FIELD EVALUATIONS OF TRAFFIC PAINTS OF KNOWN COMPOSITION

H. R. Custer, *Senior Materials Engineer, Pennsylvania Department of Highways*, and E. K. Zimmermann, *Director, Technical Service Laboratories, Titanium Pigment Corporation*

SYNOPSIS

This report is a summary of the progress thus far made on a Co-operative Project between the Pennsylvania Department of Highways and the Technical Service Laboratories of the Titanium Pigment Corporation

With the increasing volume of traffic on highways and streets, greater demands have been presented for traffic paints of known composition, possessing greater durability and visibility than was anticipated some years ago In this connection, a research and development program is being undertaken, whereby traffic paints of known composition are being evaluated and developed from field service tests This program, now in its fourth year, has produced many valuable data, with certain fields yet to be explored.

One of the primary considerations in field service testing is that equipment must be available for the application of traffic paints under the most exacting conditions In order to evaluate properly any series of traffic paints with only small variations in formulation, or to check accurately a standard paint from year to year and obtain comparable results, it is mandatory that each paint be applied at the same spreading rate per gallon, with good cross distribution and clear cut edges Another factor is that any test application should be made with equipment comparable and consistent with that used in normal traffic line painting. This equipment and procedure has been developed to procure a scientific method of application. Through the exposure and testing of formulations of known composition and by following basic principles used in evaluating paints for other purposes, it has been possible to develop traffic paint formulations of merit and to point the way toward the proper formulations of traffic paints of increased durability and service characteristics.

This work is still in progress and while the development is now approaching a focal point as regards formulation requirements, service characteristics need more extensive development and evaluation. The minor changes in formulation required to adapt satisfactory basic developments to variations in service requirements such as road composition, still need to be worked out

Application Equipment and Procedure of Application—In making a detailed study of the application of experimental traffic paints, the factors involved demand individual consideration in order that complete understanding may be had.

Prior to the event of the practical mechanical spray type traffic line machine, application was made with the push type brush machine, with the U type brush riding on the pavement surface and the paint being fed into the brush by gravity flow. It was practically impossible to control the rate of application, even though a combination of springs was attached to the brush for the purpose of applying or releasing tension. Records show that in a series of paints, the application rates would vary from approximately 150 to 700 ft. of solid 4-in. line per gallon of paint.

During the transitional period in 1939, when the brush type machines were considered obsolete, mechanical spray type traffic line painting machines were placed in use. Immediately thereupon, a program was inaugurated to develop this type of machine for use in experimental traffic line applications, in order that all paints applied experimentally or for test purposes would be applied with equipment comparable and consistent with that used in normal traffic line painting.

Starting with the Standard Model, B-3, Kelly-Creswell traffic painting machine, a self-propelled unit, modifications were designed for this particular use. Some of the modifications included an air-controlled gun, a 1-gal. paint tank with a stationary top replacing the standard tank, a paint line system whereby paint was taken from the bottom by a pipe up through the center of the tank and emerging near the top, special shut-off, check and three-way valves on the paint and air lines so that all parts of the painting system could be thoroughly and quickly cleaned, a larger air reserve chamber and placing the engine on rubber motor supports to reduce vibration to the minimum. There is also a metal tank insert or container of 5¾ quarts capacity which fits into the paint tank. The purpose of the insert is to carry the paint without getting paint on the bottom or sides of the paint tank. With the use of inserts, the time consuming efforts of tank cleaning are eliminated. After an application is made, the tank is taken off and the insert with the remaining paint is removed and another insert with the next sample of paint is placed in the tank

This machine is powered with a 4-hp Wisconsin (AK) air-cooled engine. The compressed air is supplied by a DeVilbis twin cylinder compressor with an actual output of 6¼ cu. ft per min. The spray gun, a DeVilbis WV-593 type, requires (actual) 5½ cu. ft. of air per min. at 100-lb. pressure. The engine speed is set, through experience, at approximately 2550 rpm. and the compressor at 1275 rpm.

