DEVELOPING COMPOSITION SPECIFICATIONS FOR TRAFFIC PAINTS: Regular-Dry Type

A. J. Permoda
A. R. Gabel

Research Laboratory Section
Testing and Research Division
Research Project 70 G-175
Research Report No. R-802

Michigan State Highway Commission
Charles H. Hewitt, Chairman; Louis A. Fisher, Vice-Chairman
Claude J. Tobin; E. V. Erickson; Henrik E. Stafseth, Director
Lansing, February 1972

On May 1, 1970 the Research Laboratory submitted a memorandum to R. L. Greenman listing reasons for dropping our nearly 20 year old performance specifications for the regular-dry white and yellow traffic paints and reverting to composition type specifications. The main reasons for the change were: 1) The Department was purchasing a progressively greater portion of its striping requirements in fast-dry paints (about 35 percent in 1970) on performance type specifications, 2) Good composition specifications for the regular-dry paints were available, and 3) The Research Laboratory would be hard pressed to run field performance tests on both types of paint during the same year.

At a May 12, 1970 meeting, the Traffic Control Devices Committee reviewed the Research Laboratory memorandum and approved the change of specification type covering the regular-dry paints. The Committee requested the Testing and Research Division to develop the best possible composition specifications using: a) specifications of other states and, b) road-testing the most promising of these paints to determine their performance in Michigan. These specifications were to become effective for purchases covering 1972 striping requirements.

In June and July 1970, the Research Laboratory wrote to all state highway departments requesting copies of their traffic paint specifications. On receipt, the types applicable to this study were classified roughly into the following groupings:

1. Performance type specifications as used by nine states for all or part of their regular-dry requirements.

2. Composition type specifications using an alkyd binder, patterned after Federal Specifications for White and Yellow Traffic Paint, TT-P-115c, Type I.

3. Composition specifications, using some chlorinated rubber in the binder, falling into two classes:

   a) One containing 80 percent alkyd plus 20 percent chlorinated rubber in vehicle solids, patterned after Federal Specification, TT-P-115c, Type III.

   b) Texas formula using about 50 percent chlorinated resins and plasticizers in the binder.

4. Miscellaneous composition specifications.

Pavement marking paints meeting the above groupings have, of course, been field tested in some of the previous, annual Department performance tests. However, it was decided to test representatives of all of those groupings together, in field tests scheduled for 1971, restricted to white paints only. Accordingly, the following paint samples were obtained from various sources, to be representative of the four categories:

1. Group 1 was represented by two paints, both were Department acceptance samples:

(a) the epoxy ester paint purchased in 1970 and 1971, and (b) the alkyd paint purchased in 1968 and 1969. Both were purchased for roadway striping on basis of performance tests.

2. Group 2 was represented by four paints, one from Kansas, another from Pennsylvania. Two others were laboratory formulated compromises of several state specifications.

3. a) Group 3(a) was represented by one paint, based on the Illinois specifications (about the same as New Jersey No. 3).

b) Group 3(b) was represented by one paint, the Texas specification.

4. Group 4 was represented by five paints submitted by two producers to fill the miscellaneous grouping.

In addition to the listed 13 paint samples to be performance tested with the standard complement of MDSH glass beads, it was decided to evaluate two paint additives on their ability to improve bead binding, and two bead samples surface treated with the additive chemical, the latter to be evaluated in the 1968-69 acceptance paint.

The 13 paint samples (physical characteristics listed in Table 1) were laid-down with the Laboratory stripe-applicator, on the concrete roadway of eastbound M 78 on June 3, 1971 and on the bituminous roadway of westbound M 78 on June 4, 1971. Each paint was deposited as a set of three or more stripes, as is customary. The two sections were east of E. Lansing and east of Lake Lansing Rd. The initial appearance on the concrete is shown in Figure 1, a general view, and a close-up view of several paint sets.

