2	8.8	7 9									
11	13.3	8.3	9 5	8 4	10 2	9 5	9 0	9 6	10.4	12 0	10.4	11 0	9 7	11 3	11 1	10 8	13.7	10 1									

NOTE *No readings taken on Section G

For transverse lines, each value represents an average of 60 measurements of the first eight readings and 50 measurements for last reading

For longitudinal lines, each value represents an average of 30 measurements of the first eight readings and 25 measurements of the last reading

The table values were subject to minor calibration corrections

No. 40 sieve and three percent passing the No. 100 sieve) produced initial reflectance of relatively lower values. At an age of $1\frac{1}{2}$ yr. their reflectances were nearly equal. The plastic beads, while containing a high percentage of the coarser sizes, were the poorest performers in the reflectance readings. For the sake of comparison, beads of well-graded glass were placed on a beads-in-paint type and produced the high reflectance also shown in Figure 15. This high reflectivity lasted about three months before approaching values equal to those of regular beads-on-paint. This combination may have application in certain cases where very high reflectance is required.

Weathering Test Section

The test section devoted only to weathering did not produce especially important results. It was observed that the reflectance of all paints was higher than on any of the sections open to traffic and that durability was also greater. Some bleeding was observed, particularly where excessive asphalt was present on the surface.

RESULTS AND CONCLUSIONS

Based on the 18-month study of field performance of 11 traffic-marking paints placed on 8 experimental sections and various type pavement surfaces in Virginia under different traffic conditions. The following results and conclusions have been summarized:

1. The accelerated test as developed ASTM (Designation D 713-46) is a satisfactory method for evaluating service behavior of traffic paints.

2. A good correlation existed between results of the transverse (accelerated tests) and the longitudinal paint line tests under ordinary traffic exposure. Under various test conditions, rank correlation coefficients (Spearman's method) for durability and reflectance ranged from 0.88 to 0.98.

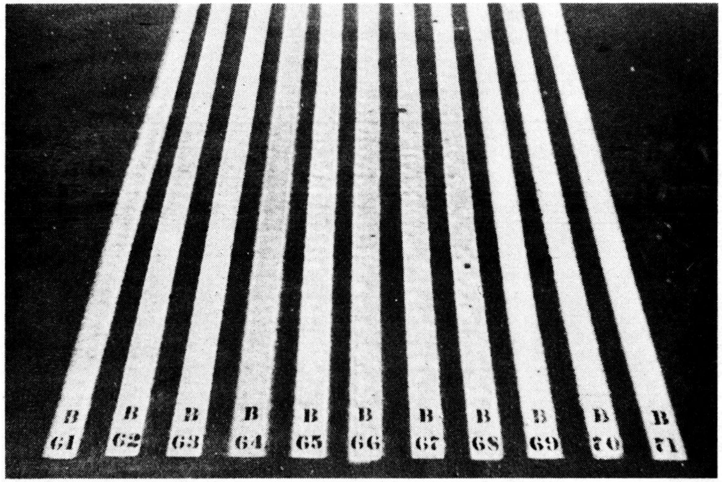

Figure 9. Test Section B at age four months.

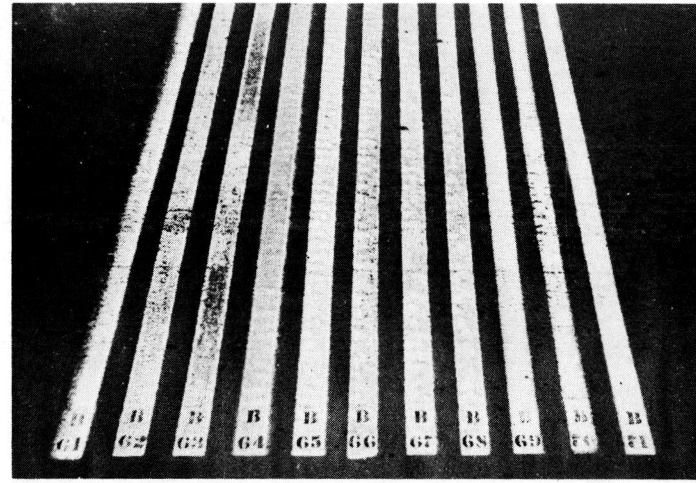

Figure 10. Test Section B at age nine months.

