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SOME PROPERTIES AND TESTS OF TRAFFIC OR ZONE PAINTS [1]

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ABSTRACT

This publication describes some properties and tests of traffic paints. These paints are of a different type from ordinary paints and vary greatly in abrasion resistance. Experience gained from actual road tests is cited. An accelerated wearing test is described. A distinct improvement in durability of the traffic paints in actual service has resulted. Specifications for white and yellow traffic paints are suggested.

CONTENTS

I. INTRODUCTION

Traffic or zone paints are used to an increasing extent for marking off street-car loading areas, cross walks, "islands" of safety for pedestrians, center line stripes on city and State roads, caution and other warning signs on roads, etc. Materials other than paint, such as metal "buttons", inserts of white brick, white plastics, white cement, mixtures of black asphalt emulsions and sand, and strips of painted cloth, all used for the same purpose as traffic paint, are not considered in this publication.

The only publications of any length, with which the writer is familiar, describing experimental work on traffic paint, are those of Nelson and Werthan, and Sweatt.[2]

While the present publication deals mainly with white traffic paint, it should be noted that colors such as bright red, yellow, orange, and black are used in some States. Whatever the color, the paint must be suitable for any kind of hard pavement, have good consistency, flow evenly and smoothly, dry rapidly, hide in one coat, be of a brilliant color, show good color retention, dry hard and tough, be resistant to water, oil, and grease, show good day and night visibility, and be extremely durable (resistant to both weather and abrasion). Some paint manufacturers make one type of paint for concrete roads, and

[1] This paper is also printed as Circular 532, Scientific Section, Ntl. Paint, Varnish, and Lacquer Assn., Inc., Wash., D. C.

[2] H. A. Nelson and S. Werthan, Ind. Eng. Chem. 18, 965 (1926). John H. Sweatt, Paper 19, Maine Technology Experiment Station, University of Maine, Orono, Maine.

another for bituminous roads. Some make paint designed separately for use in summer and winter, so that at all times the paint will be rapid-drying.

Because large quantities are used, the cost of traffic paint is an important consideration. There are three elements which enter into the ultimate cost: The cost of the paint itself, the cost of application, and the durability. The cost of application is at least twice the cost of the paint itself, and may be in even greater proportion. Durability may vary as much as 2 to 1. If paint *A* costs $1 a gallon and wears for 3 months, where paint *B* costs $1.50 per gallon and wears for 5 months, and the cost of application is $3 a gallon in each case, the ultimate cost of paint *A* is about 4½ cents per gallon-day, while paint *B* really costs 3 cents per gallon-day of use.

II. CHARACTERISTICS OF THE PAINT

Generally, traffic paints are fairly heavily pigmented, so that they dry to flat or semigloss finishes—rarely to gloss finishes. Frequently, they are made purposely of a thick consistency, so that they can be thinned on the job, generally with gasoline. However, traffic paint should not be thinned excessively with gasoline, or its durability will suffer. A heavy-bodied traffic paint, provided it can be brushed or applied by machine, is apt to wear longer than a thin-bodied paint, because a thicker film is formed, assuming other properties equal. In white paint, the opaque pigments are selected for suitable color and efficient hiding power at minimum cost. The pigments generally used are lithopone, zinc oxide, and titanium-base pigments. A certain amount of silicate-base pigments, such as china clay, magnesium silicate, silica, sand, pumice, etc., are added to increase resistance to wear, the last two mentioned materials being added also to increase visibility at night by imparting roughness to the film. Extremely small glass spheres distributed on the wet paint coat are also used for the same purpose. In paints other than white, pigments such as carbon black, iron oxide, and organic reds, chrome yellows and chrome oranges are used. Large amounts of the silicate-base pigments are added to these colors as diluents. Some zinc oxide is also beneficial for color retention in the yellow and orange colors.

Whatever the color, the vehicles or liquid portions of traffic paints of a single brand are usually the same. Generally, the vehicle is a quick-drying varnish. In the better grades, china-wood oil–rosin varnishes containing from 10 to 40 gallons of oil per 100 pounds of rosin may be employed. Ester gum and gum copals may be added to improve the adhesive properties of the film. Besides the resins, oils, and driers, traffic paints contain a large amount of volatile thinners, selected to promote the rapid drying of the paint film. The thinners are usually low-boiling fractions from petroleum or coal tar, including gasoline or varnish-makers' and painters' (V. M. & P.) naphtha and benzol. In some paints, the vehicle is a cold-cut resin, such as East India gum (powdered Batu or Macassar), or manila or damar resin dissolved in mineral spirits or, sometimes in such solvents as alcohol (formula 1), acetone, or butyl alcohol. Occasionally, blown linseed, tung, or other oil is added as a plasticizer.

Rubber latex and clear cellulose lacquers are also employed as vehicles; and water-vehicle paints, such as those made from casein, glue, and sodium silicate are sometimes used.