Inspections of the test lines were made by members of the standard rating team three days after application, and at varying intervals thereafter. The intervals at which the ratings were made and the respective

TABLE 1
PHYSICAL CHARACTERISTICS OF TEST WHITE TRAFFIC PAINTS

Paint Identification	Weight per gal, lb	Paint N-V percent by wt	Viscosity, @ 77 F Ku	Reflectivity percent	Drying Time, min[1]		Source
					Lab	Field	
70P-177	13.5	63.0	72	79.5	7	13	Sherwin-Williams Dri-Fast
71P-53	13.5	75.3	76	92.1	9	18	Illinois spec. paint
71P-89	12.2	69.2	74	84.9	8	11	Texas spec. paint
71P-83	12.1	67.6	75	88.9	9	15	Baltimore No. 134-106
71P-84	11.9	68.6	75	86.8	9	22	Baltimore No. 134-107
71P-85	11.7	69.1	75	89.2	15	22	Baltimore No. 134-108
71P-86	11.7	71.3	74	86.8	10	20	Baltimore No. 134-109
71P-87	10.4	64.1	66	87.9	8	14	Kansas[2] spec. paint
71P-88	12.0	75.0	74	88.8	9	25	Pennsylvania spec. paint
71P-90	13.0	76.7	93	90.2	18	27	Lab. formulated alkyd paint
71P-91	12.6	75.2	86	90.9	17	30	Lab. formulated alkyd-acrylic paint
71P-92	13.5	75.2	84	83.7	28	23-1/2	1970-71 acceptance paint
71P-115	11.8	74.0	82	85.6	16	29	1968-69 acceptance paint
71P-115	With DC-PA No. 21					23-1/2	above plus Dow-Corning additive
71P-115	With DC-PA No. XZ 85072					37-1/2	above plus Dow-Corning additive
71P-115	With treated beads 71GB-26					28	above plus Dow-Corning treated MDSH beads
71P-115	With treated beads 71GB-27					26	above plus Dow-Corning treated MDSH beads

[1] Determined on beaded stripes by ASTM D-711 method.

[2] Submitted sample may not have been representative.