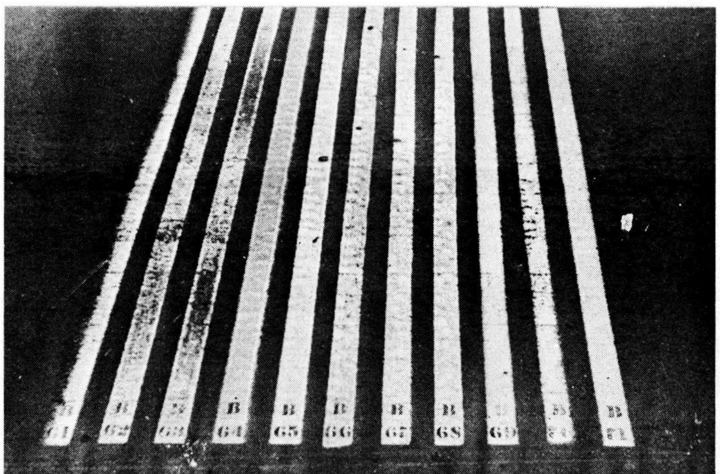

Figure 11. Test Section B at age twelve months.

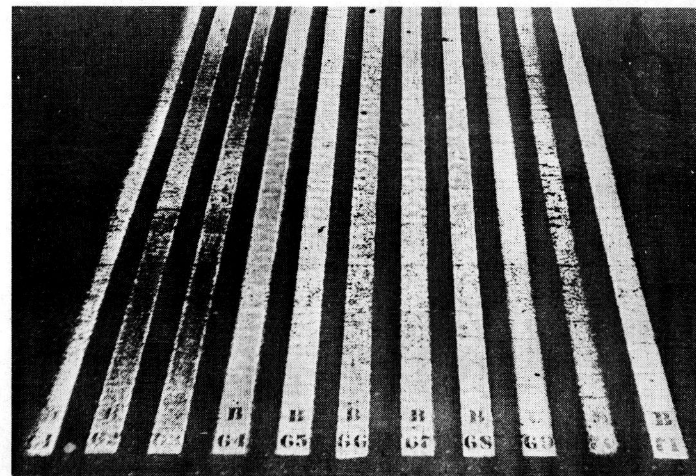

Figure 12. Test Section B at age sixteen months.