III. ROAD EXPOSURE TESTS

About 10 years ago, the National Bureau of Standards began testing traffic paints for and in cooperation with officials of the District of Columbia. Since that time the working properties of many paints in a road distributing machine and the "mileage", how long a stripe 4 inches wide can be made with 1 gallon of paint, have been determined by the District officials, while such physical tests as hiding power, reflectance, consistency, drying time, tendency of the bitumen to "bleed" (stain the paint above), and relative durability in actual service on the road have been determined at the Bureau.

The tests last mentioned were made on Connecticut Avenue, near the Bureau. Parallel stripes of the various paints, about 4 inches wide and about 15 feet long, spaced about 1 foot apart, were applied, mostly by hand brushing. The stripes were made on the road on one side of the avenue (south-bound traffic) from the curb to the car tracks in the center. Fortunately, one portion of the road was concrete, while the rest was bituminous material, so that the same paints were applied at the same time on both types of surfaces. On both portions of the road there was a gradual change in the number of automobiles to which the paint was exposed, varying from a maximum near the middle of the roadway to minima at the curb and at the car track. Traffic on the avenue was fairly heavy, but not as heavy as in congested traffic areas. A traffic count showed that, on a particular day, 4,600 cars passed over the test area in 7 hours from 8 a. m. to noon and from 3 to 6 p. m. The area lies in a 22-mile speed zone.

A great variety of paints were applied to the road, including both commercial brands and experimental paints. Among the types of experimental paints studied were the following:

1. Paints with a vehicle made from wood oil and ester gum in various proportions from 10 to 20 gallons of oil per 100 pounds of gum. With this vehicle the following pigments were used: (a) 90 percent of lithopone, 10 percent of magnesium silicate; (b) 65 percent of lithopone 25 percent of zinc oxide, 10 percent of magnesium silicate; (c) 90 percent of titanium-barium pigment, 10 percent of magnesium silicate; (d) 65 percent of titanium-barium pigment, 25 percent of zinc oxide, 10 percent of magnesium silicate.

2. Paints with a vehicle made from wood oil and modified phenolic resin in various proportions from 10 to 20 gallons of oil per 100 pounds of resin. The same series of pigments were used as with the paints of the first type.

3. Cold-cut East India gum (Batu) plasticized with a small amount of blown linseed oil, with a pigment containing 55 percent of titanium pigment, 25 percent of zinc oxide, and 20 percent of silica.

4. Spar varnish with aluminum powder (2 lb of powder to 1 gallon of varnish).

5. Straight-gloss oil vehicle (limed rosin dissolved in mineral spirits), with a pigment containing 65 percent of lithopone and 35 percent of silica.

6. A paint made with a solution of sodium silicate in water (a commercial brand known as Paint Vehicle) and a pigment consisting of 70 percent of lithopone, 20 percent of zinc oxide, 10 percent of silica. Also the same paint with the addition of rubber latex (50 ml of rubber latex added to 1 pint of paint).

7. Hydrated-lime–casein–cold-water paint consisting of 100 parts of hydrated lime, 20 parts of casein, 12 parts of trisodium phosphate, and 30 parts of whiting.
8. Rubber paints with lithopone and magnesium silicate and with aluminum powder pigments. The vehicle was a commercial product consisting of a rubber isomer in an organic solvent.

In general, the paints did not wear as well on concrete as on bitumen. However, some paints wore better on concrete. Some were satisfactory on concrete, but caused the bitumen to "bleed", changing the white color of the paint to a brownish or yellowish white. The usual life of the best paints was about 3 months. Some of the paints were worn off in less than 3 weeks. The paint near the car tracks and near the curb lasted several times as long as that in the center of the roadway, showing that weathering was of minor importance as compared with wear under the conditions of testing.

In repeated trials, one brand of paint was consistently the best of the commercial paints. This paint was, therefore, used as a "control" in comparing the durability of more recent brands and of all experimental paints. Chemical analysis failed to reveal the reason why this paint was so durable. The vehicle appeared to be a tung-oil–rosin varnish. The pigment was a mixture of 30 percent of lithopone, 40 percent of zinc oxide, and 30 percent of siliceous matter. The separated vehicle dried to a hard, very tough, and adherent film, and contained 45 percent of nonvolatile matter.

Two of the best experimental paints were of the following compositions, expressed in percentages by weight unless otherwise indicated:

Paint 1 contained 65 percent of pigment and 35 percent of vehicle. The pigment was 65 percent of light-proof lithopone, 25 percent of lead-free zinc oxide, and 10 percent of magnesium silicate.

The vehicle was a varnish made in the proportions of 9 gallons of china wood oil and 6 gallons of linseed oil per 100 pounds of modified phenolic resin and thinned with V. M. & P. naphtha and drier to contain 40 percent of nonvolatile material.