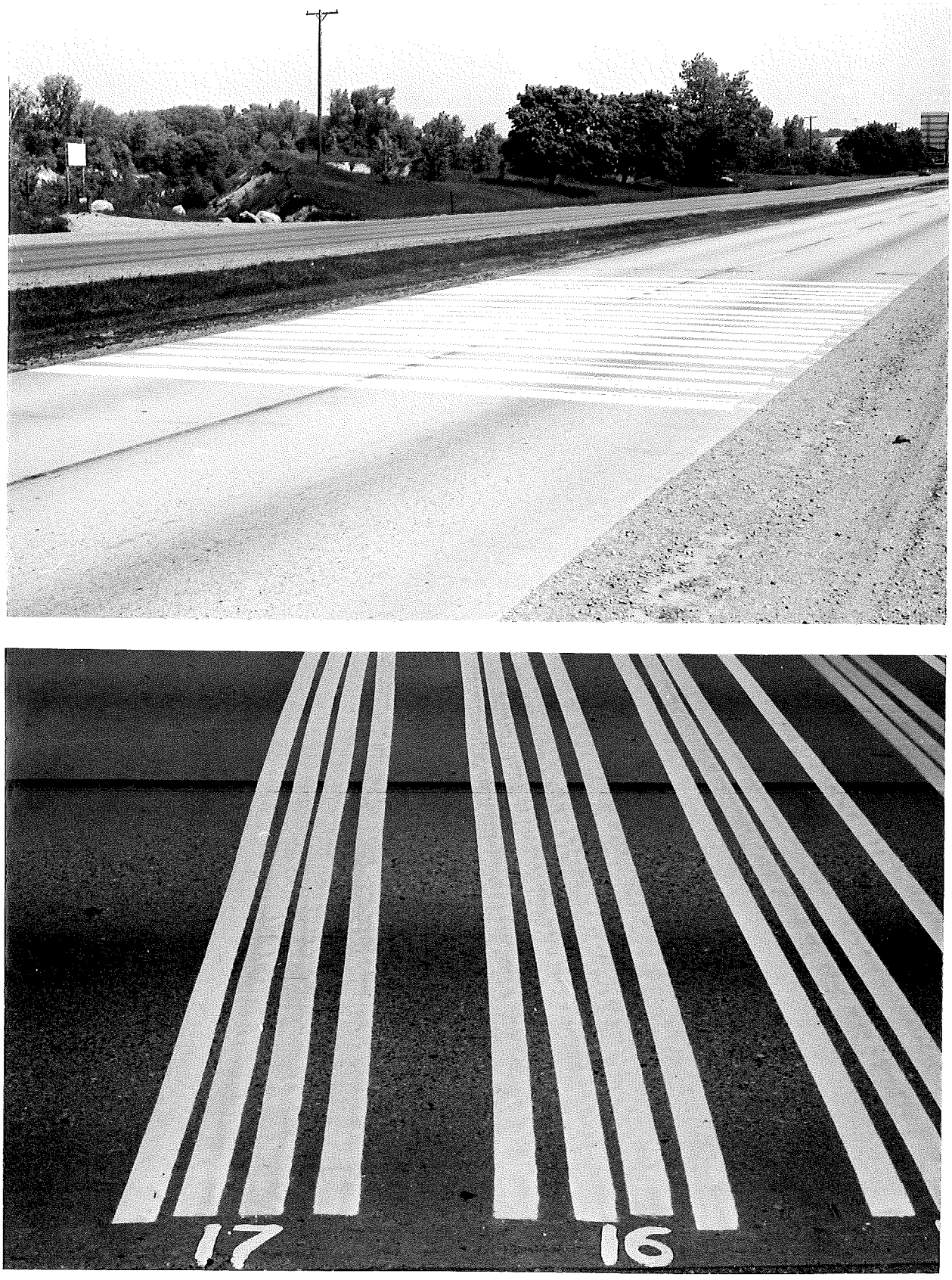

Figure 1. General and detail views of the initial appearance of test performance stripes: eastbound M 78, east of Lake Lansing Rd.

ratings are shown in Table 2; the ratings given being averaged for the two locations and the raters.

To help discern final differences in performance of the test paints, the rating intervals were shortened during the November-December period when studded tires begin appearing on vehicles. How these tires and the accompanying cold weather deteriorate the paint stripes can be seen in the fast drop-off of durability in the graphs of Figure 2, plotting that value against exposure time. The three curves shown, represent the best and poorest paints in the tests, and the average of all paints. The same accelerated deterioration was also noted on the 1971 test fast-dry paints as presented in graphs of recent Research Report No. R-798. On December 14, 1971, the terminal date of ratings, the average durability of all fast-dry paints was 1.9 after 139 days of service, while for the regular-dry paints on the same date, the durability was 2.8 after 194 days of service. This condition of the paints on the concrete pavement is shown in Figure 3.

Discussion of Results

In Table 2, after the last rating (194 days), one finds listed the overall performance of each paint during the field tests, expressed as "Service Factor"--really a measure of the area under the curve when plotting weighted rating values vs. time of tests for each paint. The last listing in Table 2 just converts the Service Factor values to a scale having 100 for the best performing paint.

A review of the listed Service Factors shows that paint No. 88, a sample of the Pennsylvania Highway Dept. paint, was the best performer in the tests, followed by paint No. 92, the paint purchased by the Department for roadway striping in 1970 and 1971. The third best performer was paint No. 115 with paint additive No. 21, the former being the paint purchased by the Department for roadway striping in 1968 and 1969. The fourth and fifth best performers were the chlorinated rubber containing paints, No. 89 (Texas' specification) and No. 53 (Illinois' specification), respectively. The sixth best performer was paint No. 90, a Laboratory combination formula of several State specifications, while paint No. 91, seventh best, was a modification thereof containing a 20 percent substitution of an acrylic resin for the alkyd, in the binder.

It is interesting to note that none of the producer-supplied samples, Nos. 177, 83, 84, 85, and 86, did especially well in the tests.

