

## PRESENT PREFERENCES FOR TRAFFIC PAINT

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### SYNOPSIS

The results of a survey on traffic paint that was completed during the fall of 1950 are discussed in this paper.

Replies to questionnaires were received from 34 states that are well distributed geographically, and from 175 manufacturers of traffic paint that are representative of varying degrees of importance in all parts of the country. Compilation of the results of this very generous response affords an up-to-date and representative canvass of opinions and preferences expressed both by the consumers of traffic paints and by the manufacturers of the product.

Estimated quantities of white and yellow road marking paints used in 1949 and 1950 by 33 states indicate that about 11 percent more whites and about 9 percent more yellows were used in 1950. The ratio of white to yellow was about 7 to 3 for both years.

A great increase in the use of retro-reflective road markings is indicated by the returns. The reported estimated consumptions for 1949 and 1950 indicate that 67 percent more beaded whites and 59 percent more beaded yellows will be used in 1950 than in the previous year.

In types of opaque white pigments preferred, both the states and the manufacturers rate titanium pigments first, followed by zinc oxide and lithopone. Among the extender pigments, magnesium silicate has first preference, definitely.

Preferences on vehicle types selected indicated no significant change between the types used in 1949 and in 1950. About half of both groups reporting indicated a preference for the alkyl resin types, and about a third of both groups reported a preference for the phenolic resin varnish types. The phenolic varnish-dispersion resin type was voted as third in importance, being somewhat more popular among the states than among the manufacturers.

Both the highway departments and the traffic paint producers indicated the relative importance of those paint properties that will receive greater emphasis during the coming year. A summation of these preferences, both on a first-choice basis and on a weighted basis, indicates that both groups have voted "Improved Service Life" as definitely first in importance. There was decidedly less unanimity of opinion on the relative importance of the other properties. Apparently, the highway departments desire better visibility and better film properties and do not stress "Cost per Gallon", while the manufacturers are emphasizing improved liquid paint and application properties while rating "Cost per Gallon" as quite important.

Those dealing extensively with traffic zone marking paints are aware of the widely varying and sometimes contradictory characteristics of these materials. They may not be as completely informed, however, on the detailed balancing and adjusting necessary in formulating the desired types of paints. The major difficulties involved are the cost and availability of the ingredients, and the preferences expressed or implied for the storage properties, liquid paint properties, application properties, and service properties of the product. To attain some of these requirements it may be necessary at

times to sacrifice other desirable characteristics. To attempt to determine what type of formula is most suitable for a given consumer, one must first know what properties or qualities are of major importance to that consumer and which ones are of minor importance. Solution of this complexity is further complicated by changes in preferences, service requirements and money available for the project.

To obtain information on those preferences most widely held at this time, our Company has made a survey on the subject. Compilations of the

results of this survey are presented in this paper. Collations of the preferences indicated by current procedures are discussed first. The comparisons of the relative choices indicated by answers to identical questions by the highway departments and by the manufacturers of traffic paint then follow. Formulations sheets are appended for one white and two yellow paints that appear to satisfy a large number of the requirements and preferences reported.

Questionnaires on traffic zone marking paints were sent to state highway departments and to paint manufacturers during the summer of 1950. The highway departments were selected as the largest group of consumers of road marking paints, and the questionnaire that they received was designed to indicate their requirements and preferences. The questionnaire sent to the paint manufacturers was designed to obtain the opinions and preferences of the traffic paint producers. In both forms, however, there were identical lists of questions about preferred paint compositions and paint service properties. Both questionnaires were arranged for ease and convenience of reply, and a number of questions that might have been of general interest were omitted for brevity. Copies of the two types of forms are appended.

Knowing that the New Jersey Zinc Company does not produce paints, you may ask why we conducted a survey on the types of traffic paints preferred. The answer is that our pigment products are used in all types of paints, with considerable tonnages being used in white and colored traffic paints. To secure information on the most effective use of these pigments, regardless of the type of vehicle used or the service conditions, our laboratory has conducted continuing investigations on the subject for almost thirty years. Some of these investigations have been quite comprehensive, and both the manufacturers and the highway departments have cooperated in making service tests on the traffic paints. Without identifying the cooperators, it has been a consistent policy of our Company to report the results obtained to all of those

interested. Indeed, the idea of the 1950 survey originated during a consideration of the most effective methods for using the information obtained from more than two hundred road service tests made in 1949. Each questionnaire was accompanied by a brief summary of the 1949 test results, a copy of which is appended.

The state highway departments, with their paint testing laboratories, trained personnel, and experienced background in specific properties needed for road marking paints in their areas, can set up standard requirements for traffic paints. Also, they can purchase these specific formulas in sufficient volume to assure the economical production of the desired types. Other users of traffic paints, namely the counties, municipalities, industry, railroad, airports, etc., seldom have the facilities, personnel and experience necessary for setting up specific traffic paint requirements. Even if these specifications are set up, the individual purchase orders may not be large enough to justify their special preparation without a price premium. Consequently, these groups of consumers usually rely on the competence, experience and integrity of the paint manufacturer to obtain the best paint for their needs.

The response to the questionnaires was very generous and the ratio of returns was surprisingly large for this type of survey, due probably to the widespread interest in new types of paints, the increased use of glass beads, and the possible necessity for considering substitute materials in the near future. Replies were received from 34 states that are well distributed geographically and from 175 manufacturers of traffic paints who are representative of varying degrees of importance in all parts of the country. We wish to express our sincere appreciation to all of those who participated.