Paint 2 contained 65 percent of pigment and 35 percent of vehicle. The pigment was 56 percent of titanium-barium pigment, 24 percent of lead-free zinc oxide, 10 percent of magnesium silicate, and 10 percent of silica. The vehicle was again 40 percent nonvolatile and made of the same constituents as the first, but in the proportions of 12 gallons of china wood oil and 8 gallons of linseed oil per 100 pounds of resin.

The results of the road tests quickly demonstrated that the character of the vehicle is far more important than that of the pigment in a traffic paint. However, the addition of zinc oxide to either lithopone or titanium pigment improved durability. The presence of some abrasion-resisting inert of the siliceous-base type is also desirable.

It was also observed that several commercial paints, all passing the same specification based on composition, gave different results during wear tests. It is not possible to state whether or not these paints were of identical composition. Methods of analysis of the vehicle of a paint are not exact enough to identify and determine the amounts of resin and oil present. Even if this were possible, chemical analysis would not reveal how the resin and oil were processed in the varnish kettle. This processing procedure affects the properties of the vehicle.

Thus, a consumer's specification for traffic paint should be based on physical and performance tests, rather than on a formula which purports to describe the composition.

IV. MACHINE FOR ACCELERATED WEARING TEST [3]

In order to test resistance to abrasion more quickly under more accurately controlled conditions, an accelerated wear test was devised. A machine originally developed at the National Bureau of Standards for measuring the relative wear of sole leather, and described in a former Bureau publication,[4] was changed in the Bureau's shops to adapt it for wear tests on traffic paint. A photograph of the machine is shown in figure 1, and a description of it and its method of use follows:

The wheel *A*,[5] 12 inches in diameter, carries a special rubber ring (⅜-inch thick) containing a uniformly distributed abrasive. When in use, it rests on and drives test panel *B* and is rotated at a speed of 1,600 revolutions per hour. The weight of the wheel and the portion of the machinery *G*, which it supports, is 40 pounds. The width of the rubber face on wheel *A* is 2 inches and the inner edge of the rubber ring is 4½ inches from the axis of *B*. The panel, *B*, is 15 inches in diameter and may be made of any suitable material, such as concrete, bituminous road material, or steel. In order to provide a greater shearing action, the freely moving turntable, *H*, supporting the panel *B* is provided with a brake, *C*, consisting of a brake wheel and a brake strap, by means of which any desired resistance to rotation may be secured by the application of dead weight. Hence, the abrading wheel travels at a greater speed than the test panel. For routine tests, it has been found unnecessary to use brake *C*, but it is used in experimental work. To keep the surface clean, a brush, *D*, and an exhaust fan, *E*, may be used.

All paints are now applied of the same wet film thickness (0.010 inch) by means of strips of shim steel and a straight edge, and the coat of paint is allowed to air-dry for 48 hours before putting it in the wearing-test machine. A single brushed coat of paint averages about 0.002 inch in thickness. However, traffic paints are applied in a thick coat, possibly about four to five times the thickness of the average brushed coat. After experimenting with various thicknesses ranging from 0.005 to 0.010 inch, the last one was selected for the test.

Likewise, the effect of drying the paint for varying periods, including 7, 18, 24, and 48 hours, was studied. One of the chief requirements of a traffic paint is that it shall dry rapidly (generally within 1 hour). However, it was found that the results of the accelerated wear test agreed more closely with the results of actual tests on roads, when the paint on the test panels was allowed to dry for 24 to 48 hours, than when the test panels had been dried for the shorter periods. For this reason, a drying period of 48 hours was selected for the accelerated test. All paint coats are dried at 25° C (77° F) and 50-percent relative humidity.

[3] The machine for testing the wear-resistance of traffic paints has been used since February 1934, and descriptions of it have been sent to several States and various individuals. A brief description, including a photograph of the machine, appeared in the 1935 and 1937 editions of Gardner's book entitled, "Physical and Chemical Examination of Paints, Varnishes, Lacquers, and Colors."

[4] R. W. Hart and R. C. Bowker, *An apparatus for measuring the relative wear of sole leathers, and the results obtained with leather from different parts of a hide*, Tech. Paper BS **13** (1919). T147.

[5] A separable truck wheel purchased from Julius Fowl, Inc., 207 West 18th St., New York City. The tire was replaced by a rubber ring made by Eberhard Faber Rubber Co., 47 Golden St., Newark, N. J., of special eraser stock 1071.

A control paint of known durability on the road is always included when testing new materials.

Some of the results of the accelerated wear tests are shown in figures 2, 3, and 4. The same paints were used in figures 2 and 3, figure 2 showing results after 31 hours of wear (50,000 revolutions) and figure 3 after 51 hours of wear (80,000 revolutions). The same paint was placed on opposite sectors, so as to illustrate the uniformity of results. In other words, four paints were under test, of which V, the control paint, was the best, W next, C_B next, and C_D was the poorest. Paint V was made according to formula 2, given in the preceding section, and was very durable on the road. Figure 4 shows the uniformity of wear of two additional paints. These paints are on steel panels; concrete and asphalt panels are also used.