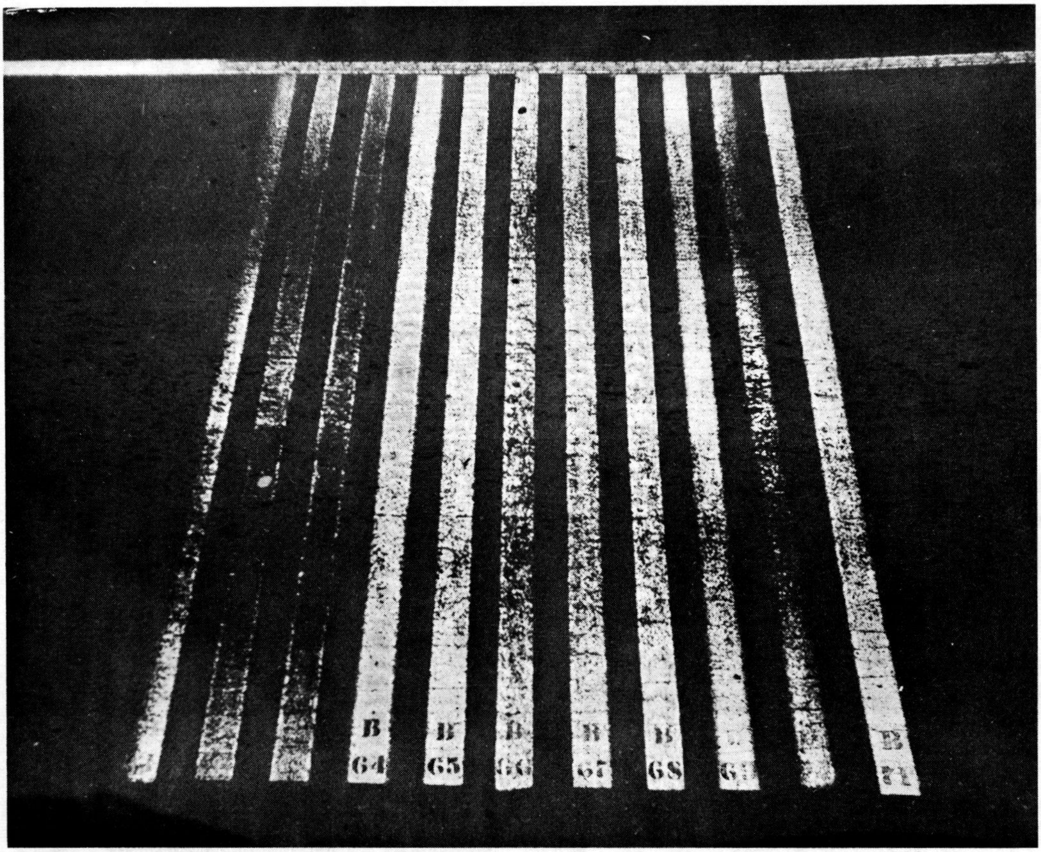

Figure 13. Test Section B at age nineteen months.

3. Except for initial readings, reflectance values on longitudinal lines were consistently higher than those on comparable transverse lines throughout the 18-month period.

4. The composition, type, shape, and size of beads are important factors affecting performance of the beads-on-paint type lines, particularly as determined from reflectance readings. From the experiments it is indicated that the coarse beads (plus 40-mesh) give high reflectance initially, but this is not maintained over a long period. On the other hand, the fine beads (minus 40-mesh) have lower initial reflectance which is more constant with age. The reflectance of graded beads (coarse and fine) is intermediate.

5. In analyzing overall performance, a wide variation was found in the 11 paints tested. The order of ranking the paints at each test section was nearly constant. It was determined that four paints exhibited characteristics which ranked them as being superior in quality. The four top ranking paints in order of performance were Nos. 4, 8, 11 and 5.

6. It is anticipated that the field studies of traffic paints be a continuing one. Periodically, the paints in use by Virginia will be compared under accelerated field exposure with other paints (and perhaps improved types) as they become available.

On the basis of these studies, specifications were developed to secure paints equivalent to Nos. 4 and 5. (It may be pointed out that Paints 8 and 11 were proprietary materials for which specifications were not available.) Specifications for glass beads are given in the appendix.

From competitive bidding on these specified materials some 80,000 gal. of paint and 532,000 lb. of glass beads were purchased and applied during 1950. It is

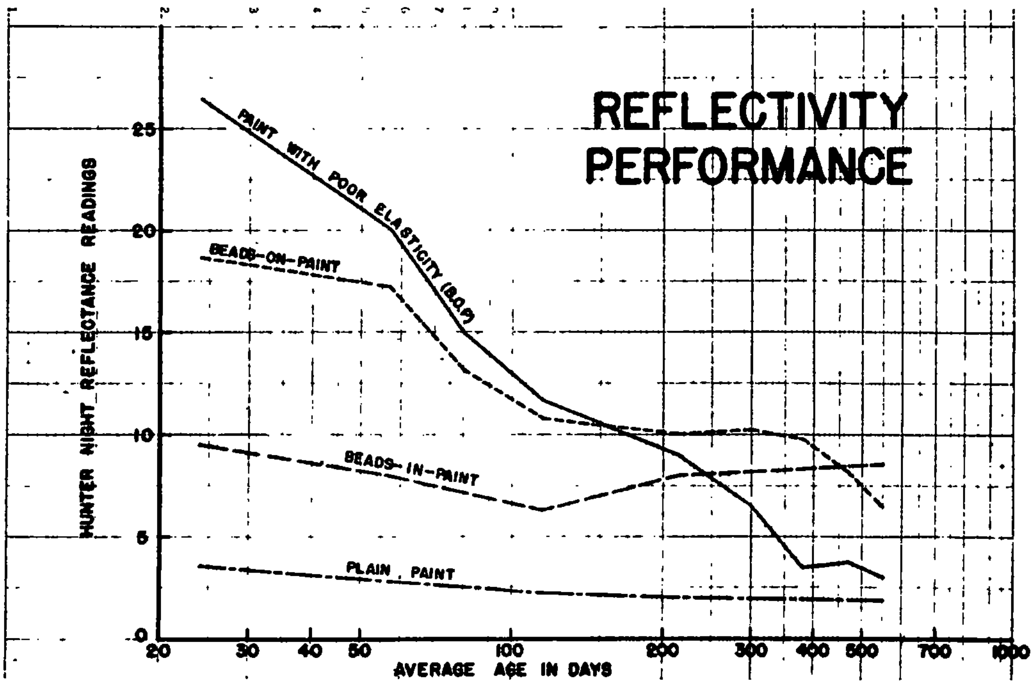

Figure 14. Typical night reflectance readings on transverse lines.