The modifications referred to were not achieved by simple calculation Rather, the accomplishments were only made possible by actual and concentrated field work, combined with research and development over a period of 8 years. This work has provided us with a traffic line painting machine which is used exclusively for the application of experimental and bid samples of traffic paints, under the most exacting and positively controlled conditions.

For the field control of application, an unusual procedure has been developed. The lane of traffic in which the work is to be performed is completely blocked to traffic, and a field laboratory is used to determine the rate of application of the traffic paint. This laboratory is housed in a personnel bus or a glass paneled truck. The body of the truck is completely raised from the springs by means of four hydraulic jacks, and wooden blocks are wedged under the sides of the body frame. The jacks are then slightly lowered to equalize the truck weight on both the jacks and blocks. This procedure is necessary for elimination of the effects of wind currents on the sensitivity of the balance used for weighing purposes.

Rolls of roofing paper are unrolled and placed on the pavement surface, so that the painting machine may be operated under actual conditions for determination of the rate of application On the basis of a predetermined weight per gallon of each paint, the weight in grams of one lineal foot of painted line 4 in. wide is calculated. The painting machine is then adjusted in an attempt to apply the required amount of paint. Experienced personnel, knowing the weight per gallon of the paint, viscosity, and the grams of paint desired per lineal foot, will apply the required amount of paint with a minimum number of readjustments of the equipment. Practically all readjustments are limited to the paint tank and atomizing pressures.

In determining the rate of application, a line approximately 15 ft. long is applied by the painting machine on the roofing paper. During this application, the actual rate of application is determined by placing a preweighed section (12 in. by 12 in.) of roofing paper in the path of the spray gun. As soon as the square foot section of roofing paper is painted by the machine, it is immediately weighed in the field laboratory. If the weight of the painted one lineal foot does not fall within the established narrow limits, the machine is readjusted until the desired rate of application is obtained. By using this procedure, traffic paints are applied at a determined rate of spread per gallon of paint, the cross distribution of the painted line is excellent and clear cut edges are obtained. These factors are all deemed necessary to accurately evaluate field service tests of traffic paints. It may be said that it is erroneous to control weights on the wet film. This is not a fact, especially when the weights are determined by a trained and experienced technician. These tared sections have been allowed to dry for four or five days, and then the non-volatile weight has been determined by the field laboratory and checked on analytical balances. Any differences between the actual and calculated non-volatile weights have been negligible.

Selection of the section or sections of road to be used for service tests of paints is carefully made, taking into consideration the surface texture of the pavement, the uniformity of such texture, the drainage conditions and uniformity of exposure to sun light, and avoiding shaded areas through cuts or near trees or buildings which would cast a shadow on the test section Another important factor for the acceleration of tests is selection of roads having high traffic counts

A serious situation exists that affects both the traffic paint consumer and the paint industry in that many applications of traffic paints are made each year, the evaluations of which are considered reliable without justification. For example, in a known series of applications consisting of some 200 different paints, the application rate per gallon of paint of 4-in line was found to range from 265 to 798 ft. With this variance, in the judgment of the authors, the results obtained were not worthy of consideration. Another example results from use of improper devices for application which produce traffic lines having heavy ridges and deep valleys It is agreed throughout the paint industry, that a valley in any paint film is the weak spot where break-down will first occur. In view of the increasing volume of traffic paint purchased each year, and the greater demand for superior traffic paint, the need for realization of the involved factors should be appreciated.

Development and Evaluation of Formulation Principles—In 1946 a co-operative study of traffic paint formulation and testing was begun jointly by the Pennsylvania Department of Highways and the Technical Service Laboratory of the Titanium Pigment Corporation. A co-operative effort of this kind was deemed necessary since it was beyond the ability of either of the co-operators to handle the problem alone The road testing and evaluation of the paints to be exposed was assigned to the Pennsylvania Department of Highways while the formulation and preparation of the paints became the responsibility of the Technical Service Laboratory of the Titanium Pigment Corporation.