Bid samples (generally eight in number) are run at the same time with the control paint until the paints are worn badly. Generally, one or two paints show such superiority that the others are eliminated from consideration. The test is repeated, using only the paints which showed up well against the control. This elimination permits much larger areas to be painted for the final tests.

A paint film (0.010 inch thick) that shows practically no wear to the bare surface after 38,000 revolutions (about 24 hours) is considered to be a good wearing paint. A paint film that shows not over 50 percent of the area worn down to the bare surface after 50,000 revolutions is outstanding for wear resistance. Some traffic paints show as much as 50 percent wear after 10,000 revolutions. In some recent tests, particularly good resistance to wear was shown by two rubber-resin paints, formulated by different manufacturers. A third paint, supplied to the State of New York, a sample of which was received directly from the manufacturer, has shown unusually good resistance to wear on the machine. This paint contained powdered pumice and dried to a rough "sandy" finish which improves visibility at night. The same paint without the pumice dried to a smooth film and did not wear as well. A fourth sample, likewise embodying the rough-finish principle and representing material supplied to Pennsylvania, was also found to be a good-wearing paint in the machine.

The wearing test is still in the development stage, although the best-wearing paints on the road are generally the best in the accelerated tests. It must be remembered that, for paint under heavy traffic, resistance to abrasion is more important than resistance to weathering. A measure of the abrasion resistance may to a certain extent be indicated by the hardness of the paint coat, since the two properties are related. However, the hardest paint does not always wear the best, because the toughness of the paint film is an important factor. On the other hand, for paints on country roads, weathering and night visibility may be the more important factors.

A weathering cycle might, therefore, be introduced into the test. The following is suggested, the cycle to be repeated each day until badly worn paints are obtained:

9 a. m. to 3 p. m.—6 hours of carbon-arc light and water spray.
3 p. m. to 9 a. m.—18 hours of abrasion.

Wetting the panel during the wear test is not advisable because the film of water acts as a cushion, prolonging the test.

The conditions of service should be studied, and the accelerated tests made to fit these conditions. For example, the center-line stripe out on a country road is subjected to more weathering and less