Additional Comments on Performance: Paint No. 88 earned a high performance rating because of good durability and high night-visibility throughout the tests. Why other test paints, comparable in composition to No. 88,

TABLE 2
PERFORMANCE RATING DATA

Exposure Days	Factor Evaluated	Paint Identification Numbers																
		177	89	53	83	84	85	86	87	88	90	91	92	115[1]	115[2]	115	115[3]	115[4]
3	General Appearance	7.8	10.0	8.5	8.5	8.5	8.2	8.4	8.6	7.6	8.6	9.1	8.4	8.0	7.5	8.8	8.9	8.4
	Durability	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
	Night Visibility	7.9	6.2	5.5	4.8	4.5	5.6	5.3	3.8	9.5	4.4	4.4	5.7	6.2	3.8	5.2	4.9	5.2
	Weighted Rating	8.7	8.1	7.6	7.3	7.1	7.6	7.5	6.8	9.5	7.1	7.1	7.7	7.9	6.7	7.5	7.4	7.4
45	General Appearance	7.4	7.6	7.4	7.2	7.4	7.1	7.6	7.6	6.0	7.8	8.0	7.8	7.1	7.7	8.2	8.1	7.1
	Durability	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
	Night Visibility	6.4	6.4	4.6	4.0	3.8	4.6	5.1	4.2	8.9	4.9	5.0	6.8	6.1	3.2	5.6	4.6	4.9
	Weighted Rating	7.9	8.0	7.0	6.7	6.6	7.0	7.3	6.9	9.0	7.2	7.3	8.2	7.8	6.4	7.6	7.1	7.2
97	General Appearance	7.4	7.1	6.8	6.5	6.2	6.2	6.5	6.0	5.2	7.2	7.8	7.5	7.0	7.9	7.6	7.8	7.4
	Durability	9.8	10.0	10.0	10.0	10.0	10.0	9.2	7.2	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
	Night Visibility	3.6	5.8	5.4	4.6	4.0	4.4	5.1	3.2	7.1	4.5	4.0	4.9	5.4	3.8	4.5	4.4	4.6
	Weighted Rating	6.4	7.6	7.4	7.0	6.6	6.8	6.9	5.1	8.1	7.0	6.8	7.2	7.4	6.7	7.0	7.0	7.0
130	General Appearance	6.8	6.8	6.6	6.4	6.4	6.4	6.4	5.0	5.6	7.0	7.5	7.4	6.6	7.6	7.2	7.5	6.6
	Durability	9.4	9.2	9.4	9.2	9.0	9.0	9.0	5.6	9.5	9.4	9.4	9.6	9.6	9.4	9.4	9.2	9.4
	Night Visibility	3.7	6.8	6.9	5.2	5.7	6.2	6.5	4.9	8.2	6.1	6.5	7.5	7.0	5.5	5.2	5.6	5.6
	Weighted Rating	6.3	7.8	7.9	7.0	7.1	7.3	7.5	5.2	8.5	7.5	7.8	8.3	8.0	7.3	7.1	7.2	7.2
161	General Appearance	7.6	7.3	7.9	7.4	7.4	7.6	7.5	4.1	7.0	8.1	7.8	7.3	7.7	8.4	8.2	8.2	7.8
	Durability	9.1	9.3	9.3	9.4	9.2	9.2	9.3	4.7	9.2	9.3	8.8	9.3	9.2	9.1	9.1	8.9	9.1
	Night Visibility	3.2	4.8	6.3	5.2	4.6	5.5	4.8	3.4	6.1	5.2	5.8	5.8	6.2	4.6	5.0	4.8	4.8
	Weighted Rating	6.0	6.8	7.7	7.1	6.7	7.2	6.9	4.0	7.4	7.2	7.2	7.4	7.6	6.8	6.9	6.8	6.8
180	General Appearance	6.2	7.2	6.1	6.4	6.7	6.6	5.6	3.5	6.8	6.5	5.9	7.1	6.7	6.2	6.2	6.2	6.2
	Durability	5.4	6.8	5.7	6.3	6.8	6.4	5.2	2.2	6.5	6.1	5.2	6.9	6.1	6.0	5.5	5.5	5.7
	Night Visibility	2.9	3.5	3.3	3.8	3.8	4.0	3.2	1.1	4.5	4.3	3.7	4.1	3.9	3.4	3.0	3.0	3.5
	Weighted Rating	4.2	5.2	4.5	5.1	5.3	5.2	4.2	1.8	5.5	5.2	4.5	5.5	5.1	4.8	4.3	4.3	4.6
194	General Appearance	2.2	3.0	1.9	2.4	3.1	2.8	2.3	0.3	3.0	3.1	2.1	4.2	3.1	2.6	2.6	2.6	2.6
	Durability	2.2	3.4	2.5	2.8	3.4	3.1	2.8	0.4	3.5	3.4	2.2	4.5	3.0	2.8	2.6	2.5	2.6
	Night Visibility	0.9	1.8	1.6	1.7	1.9	2.4	1.8	0.2	2.7	2.7	1.8	3.1	2.4	1.5	1.1	1.3	1.6
	Weighted Rating	1.6	2.5	2.0	2.2	2.6	2.8	2.2	0.3	3.0	3.0	2.0	3.8	2.7	2.1	1.9	1.9	2.1
	Service Factor	66.4	72.8	70.0	66.2	65.1	68.1	67.8	51.6	80.7	68.7	67.9	74.4	73.0	63.8	68.1	66.7	67.2
	Service Factor, percent of maximum	82.2	90.2	86.7	82.0	80.6	84.3	84.0	63.9	100.0	85.1	84.2	92.1	90.5	79.0	84.3	82.6	83.3