The main purpose of this program of traffic paint formulation and testing is to expand the general information on paint formulation and to determine the service factors which depend directly on formulation and paint composition. During the past decade, or since the start of the war in Europe, considerable advance in raw materials available to the paint industry, both as regards pigments and vehicle components, has been made. In certain types of organic protective coating materials, such as industrial finishes for household appliances and automobiles, exterior house paints and interior architectural finishes, developments over the past ten years have been so extensive that the present day service obtained from such finishes far exceeds that which was considered normal ten years ago

The tendency in all white finishing systems such as white appliance finishes, white house paint and white architectural finishes, has been towards greater and greater hiding power in the finishes themselves, resulting in fewer and thinner coats of paint needed for satisfactory coverage This tendency towards thinner and fewer coats, with the consequent saving in costs of applying these paints, has been made possible by a gradual transition in the types of raw materials employed in the formulation of these organic protective coatings Pigmentary materials of higher opacifying power have gradually displaced pigments of lesser opacifying power in the various types of finishes In the industrial white appliance enamel field this transition has been complete and it is fast reaching that stage in the exterior house paint and interior architectural finish fields The irresistible force of economy together with improved quality and service life has brought about this transition. Very extensive formulation revision and product testing was required during this transition period and the change was effected only after thorough testing and product evaluation.

In the field of traffic paint formulation this change to the use of the newer raw materials has not occurred to such an extent and we find many highway departments using formulations that are believed to be outmoded and costly and that do not have service characteristics comparable with more modern formulations

There are two very good reasons for this. During the war years traffic paints were considered non-essential as far as priorities for raw materials went, and consequently, very little technological progress in traffic paint formulation was made during those years, and secondly, traffic paints for the most part are purchased on competitive bidding and costs are a major consideration Such products are not likely to be formulated with new raw materials which are often high in cost upon introduction. Use comes only after the cost of producing the raw material has become stabilized, service characteristics have been fully evaluated, and costs as opposed to service characteristics demand its use because of the economy secured. Also the selection of a suitable traffic paint is made only after extensive field testing which is subject to many variables, often intangible and difficult to recognize Changes in paint specifications for traffic paints are very often made with great reluctance and misgivings

In order to correlate paint composition with service life and performance through very carefully controlled and accurate field testing, it was necessary to apply to traffic paints the fundamentals of paint formulation so commonly employed in the formulation of exterior house paints and interior architectural finishes. Such paints are what the paint formulator calls "mixed pigment paints," and the modern traffic paint in which the pigmentary portion of the paint consists of a combination of two or more pigments added for specific purposes, can also be classed as "mixed pigment paint". The same principles of formulation which were developed for exterior house paints from extensive painting tests could therefore also be applied to traffic paints and the limits of the different variables involved, determined by accurate field testing The first of these so-called variables in paint formulation is what is known as the "pigment volume concentration", which may be briefly defined as the ratio of the volume of the pigmentary materials contained in a dried paint film to the volume of the dried paint film itself. In other words, if a gallon of traffic paint as applied to the road contained one-third of a gallon of pigmentary material, one-third of a gallon of fixed binder and one-third of a gallon of volatile thinner, the dried paint film on the road would contain only the original one-third of pigment and one-third of fixed binder, the volatile solvent having been evaporated The "pigment volume concentration" in this dried paint film would then be 50 percent. This is a very important paint formulation characteristic as will be shown