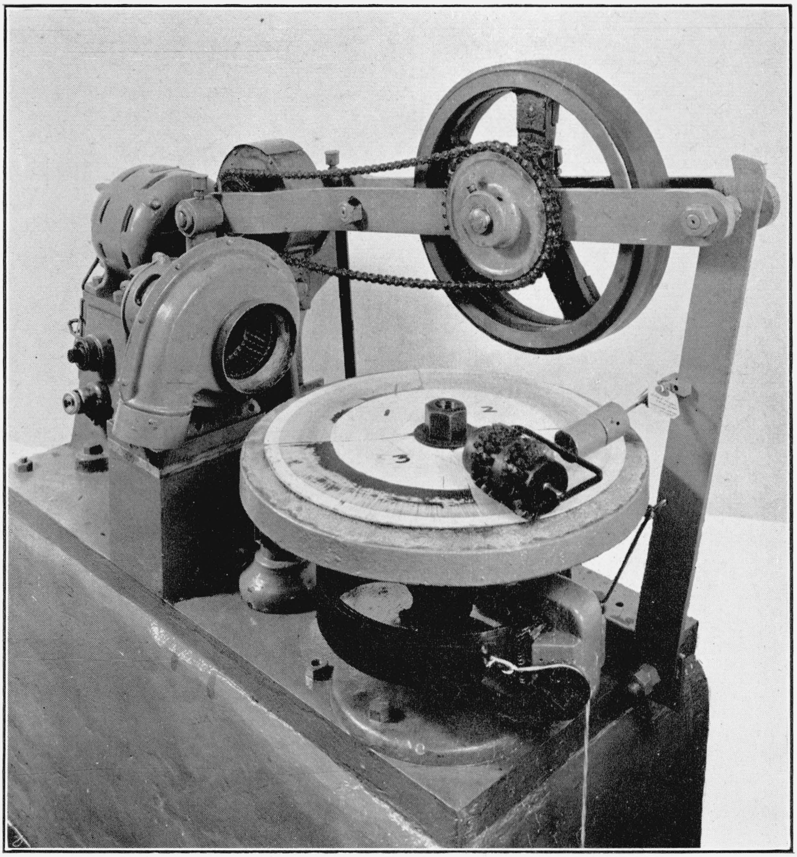

FIGURE 1.—*Apparatus for testing abrasion resistance of traffic paints.*

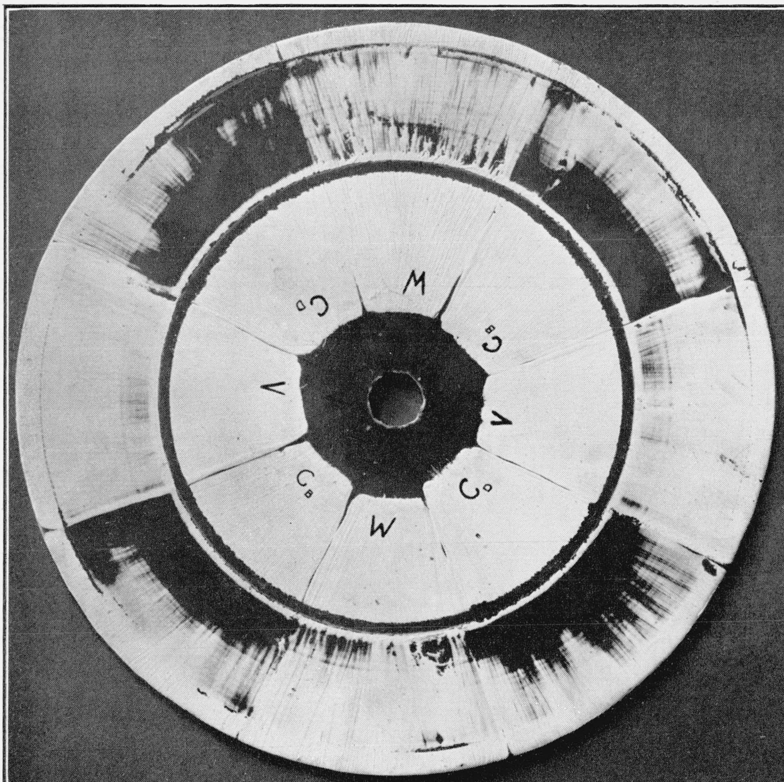

FIGURE 2.—*Appearance of four typical traffic paints after 50,000 revolutions in the testing machine.*

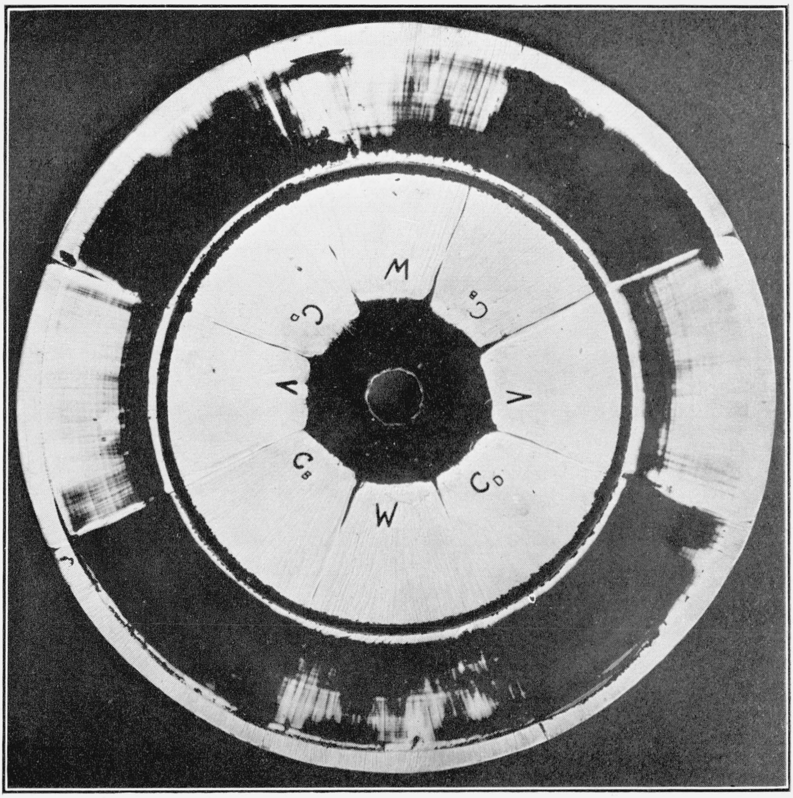

FIGURE 3.—*Appearance of four typical traffic paints after 80,000 revolutions in the testing machine.*

(The same paints after 50,000 revolutions are shown in fig. 2.)