[1] PA No. 21

[2] PA No. XZ 85072

[3] 71 GB-26 treated beads dropped-on paint stripes

[4] 71 GB-27 treated beads dropped-on paint stripes

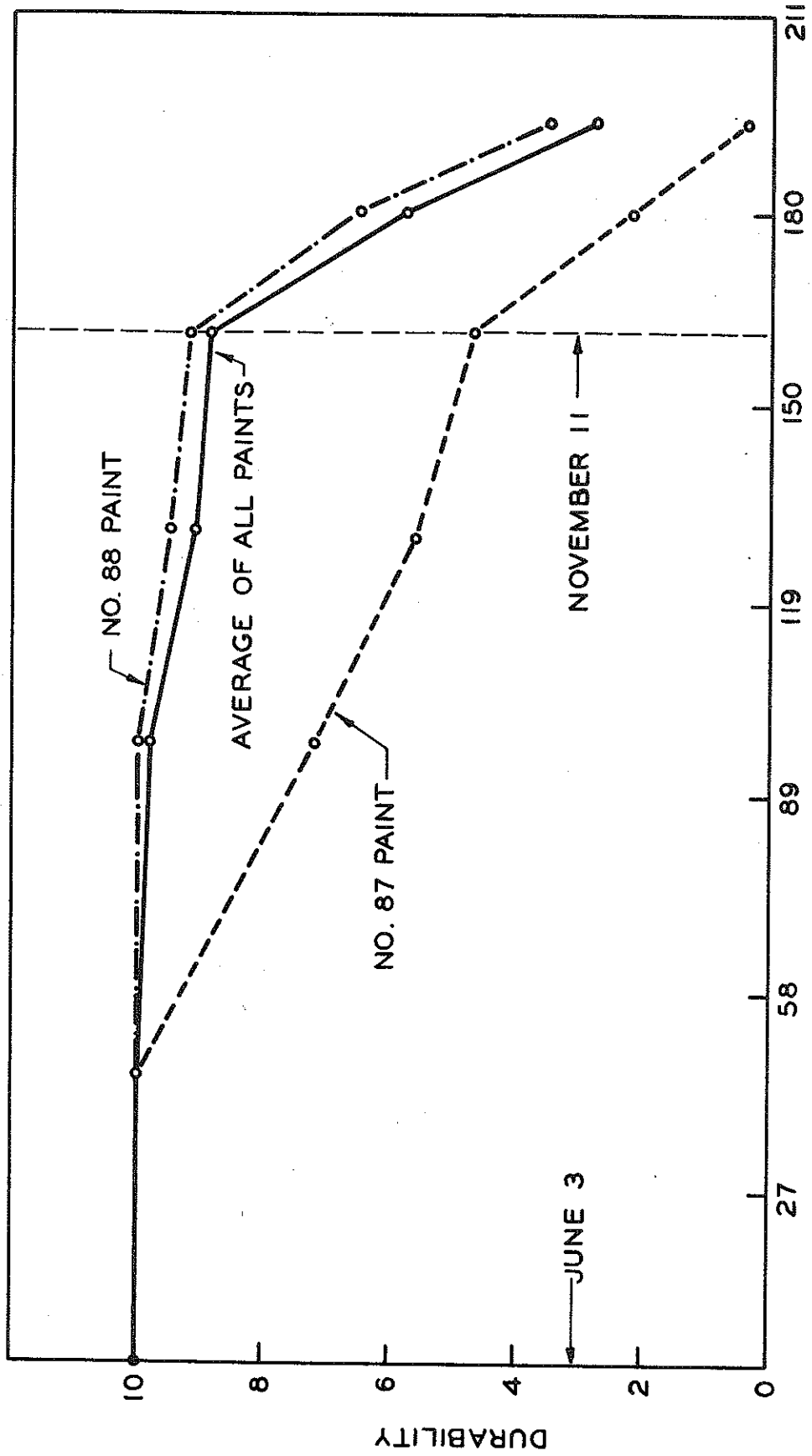

Figure 2. Durability values of some test paints during road service.

Figure 3. General view of strip appearance at end of ratings. These were in somewhat poorer condition than the stripes on the bituminous pavement. The 1971 fast-dry test stripes (concrete) can be seen in the background.

such as Nos. 90, 115, 84, and 85 did not also show the persistently high night-visibility values is not known and remains anomalous. Part of the answer may be in our current bead-gradation specification and part may be forthcoming from NCHRP Project 5-5A, "Development of Optimum Specifications for Glass Beads in Pavement Markings."

Additional Comments on Silicone Additives and Treatments: Users of traffic paints have realized that the durability of a beaded stripe could be improved if the comparatively hard glass beads could be kept from becoming dislodged by traffic through a firm locking in the paint, i.e., a better adhesive bond need be formed. Continuing our research in that direction, the tests contained several additives and treatments supplied by the Dow-Corning Corporation. These were evalued in paint No. 115, the Department's 1968-69 acceptance paint.

Table 2 shows that the silicone treatment on the beads, Corning's No. Z-6040 epoxide silane, was not effective in increasing durability; while paint additive No. XZ 85072 increased drying time and decreased overall performance. However, paint additive No. 21 improved the durability and night-visibility and consequently the Service Factor by 6.2 points: A similar improvement was noted in the 1965 Performance Tests as presented in Research Report No. R-611, and reviewed with the Committee.