A survey of state specifications wherein composition is specified, revealed, after calculation of the "pigment volume concentration" of the composition given, that for traffic paints based on lithopone and anatase titanium barium pigment, the resultant "pigment volume concentrations" were in the range of 60 percent. Experience had shown that for these pigments and the types of oleo-resinous vehicles employed with them, a "pigment volume concentration" of 60 percent was optimum However, this is not necessarily true when traffic paint specifications are re-written to make use of the more economical pigments derived from titanium, such as titanium dioxide and rutile titanium calcium pigment. For instance, 100 lb of lithopone pigment bulk 2 29 gal and 100 lb. of rutile titanium calcium pigment bulk 3 69 gal. Substitution of one of these for the other on a weight basis alone, without regard for this difference in bulking is not justified The paint obtained by such a replacement has a "pigment volume concentration" entirely different from the other and its performance characteristics are different

In making replacements of this type, the bulking of the various pigments involved must be taken into consideration and such replacements are only justified if the "pigment volume concentration" is maintained at a constant figure. In Table No. 1 are recorded the results obtained over a 44-week field test on a group of longitudinal lines. For these paints the "pigment volume concentration" was maintained at 60 percent and the results indicate that performance characteristics are about the same for all paints. In these tests the prime white pigments (with the exception of the pure titanium dioxide) were substituted on an equal weight basis for each other, and all the other pigments in each formulation are in the same relative weight relation to each other, but the total "pigment volume concentration" for all the pigments in each formulation was set at 60 percent and the volume relationship of pigmentary material to fixed binder of the paint on the road is the same in each case. The one relationship however, which is commonly specified in traffic paint specifications, and which is not common to all these paints is the percentage of pigment by weight in a given weight of paint It could not be the same and therefore becomes largely meaningless unless definite composition is specified Such restriction is not justified under any other circumstance In the case shown in Table 1 substitution with the extremely high hiding titanium dioxide on a 50 percent by weight basis of the total pigmentation was not justified, so a 1 to 2 blend by weight of titanium dioxide and magnesium silicate was made and used for 50 percent of the total pigmentation. As mentioned before, the total "pigment volume concentration" in each of these paints is 60 percent Also, as explained, the total percentage of pigment by weight is not the same for all of these paints, nor is the weight of anyone of the common pigmentary ingredients the same for all of these paints, even though the percentage composition by weight of, say zinc oxide, is 20 percent of the total pigment composition by weight in each case Since the total weight of pigment by percent is not the same for all of these paints,

TABLE 1
LONGITUDINAL EXPOSURE—1947

Line No	Weight Prime Pigment	ZnO	Asb	Pumice	Rating—Weeks Exposure			
					7	9	21	44
	%	%	%	%				
53-765	50-Lithopone	20	15	15	10[a]	10	7	5
54-766	50-Titanated Lithopone	20	15	15	10	10	8	4
52-763	50-Anatase Titanium Barium	20	15	15	10	10	8	6
51-762	16 5-Anatase Titanium Dioxide	20	48 5	15	10	10	7	6
50-768	50-Rutile Titanium Calcium	20	15	15	10	10	7	5

[a] Paints fail by flaking, scaling and erosion

Rating figures designate percentage of original paint still on road at time of reading Thus figure 8 indicated 80 per cent of original paint left on road, 5 indicates 50 per cent, 1 indicates 10 per cent, and so on.

All paints show a composition of 50 per cent prime white pigment, 20 per cent zinc oxide, 15 per cent magnesium silicate (Asbestine) and 15 per cent Pumice in their pigment composition, with the exception of paint 51-762

neither is the total weight of vehicle or fixed vehicle the same, yet their road behavior and service are identical. If, a specification written for paint 54-765 showed a pigment composition of 50 percent lithopone, 20 percent zinc oxide, 15 percent magnesium silicate and 15 percent pumice and specified X per cent pigment by weight and Y percent vehicle by weight; and then contained a clause wherein it would be permissible to substitute some other prime white pigment such as the rutile titanium calcium pigment for any or all of the lithopone on a weight basis, no paint so formulated would comply since it would not contain X percent pigment and Y percent vehicle by weight. Purchasers of traffic paints penalize the paint they buy and the paint manufacturer when they only permit the use of titanium pigments as alternate for the zinc sulphide pigments without consideration for the "pigment volume concentration" and adhere to a relationship of "percent of pigment and vehicle by weight" arrived at for paints made with zinc sulphide pigments

In Table 1, a group of five paints having comparable "pigment volume concentration" and vehicle composition, but varying in pigment composition, gave comparable performance on the road. The "pigment volume concentration" employed was 60 percent, which was derived from experience with paint formulations based on lithopone.