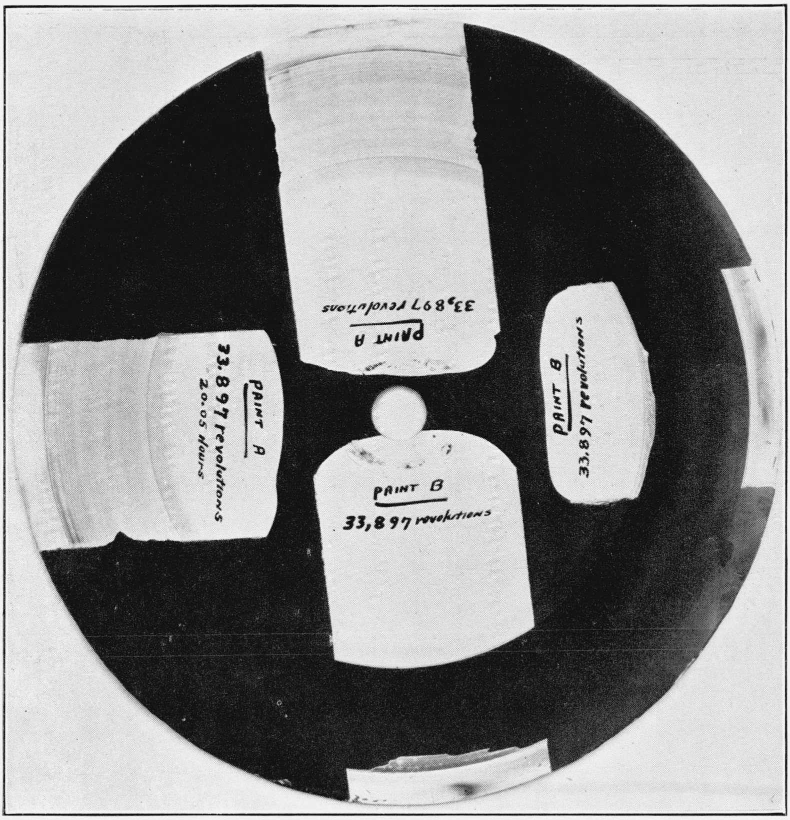

FIGURE 4.—*Appearance of two traffic paints after about 34,000 revolutions in the testing machine.*

(Note the uniformity of duplicate tests.)

abrasion than the stripes on the downtown streets of the city of Washington. Thus, in the former case, it might be advisable to expose the test panels to outdoor weather for a period of 10 days to 2 weeks before making the accelerated wear test. The wear test described in this paper was developed for *severe* traffic conditions.

V. SPECIFICATION FOR WHITE TRAFFIC PAINT

The following performance specification is being used at the present time by the District of Columbia in buying white traffic paint. The award is given the lowest-priced paint meeting the specification. Awards are not made by brands, and all paints are actually tested (both bid and delivery) before acceptance. The specification is based on work described in this publication, the accelerated service test being the one just described. The "control" paint, the formula for which is specified, was among the best of the experimental paints tried on the road. *Bidders do not have to make their paint according to this formula*, but the wear test must show their paint to be at least the equal of a paint properly made on this formula. It should be noted that the test paint has to pass not only the wear-resistance test, but the other tests in the specification also. The specification follows:

-------- gallons, paint, white traffic, ready-mixed, put in 5-gallon containers, with wire bail.

General.—All paint must be furnished in strong, substantial containers, plainly marked with lot number, name and address of manufacturer. The paint shall be well ground and mixed, shall not settle badly nor cake in the container, shall not thicken in storage to cause change in consistency, shall be readily broken up with a paddle to a uniform condition, capable of easy application with brush or mechanical distributor, in the ordinary manner according to the methods of standard practice. The paint is intended for use on bituminous or portland cement pavements.

Ready-mixed paint.—Ready-mixed paint, as received, shall be suitable for use with the usual paint brush or paint machine. It shall be well made, shall not "liver" nor settle badly, cake or thicken in the container within 3 months of delivery. It shall flow evenly and smoothly, and cover solidly in one coat on bituminous and portland cement pavements. It shall not cause the bitumen to "bleed" either during application or while it is drying. A single coat shall set in not less than 15 minutes nor more than 45 minutes (so that there shall be no pick-up under traffic) and *thoroughly* dry within 1½ hours, free from tackiness, to an elastic, opaque, adherent finish, when applied at temperatures between 40 and 90° Fahrenheit. It shall give a brilliant white finish, free from laps or brush marks. It shall not turn gray in sunlight, nor show appreciable discoloration with age. It shall show a wet hiding power of not less than 225 ft^2 per gallon (checkerboard brush-out method, ASTM Specification D 344–32T). It shall show a daylight reflectance of not less than 80 percent relative to that of magnesium oxide as the standard white (see National Bureau of Standards Letter Circular 395). The paint as received shall show a consistency of not less than 50 nor more than 200 seconds, using the Gardner Mobilometer with the 51-hole disk, a total moving load of 100 g, and a distance of 10 cm. (See Physical and Chemical Examination of Paints, Varnishes, Lacquers, and Colors, by H. A. Gardner, 8th edition, page 590.) The paint furnished shall be at least equal, with respect to wearing properties, weathering, and water resistance, of a paint of the following composition:

Pigment	*Paint*
56 percent of titanium-barium pigment (not less than 25 percent of TiO_2).	Pigment 65 percent
24 percent of zinc oxide (American Process—lead free), for exterior use.	Vehicle 35 percent
20 percent of magnesium silicate.	