Nothing further was previously done regarding additive No. 21 because the 2 oz addition per gallon costs about $0.30 and the improvement is only noted on fresh addition to the paint. However, we recommend it be evaluated in 1972 fast-dry paints, where the fall-off of night-visibility with field exposure is greater than in regular-dry paints.

Conclusions and Recommendations

In accordance with the objective of this project, Departmental composition specifications for the regular-dry traffic paints were based on the best performing paint in the tests. That was the Pennsylvania Highway Department formula, which was a modification of Federal Specifications for Traffic Paints, TT-P-115c, Type I. Because the Department specification was needed earlier for bid purposes, it was completed and dated January 10, 1972.

Since then the bids have been opened and the contract has been awarded. We are happy to note that the Department will be buying white paint for its 1972 regular-dry requirement for 50 cents less a gallon than it paid in 1971, for a paint of no better test performance. We are also happy to state that subject specifications do not add to the glut of available ones, but are basically based on a national specification.

In conclusion, we wish to add that the current specifications, dated January 10, 1972, will have to be revised on pigment composition before next year since the titanium-calcium pigment specified in both the white and yellow paints will no longer be available. We hope the revision can be made in accordance with the anticipated revision of Federal Specifications TT-P-115, which will undoubtedly contain titanium-dioxide plus other suitable extender pigments.