Satisfactory performance, war and mileage requirements dictated the film thickness to be applied to the road. Satisfactory hiding at that film thickness determined the amount of pigment to be used in making the paint and pigment requirement determined in that way calculated out to 60 percent by volume In the transition from the higher specific gravity zinc sulphide pigments to the lower specific gravity titanium pigments, 60 per cent is no longer necessarily the optimum "pigment volume concentration" to use. It was seen from Table 1 that at that total pigment volume concentration the titanium pigments gave performance comparable with the zinc sulphide pigments.

The relationship of "pigment volume concentration" to road performance is illustrated by Table 2 in which a simple titanium dioxide-magnesium silicate pigmented traffic paint was exposed at various pigment volume concentrations in both an oleo-resinous and an alkyd resin vehicle

It is recognized that some of the paint compositions indicated in Table 2 may not constitute good traffic paint formulations. When trends and the effects of variation of a variable are being studied, the limits included in the data may exceed what constitutes an acceptable limit to one familiar with the subject under investigation. In this co-operative program the ultimate aim was the development of traffic paint formulations eminently suited for their needs, these formulations to be covered by composition specifications. The formulations were to comprise economy commensurate with satisfactory performance. Two general raw materials enjoying increasing use in paint formulation but not too generally applied to traffic paint formulation are the titanium pigments and the synthetic resins of the alkyd type. In the titanium pigment field, whiteness, brightness and opacity is obtained more cheaply with the rutile titanium calcium pigment, and it was for this reason that efforts were directed primarily toward the use of this pigment.

TABLE 2
EFFECT OF PIGMENT VOLUME CONCENTRATION ON DURABILITY

Pigmentation—30% anatase titanium dioxide; 70% magnesium silicate
Vehicle — Medium oil length alkyd
Accelerated Transverse Exposure—1947

Line No	PVC	Exposure Weeks			
		7	9	12	21
	%	Rating			
742	30	10	10	9	1
743	40	10	10	9	1
741	50	9	4	1	0
745	60	4	1	0	0

Longitudinal Exposure—1947

Line No	PVC	Exposure Weeks			
		7	9	21	44
	%	Rating			
742	30	10	10	8	8
743	40	10	10	9	7
744	50	10	8	4	3
745	60	10	8	3	2

Pigmentation—30% anatase titanium dioxide; 70% magnesium silicate
Vehicle — 15 gal linseed oil—ester gum
Accelerated Transverse Exposure—1947

Line No.	PVC	Exposure Weeks			
		7	9	12	21
	%	Rating			
748	50	10	10	9	3
749	60	1	0	0	0

Longitudinal Exposure—1947

Line No	PVC	Exposure Weeks			
		7	9	21	44
	%	Rating			
748	50	10	10	9	7
749	60	10	10	8	6

Extensive field testing of formulations of known composition during the first two years of co-operative effort indicated quite clearly that alkyd resins of the medium oil type, containing about 35 percent phthalic anhydride and modified entirely with vegetable oils such as linseed oil, soya bean oil, and the like, were eminently satisfactory for traffic paint use Excellent service life was obtained with vehicles of this type. For traffic paints with which it is desired to apply glass beads to enhance night visibility, alkyd resins are definitely superior as paint vehicles to other types of binders.