Liquid.—A properly cooked, quick drying, pale colored varnish, composed of drying oils, resins, drier, and volatile thinner. The oil portion is a mixture of

TABLE 1.—*Tests of white traffic paints*

Paint	1	2	3	4	5	6	7	8
Condition in can	Good	Good	Good	Good	Good	Good	Good	Settled badly.
Mobility, sec (25° C)	352	41	56	26	Over 600	21	Over 600	2.
Hiding power, ft²/gal	286	241	308	244	307	244	192	225.
Weight/gallon, lb	15.1	14.6	14.4	13.7	14.9	14.1	15.2	11.4.
Reflectance, percent	82	82	83	81	76	75	83	77.
Darkening of paint coat in strong light (6 hr carbon-arc)	None	None	None	None	None	None	None	None.
Bending test on nonvolatile vehicle [a]	O. K.	O. K.	O. K.	Slight cracking	O. K.	Cracked badly	O. K.	O. K.
Pigment, percent (by wt)	65.6	65.1	64.8	64.6	64.8	59.2	65.3	49.6.
Volatile, percent (by wt)	18.3	22.6	20.4	18.5	18.2	22.0	19.1	35.1.
Nonvolatile, percent (by wt)	16.1	12.3	14.8	16.9	17.0	18.8	15.6	15.3.
Nonvolatile vehicle, percent (by wt)	46.8	35.3	42.0	47.7	48.3	46.1	45.0	30.4.
Pigment analysis:								
Zinc oxide, percent	24.7	24.4	24.7	24.5	26.1	22.4	25.2	25.8.
Titanium oxide (TiO_2) percent	14.7	13.8	15.1	15.7	14.4	None	13.8	18.2.
Zinc sulphide, percent	None	None	None	None	None	18.7	None	None.
Barium sulphate, percent	Present	Present	Present	None	Present	Present	Present	Present.
Calcium	None	None	None	Present	None	None	None	None.
Siliceous	Present	Present	Present	Present	Present	Present	Present	Present.
Probable pigment composition:								
Zinc oxide, percent	25	25	25	25	26	22	25	26.
Titanium-barium pigment, percent	59	55	60	52 [c]	58	0	55	0.
Lithopone, percent	0	0	0	0	0	67	0	0.
Siliceous, percent	16	20	15	23	16	11	20	Balance.[d]
Set to touch, min (86° F)	10	10	15	35	30	15	25	15.
Dry—hours (86° F)	1	1	1¼	1½	1½	1¼	1¼	1.
Accelerated wear test [b]	Equal	Nearly equal	Equal	Below	Below	Below	Below	Equal.

[a] Air dry 30 minutes, bake 3 hours at 105° C, air dry 3 days, then bend over 3-mm rod at 25° C.
[b] Rating relative to "control" paint.
[c] Titanium-calcium pigment.
[d] Titanium oxide and inerts.

TABLE 2.—*Tests of yellow traffic paints*

Paint	1	2	3	4	5	6	7	8	9	"Control" 10
Composition of paint:										
Pigment, %	50	55	49	60	60	54	47	32	55	
Volatile, %	24	26	28	28	22	20	25	41	22	
Nonvolatile, %	26	19	23	12	18	26	28	27	23	
Composition of vehicle:										
Volatile, %	48	58	55	70	55	44	47	60	49	
Nonvolatile, %	52	42	45	30	45	56	53	40	51	
Major pigment constituents: [a]										
Zinc oxide, %	15	16	16	16	15	17	17	11	16	
Lead chromate ($PbCrO_4$), %	18	24	45	28	29	18	29	17	27	
Insoluble in HCl, %	43	43	15	43	41	42	42	43	42	
Zinc sulphide, %	None	None	None	None	None	None	None	None	None	
Weight per gallon, lb	12	12.3	11.4	13.1	13.5	12.8	12.2	8.4	12.9	
Odor	Mineral spirits	Benzol	Turpentine	Benzol	Benzol	Toluol	Benzol	Benzol	Naphtha	
Consistency	Paint	Thick paint	Paint	Thick paint	Paint	Livered in can	Thick paint	Thin paint	Thick paint	
Mobility, sec	50	193	51	255	62	Not determined	500	2	450	
Skinning in can	None	Skins	None	None	None	Skins	None	None	None	
Brushing properties	Good	Slight pull	Good	Slight pull	Slight pull	Bad pull	Slight pull	Good	Slight pull	
Hiding power (wet), ft²/gallon	256	269	375	337	291	Not determined	200	171	249	
Gloss	Eggshell	Flat	Semigloss	Flat	Flat	Flat	Eggshell	Eggshell	Flat	Flat.
Color (compared to standard)	Lighter	More orange	Good (best match)	Much lighter	Fair (lighter)	Much lighter	Good	Too green	Too orange	White.
Drying properties:										
Set to touch, min	10	1	10	5	5	5	5	5	5	10.
Dry firm	1½ hr	10 min	1½ hr	10 min	10 min	10 min	20 min	15 min	15 min	1½ hr.
Hardness (after 24 hr. air drying)	Soft	Hard	Hard	Hard	Hard	Hard	Soft	Hard	Hard	Hard.
Flexibility tests: [b]										
18 hr air dry	No cracks	No cracks	No cracks	Fine cracking	Fine cracking	Definite cracking	No cracks	Flakes from panel	No cracks	No cracks.
2 hr carbon arc [c]	No cracks, no color change.	No cracks, no color change.	No cracks, no color change.	Slight cracking, no color change.	Slight cracking, no color change.	Bad cracking, no color change.	Bad cracking, no color change.	Flakes from tin, slight darkening.	Slight cracking, no color change.	Do.
4 hr carbon arc [c]	do	Slight cracking, no color change.	do	Slight cracking, slight darkening.	do	do	Bad cracking, slight darkening.	do	do	
6 hr carbon arc [c]	do	do	do	do	Slight cracking, slight darkening.	do	do	Flakes from tin, definite darkening.	do	
24 hr carbon arc [c]	do	Definite cracking, no color change.	Slight cracking slight darkening.	do	do	do	Bad cracking, definite darkening.	do	Definite cracking, no color change.	
Accelerated wear test [d]	Equal	Equal	Better	Worse	Worse	Equal	Better (best)	Worst	Better	Used as standard.
Accelerated weathering, 48 hr air dry:										
Steel (one coat), 4 days	No cracks, best color retention.	No cracks, slight fading.	No cracks, very slight darkening.	No cracks, very slight fading.	No cracks, definite fading.	Not determined	No cracks, slight fading.	Slight checking, definite darkening.	No checking, very slight darkening.	
Steel (one coat), 5 days	do	do	do	do	do		do	Definite checking	do	
Concrete (one coat), 4 days	do	do	Blistered, very slight darkening.	do	do	No cracks, slight fading.	Slight blistering, slight fading.	Slight blistering, definite darkening.	do	
Concrete (one coat), 5 days	do	do	do	do	do	do	Bad blistering, slight fading.	Definite blistering, definite darkening.	do	