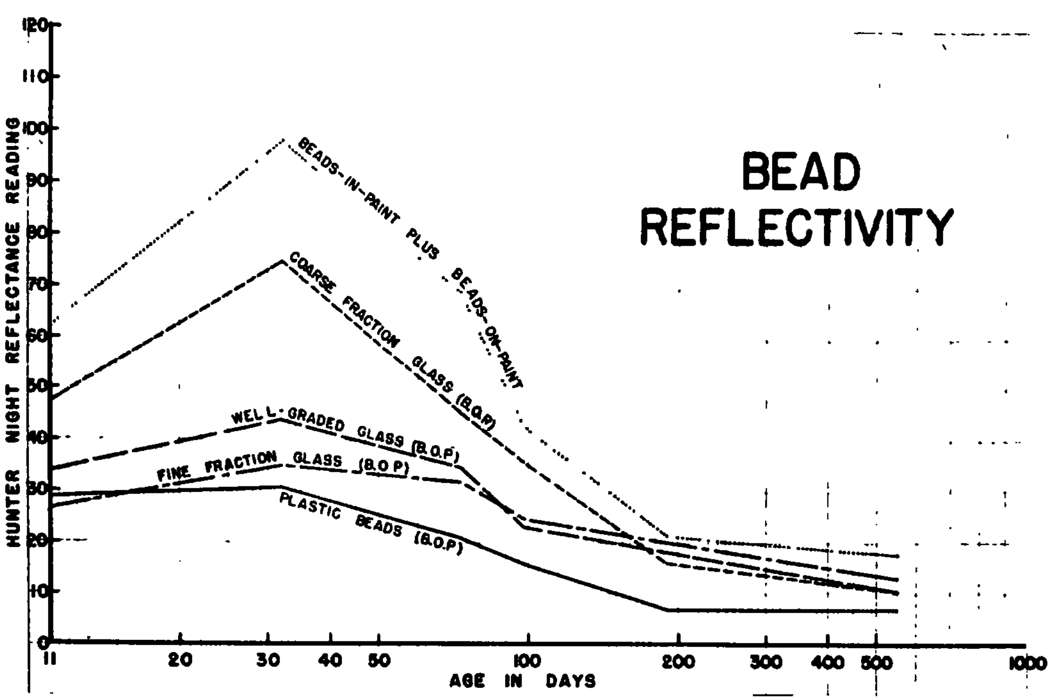

Figure 15. Night reflectance readings for various beads.

important to point out the materials were purchased in 1950 at a saving of approximately $80,000 as compared to the cost of equivalent materials previously used by the highway departments. Performance of the materials purchased under these specifications and applied in 1950 gave very satisfactory performance. Despite the severe winter, field forces reported the following spring (1951) that the pavement lines on primary roads after about one year's service were generally in good condition and that in many cases only spot work would be necessary perhaps until late summer or early fall.

In conclusion, the paint studies have been very beneficial to Virginia's highway department and have demonstrated the savings that may be effected through a small investment in research. It is urged that other states that have not recently made field evaluation of the newer marking paints do so in order to determine which ones are best suited to their particular conditions.

ACKNOWLEDGMENTS

The authors wish to acknowledge the help given in this project. It was initiated and authorized by C. S. Mullen, chief engineer of the Virginia Department of Highways. The work was planned and executed through the Division of Tests, the Maintenance Division and the Virginia Council of Highway Investigation and Research.

Employees of all three cooperating agencies worked together applying and evaluating the paints. However, the laboratory tests were performed by the test division and the night-reflectance readings, as well as the tabulation and analysis of results were made by the research council.

R. L. Sheppe, associate research engineer (now on military leave) supervised the work for the research council. Special acknowledgment is given to C. A. Franklin, a chemist of the test division, and to J. L. Thomas, field engineer in charge of paint crews, for invaluable help and cooperation.

Appendix

VIRGINIA DEPARTMENT OF HIGHWAYS

SPECIFICATIONS FOR

NO. 4 REFLECTORIZED WHITE TRAFFIC-ZONE PAINT

TYPE A

(Test Paint No. 4)

January 31, 1950
Rev. November 15, 1951

General

All traffic zone paint shall be thoroughly ground, shall not settle badly nor cake in the container, shall be readily broken up with a paddle to a smooth uniform paint, capable of easy application with a brush or mechanical distributor in accordance with the rules of good standard practice.