TABLE 3
COMPARISON OF VEHICLE BINDERS

Pigment Volume Concentration—50%
Pigmentation—85% Rutile titanium calcium; 15% No 1 Pumice
Longitudinal Exposure—1947

Paint No.	Vehicle	Exposure—Weeks			
		7	9	21	44
		Rating			
705	alkyd-1	10	10	6	4
706	O R-1	10	10	7	1
707	O-R-2	10	10	7	8
708	O-R-3	10	10	7	0
787	alkyd-2	10	10	7	3

Pigment Volume Concentration—50%
Pigmentation—30% Anatase Titanium Dioxide; 55% Magnesium Silicate; 15% No 1 Pumice
Longitudinal Exposure—1947

Paint No	Vehicle	Exposure—Weeks			
		7	9	21	44
		Rating			
786	alkyd-2	10	10	8	6
702	O-R-1	10	10	8	5
725	O-R-4	10	10	7	2
726	O R-5	10	10	8	2

Vehicle OR-1 Linseed Oil/Ester Gum—15 gal
OR-2 DHCO/LO/Mod Phenolic—20 gal.
OR-3 Linseed Oil/Ester Gum—15 gal
OR-4 Linseed Oil/Penta Ester Gum—15 gal
OR-5 China Wood Oil/Ester Gum—15 gal.
Alkyd-1 Medium Oil Alkyd A
Alkyd-2 Medium Oil Alkyd B

In Table 3 are recorded some field test results of a group of traffic paints exposed in 1947. These tests were made parallel to traffic on concrete highways and the results indicate the general superiority of the alkyd resins of medium oil length as compared to a variety of oleo-resinous (varnish type) paint binders.

These general results were also obtained with pigmentations other than those indicated and were definitely corroborated by the results of the field tests put down in 1948. With this information obtained from the 1947 and 1948 field tests, the paints exposed in 1949 were formulated entirely with alkyd vehicles of this type. Resins from several manufacturers were used and the variables being evaluated in the 1949 series of field tests, are variations in pigment composition and other changes to adapt the paints for satisfactory performance over different road compositions. These data are still being accumulated and the results of this series of field tests will be in a subsequent report.

In a recent paper[1] it was pointed out that the rutile titanium calcium pigment offers the cheapest hiding power per dollar among the family of titanium pigments. One dollar will purchase 13.33 lb. of rutile titanium calcium pigment or 760 hiding units; or, 5.12 lb of anatase titanium dioxide equal to 590 hiding units; or, 4 65 lb of rutile titanium dioxide equal to 651 hiding units A similar comparison involving other prime white pigments used in traffic paint formulation will indicate that the rutile titanium calcium pigment offers the cheapest hiding power per dollar.

With this premise established, efforts have been centered on developing the system rutile titanium calcium pigment—medium length oil modified alkyd resin, into the most satisfactory and universally acceptable traffic paint possible For this system the preliminary work carried on over the first two years of field testing indicated that a pigment volume concentration in the range of 40 to 50 percent, gave the most satisfactory results

From Table 3, paint 787 is indicated as a simple mixture of 85 percent rutile titanium calcium pigment and 15 percent pumice at a pigment volume concentration of 50 percent and formulated into a paint with an alkyd resin of the No 2 type

After nine weeks of longitudinal exposure this paint still showed a rating of 10, and after 21 weeks of continuous exposure the rating was still 7. However at a spreading rate of 400 lineal feet per gallon for a 4-in line, this paint contains more titanium pigment than is necessary to give satisfactory appearance, and is therefore somewhat more costly than is necessary. The aim was therefore, to try to modify this paint to reduce its cost and at the same time upgrade its service characteristics

[1] Zimmermann, E K, "Traffic Paint Studies"—Progress Report No 1—Official Digest, Page 353 (1949)

If the 787 paint is modified so that the pigmentation becomes
50 percent Pigment Volume Concentration,
75 percent Rutile Titanium Calcium Pigment,
10 percent American Process Zinc Oxide,
15 percent No 1 Pumice,
in the same type alkyd resin solution, the 1948 field tests indicated:

Paint No 862

	Transverse Exposure	
Months	2	4
Rating	9	7
	Longitudinal Exposure	
Months		5
Rating		7

If the pigmentation is still further modified to
50 percent Pigment Volume Concentration,
50 percent Titanium Calcium Pigment,
20 percent American Process Zinc Oxide,
15 percent Magnesium Silicate,
15 percent No. 1 Pumice,
the exposure data obtained in 1948, indicates the following:

Paint No 812

	Transverse Exposure	
Months	2	4
Rating	9	8
	Longitudinal Exposure	
Months		5
Rating		7

Further modification by replacing 67 percent of the magnesium silicate used with No. 325 mesh mica, as follows
50 percent Pigment Volume Concentration,
50 percent Rutile Titanium Calcium Pigment,
20 percent American Process Zinc Oxide,
5 percent Magnesium Silicate,
10 percent No. 325 Mesh Mica,
15 percent No 1 Pumice,
yields the following exposure data:

Paint No. 813

	Transverse Exposure	
Months	2	4
Rating	10	9
	Longitudinal Exposure	
Months		5
Rating		9

If the American Process Zinc Oxide in paint 812 is replaced with an equal weight of magnesium silicate, modifying the pigmentation to the following:

50 percent Pigment Volume Concentration,
50 percent Rutile Titanium Calcium Pigment,
35 percent Magnesium Silicate,
15 percent No 1 Pumice,
the exposure data obtained in 1948 indicates:

Paint No 871

	Transverse Exposure	
Months	2	4
Rating	9	6
	Longitudinal Exposure	
Months		5
Rating		8

The introduction of mica in an amount equivalent to about 30 percent of the magnesium silicate in paint 871, yields a pigment formulation as follows:
50 percent Pigment Volume Concentration,
50 percent Rutile Titanium Calcium Pigment,
25 percent Magnesium Silicate,
10 percent No. 325 Mesh Mica,
15 percent No. 1 Pumice

The 1948 exposure history for this combination indicates:

Paint No 865

	Transverse Exposure	
Months	2	4
Rating	. 8	5
	Longitudinal Exposure	
Months		5
Rating		5

Comparison of the exposure data for the five paints listed above which were field tested in 1948, with the exposure data obtained for paint 787 as shown in Table 3, and which was field tested in 1947, indicates that the addition of complementary pigments (such as zinc oxide, magnesium silicate, etc.) commonly used in mixed pigment traffic paint formulations, add little extra durability to the system rutile titanium calcium pigment—alkyd resin straight oil modified, for traffic paint performance The inclusion of an extender pigment such as mica appears to be beneficial when zinc oxide is present in the pigmentation as indicated by comparison of the exposure data for lines 812 and 813.

At this point, these results merely indicate trends which definitely need further confirmation. The comparisons must be made in the same field test series and must be confirmed by repeated exposures over a period of years. Furthermore, other pigmentary extender materials such as the calcium carbonates must be evaluated

In the 1949 field test series we are attempting to obtain this confirmatory data as well as additional data on the performance of traffic paints based on rutile titanium calcium pigment and alkyd resins, as compared to the performance of paints based on state specifications where composition is specified. These data are now being accumulated and the information obtained from them will determine the comparisons and evaluations to be included in the 1950 series of field tests.

In this discussion, nothing has been said about beaded paints. We are at present trying to determine the characteristics required in a traffic paint to obtain the most satisfactory bead retention This would include beads applied to the wet traffic line and beads incorporated into the paint. The formulation of paints satisfactory for application on bituminous highways is also included in the study. The rutile titanium calcium-alkyd resin systems show superior durability on this type road but tend to "bleed" too badly. Such paints, applied to bituminous road surfaces, can be beaded with much better bead retention than can the paints based on extremely short oil oleo-resinous vehicles which give superior bleed resistance

The ultimate aim, is the determination of the formulation requirements for a satisfactory traffic paint which will accept and retain beads for application to both concrete and bituminous road surfaces