[a] Remainder of pigments is essentially lead compounds other than chromate.

[b] All bends made over ⅛-inch mandrel at 25° C.

[c] 18 hours air dry first.

[d] Rating relative to "control" paint.

properly cooked China wood oil and heat-bodied linseed oil, in the proportion of 60 parts china wood oil to 40 parts of linseed oil. The resin is a modified phenolic resin. The driers and volatile thinners are to give a quick-drying varnish, containing not less than 40 percent of nonvolatile matter. The varnish is 15 to 20 gallons in length (15 to 20 gallons of the above oils to each 100 pounds of the resin.)

Samples of paint submitted will be subjected to chemical analysis and test. The samples of paint will be applied on the pavement under field conditions and subjected to an *accelerated laboratory service test*. Comparative determinations of the rate of drying, amount of spread, resistance to discoloration, and durability will be noted.

VI. PROPERTIES OF WHITE PAINTS SUBMITTED UNDER THE SPECIFICATION

The results of examination of eight samples of commercial traffic white paints submitted under this specification are shown in table 1. The paints are arranged in order of increasing prices. The award was given paint 3. It is proving durable in actual service. Paint 1, while showing good wear, was too mobile to flow satisfactorily in the distributing machine.

VII. SPECIFICATION FOR YELLOW TRAFFIC PAINT

Recently, the District of Columbia desired to try (for the first time) some *yellow* traffic paint, in marking off street car-loading zones on bituminous roads. The National Bureau of Standards was asked to help in preparing a specification. It was suggested that the above-described specification for white traffic paint be used, except the hiding power be increased to a minimum of 250 ft^2, the color be light chrome yellow to match a standard, the paint to show good color retention when tested in the carbon-arc light, and the composition of the pigment to be specified as:

40 percent of (minimum) cp chrome yellow.
15 to 20 percent of zinc oxide (lead free), suitable for exterior use.
45 percent (maximum) of inert pigment (silica, china clay, magnesium silicate or a mixture).

In the accelerated wear test the white paint made on the suggested formula was still used as the "control."

VIII. PROPERTIES OF YELLOW PAINTS SUBMITTED UNDER THE SPECIFICATION

Table 2, showing the examination of nine yellow traffic paints submitted under this specification, may be of interest. It is to be noted that for information, some tests (flexibility tests, exposing panels to the carbon-arc light) were made other than those called for in the specification. The paints are arranged in order of increasing prices. The award was given paint 3. It is proving durable in actual service. Paints 1 and 2 failed to match the standard color.

The following manufacturers have contributed either raw materials, experimental paints, or suggestions:

Varcraft Works, Inc.	Philadelphia Quartz Co.
U. S. Gutta Percha Paint Co.	Goodyear Tire and Rubber Co.
Monroe, Lederer & Taussig.	The Watson-Standard Co.
Industrial Paint Co.	Hanline Brothers.
Central Paint and Varnish Works.	Baltimore Paint and Color Works.

J. C. McRae, division of materials, District of Columbia, cooperated closely with the author in this work. Clara Sentel and W. C. Porter, of the Bureau's paint laboratory, performed most of the analyses given in tables 1 and 2.

WASHINGTON, February 26, 1937.