Detailed Requirements

It is intended that this paint shall bind properly graded glass beads in such a manner as to produce maximum adhesion, refraction and reflection. (Beads to be placed on freshly applied line at the rate of 6 lb. of beads to 1 gal. of paint. Wet film thickness of paint to be 0.015 in. The capillary action shall be such as to provide adequate anchorage and refraction without excessive envelopment of the beads.

Composition	Minimum	Maximum
Vehicle	. . .	40%
Pigment	60%	. . .
Titanium Dioxide	24%	26%
Calcium Carbonate	30%	32%
Barium Sulfate	30%	32%
Asbestine	12%	14%

Coarse particles and skins, (total residue on No. 325 sieve based on pigment), maximum 0.5 percent.

Vehicle

The vehicle shall consist of pure alkyd resin, thinners and driers. It shall be free of other synthetic or natural resins. The non-volatile content shall be not less than 45 percent and shall be a glycerol phthalate alkyd containing a minimum of 24 percent phthalic anhydride based on the vehicle solids. The alcohol portion shall be limited to glycerine and the oil portion to refined soya bean oil. The vehicle shall be so processed as to provide a product with an acid number of 5 maximum and color of 7 maximum based on resin solution at 60 percent non-volatile. The volatile portion shall contain not less than 20 percent of a high solvency thinner. (Amsco A type)

Weight Per Gallon

The weight per gallon of the paint shall be not less than 13.2 lb.

Color

It is required under this specification that the color after drying shall be a pure flat white, free from tint, furnishing the maximum amount of opacity and visibility under both daylight and artificial light. The fixed drying oils used shall be of such character as will not darken under service or impair the color and visibility of the paint.

Drying Time

The paint furnished under this specification shall, when applied at the rate of 0.015 in. wet film thickness, dry sufficiently within 1 hr. after application so that it will not be marred under traffic.

Viscosity

Forty-eight hours after this paint has been prepared and put in containers it shall have a consistency of from 80 to 85 K. U. as determined with the Krebs Modification of the Stormer Viscosimeter. An initial viscosity of 80 to 82 K. U. is desired.

Elasticity

A cleaned panel of tin plate (No. 30 U. S. standard plate gauge) measuring 2¾ in. by 6 in. shall be coated with a film of the paint, having a wet film thickness of 0.006 of an in., and baked for 6 hr. in an oven maintained at a temperature of 100C. The panel shall be allowed to cool at room temperature for 1 hr. and shall then be bent rapidly around a ¼ in. rod., The paint film shall withstand this test without checking, cracking, or flaking.

Sample

The color, hiding power, and flatness of the paint furnished under this specification shall be equal to that of a sample mutually agreed upon. When dry it shall show a flat, white, opaque finish, and shall show no graying nor discoloration when exposed to the equivalent of direct summer sunlight for 7 hr. The paint shall show no skinning when a half pint friction top can is half filled, the lid replaced and allowed to set for 18 hr.

A quart sample of paint which the manufacturer proposes to furnish under this specification shall accompany each bid. No bid shall be considered if the sample submitted therewith does not meet fully the requirements of this specification.

TYPE B

(Test Paint No. 5)

January 31, ,1950
Rev. November 15, 1951

General

All traffic zone paint shall be thoroughly ground, shall not settle badly nor cake in the container, shall be readily broken up with a paddle to a smooth uniform paint, capable of easy application with a brush or mechanical distributor in accordance with the rules of good standard practice.

Detailed Requirements

It is intended that this paint shall bind properly graded glass beads in such a manner as to produce maximum adhesion, refraction and reflection. (Beads to be placed on freshly applied line at the rate of 6 lb. of beads to 1 gal. of paint. Wet film thickness of paint to be 0.015 in. The capillary action shall be such as to provide adequate anchorage and refraction without excessive envelopment of the beads.

Composition	Minimum Percent	Maximum Percent
Vehicle	36.0	38.0
Pigment	62.0	64.0
Zinc Oxide	40.0	42.0
Lithopone	30.0	32.0
Titanium Dioxide	6.0	8.0
Magnesium Silicate	20.0	22.0

Coarse particles and skins, (total residue retained on No. 325 sieve based on pigment), maximum 0.5 percent.

Vehicle

The vehicle shall be a kettle treated product composed of resins, oils, thinners, and driers so porportioned as to produce a paint of the maximum film elasticity, hardness, durability, and required drying time. The vehicle shall contain not less than 42 percent of non-volatile matter. The non-volatile portion shall contain not less than 55 percent of tung oil. The remainder of the oils shall be linseed oil or dehydrated castor oil. The resin used shall be of the modified phenolic type.

Weight Per Gallon

The weight per gallon shall be not less than 14 lb.

Color

It is required under this specification that the color after drying shall be a pure flat white, free from tint, furnishing the maximum amount of opacity and visibility under both daylight and artificial light. The fixed drying oils used shall be of such character as will not darken under service or impair the color and visibility of the paint.

Drying Time

The paint furnished under this specification shall, when applied at the rate of 0.015 in. wet film thickness, dry sufficiently within 1 hr. after application so that it will not be marred under traffic.

Viscosity

The paint furnished under this specification shall have a viscosity, at 77° F. of from 80 to 83 K. U. as determined with the Krebs Modification of the Stormer Viscosimeter.

Elasticity

A cleaned panel of tin plate (No. 30 U. S. standard plate gauge) measuring 2¾ in.

by 6 in. shall be coated with a film of the paint, having a wet film thickness of 0.006 of an in., and baked for 6 hr. in an oven maintained at a temperature of 100C. The panel shall be allowed to cool at room temperature for 15 min. and shall then be bent rapidly around a ⅛ in. rod. The paint film shall withstand this test without checking, cracking, or flaking.

Sample

The color, hiding power, and flatness of the paint furnished under this specification shall be equal to that of a sample mutually agreed upon. When dry it shall show a flat, white, opague finish, and shall show no graying nor discoloration when exposed to the equivalent of direct summer sunlight for 7 hr.

A quart sample of paint which the manufacturer proposes to furnish under this specification shall accompany each bid. No bid shall be considered if the sample submitted therewith does not meet fully the requirements of this specification.

SPECIFICATION FOR GLASS BEADS FOR REFLECTORIZING TRAFFIC-MARKING PAINT

January 31, 1950
Rev. November 15, 1951

General

1. This specification is intended to cover glass beads for application on traffic paint for the production of a reflective surface to improve the night visibility of the paint film.

2. The beads shall be manufactured from glass of a composition designed to be highly resistant to traffic wear and to the effects of weathering.

Material

The beads shall conform to the following requirements:

1. The beads shall be spherical in shape, and shall not include more than 25 percent of irregularly shaped particles. They shall be essentially free of sharp angular particles, and particles showing milkiness or surface scoring or scratching.

2. Gradation: The beads shall meet the following gradation requirements:

U. S. Standard Sieve	Minimum Percent	-	Maximum Percent
Passing No. 20 Retained No. 30	5	-	20
Passing No. 30 Retained No. 50	30	-	75
Passing No. 50 Retained No. 80	9	-	32
Passing No. 80 Retained No. 100	0	-	10
Passing No. 100	0	-	5

3. Index of Refraction: The beads when tested by the liquid immersion method at 25° C. shall show an index of refraction within the range of 1.50 to 1.65.

4. Crushing Strength: When tested in compression at a loading rate of 70 lb. per min., the average resistance to failure of 10 beads shall be not less than the following:

20-30 mesh size	40 lb.
30-40 mesh size	30 lb.

5. Chemical Stability: Beads which show any tendency toward decomposition, including surface etching, when exposed to atmospheric conditions, moisture, dilute acids or alkalies or paint film constituents, may, prior to acceptance, be required to demonstrate satisfactory reflectance behavior and maintenance under such tests as may be prescribed.

6. Initial Reflectance: When the beads are applied at a rate of 6 lb. per gal. on binder having a wet film thickness of 15 mils, the resulting stripe, at the end of 24 hr. drying, shall show a directional reflectance value of not less than 14 using the Hunter night visibility meter. The binder shall be the Virginia Department of Highways Reflectorized White Traffic Zone Paint or paint of similar pigmentation and non-volatile content.

7. Packing: The beads shall be furnished in units of 100 lb. packed in standard moisture proof bags.

8. Sample: A 5 lb. sample of the material which the bidder proposes to furnish under this specification shall accompany each bid.