Thirty-four state highway departments replied to questions on the "Highway Department" form, but some did not answer each group of questions. Therefore, some of the compilations discussed below represent a fewer number of states.

Estimates on the gallons of white and yellow traffic paints used in 1949 and 1950 were reported by 33 states. The respective totals for the retro-reflective type paints were also reported. Summations of these reported totals, together with reported data on black marking paint, are given in Table 1.

TABLE 1

ESTIMATED GALLONS OF ROAD MARKING PAINTS  
USED IN 1950 AND 1949, 33 STATES REPORTING

	1950	1949
White	580,025	677,290
White with Beads	519,080	310,034
Total White	1,099,105	987,324
Yellow	178,805	250,430
Yellow with Beads	298,100	187,865
Total Yellow	467,905	438,295
Grand Total	1,576,010	1,425,619
Ratio of White to Yellow	70 to 30	69 to 31
Black	104,650 <sup>a</sup>	143,500

<sup>a</sup>Four states reporting. This represents about 11 percent increase over the total for these states in 1949. A fifth state reporting for 1949 will not apply black in 1950.

The estimated totals for white and yellow paints used in 1949 and 1950 are represented in Figure 1 together with the estimated total of white and yellow paint used in 1948 by the same 33 states.

Based on 1948 data reported by Waters<sup>1</sup> for these states, the 1950 total for white and yellow traffic paints is about 16 percent higher than the 1948 total. The total 1948 usage of white, yellow and black reported by Waters (for 44 states only) is in excess of 1,893,000 gallons. Assuming a 16 percent average increase from 1948 to 1950 for these 44 states, their estimated total usage in 1950 would be more than 2,202,000 gallons. It is probable, therefore, that the 1950 total usage of road marking paints for all states might be about 2-1/2 million gallons.

<sup>1</sup>"Progress Report of Comments on Roadway Pavements Markings", by C. R. Waters, Highway Research Abstracts, July 1949.

The proportions of the various types of paints used in 1949 and 1950 and the percentage changes in 1950 for the estimated paint quantities listed in Table 1 are shown in Table 2.

It will be noted that the ratios for the states completing this portion of the questionnaire show that for the white traffic paints the beaded applications represented about one-third of the total in 1949 and about one-half of the total in 1950. In the yellow traffic paints, the use of beaded marking lines increased from about two-fifths of the total in 1949 to about three-fifths of the total in 1950. During both of these years the ratio of all whites to all yellows was about 7 to 3.

TABLE 2

RATIOS OF WHITE AND YELLOW TRAFFIC PAINTS  
USED IN 1950 AND 1949, 33 STATES REPORTING

	1950 Percent	1949 Percent	Change in 1950 Percent
White	53	69	- 14
White with Beads	47	31	+ 67
Total White	100	100	+ 11
Yellow	38	57	- 29
Yellow with Beads	62	43	+ 59
Total Yellow	100	100	+ 9

The right hand column of Table 2 shows increases from 1949 to 1950 of 67 percent for the white beaded markings and of 59 percent for the yellow beaded markings. These very large rates of change serve to emphasize the rapidly increasing and widespread adoption of glass beads in traffic paints. This conversion to the beaded type road markings was accompanied by a moderate increase in the total amount of traffic paint used. The increase in quantity of white paints used in 1950 versus 1949 amounted to about 11 percent, that of the yellow paints to about 9 percent, while the combined increase for both types was slightly less than 11 percent.

Table 3 summarized the replies given by 34 states regarding the basis of traffic paint purchases by their depart-

ment. Twelve of the states indicated that a single major requirement was used, and none of these cited cost per gallon as the requirement. Thirteen states indicated that two requirements were used, and nine of these cited cost per gallon as one requirement. Nine states reported that three or more requirements were used, with six indicating that cost per gallon was one of the bases of purchase.

trend towards the use of glass beads regardless of the significant increase in first cost.

Questions on the relative road service life obtained with the various types of paint were answered by 34 states. Most of those pointed out that their estimates were for average service under average conditions, since the type of road, traffic concentration, film thickness, and many other factors

TABLE 3

## BASIS OF TRAFFIC PAINT PURCHASE IN 1950, 34 STATES REPORTING

Basis of Purchase	Number of Requirements per State			Total Votes All States
	Single	Double	Multiple	
Specification	4	8	8	20
Composition	2	7	5	14
Performance	6	2	6	14
Cost per Gallon	None	9	6	15
Other	None	None	2	2
Number of States	12	13	9	34

TABLE 4

MONTHS ESTIMATED ROAD SERVICE LIFE  
34 STATES REPORTING

Type of Stripes	Average Normal Service	Average Optimum Service	Range <sup>a</sup>
White Paint	6	13	4 to 20
White with Beads	9	14	6 to 20
Yellow Paint	6	12	5 to 18
Yellow with Beads	8	14	3 to 20

<sup>a</sup>Two of the 34 states indicated a possible life of 24 months and one a possible life of 36 months. These estimates are not included in the ranges listed.

Considering the total votes listed in Table 3, purchase of paint by specification, either general or composition, or combined with performance, is the most general procedure in 20 of the 34 states. Of the 14 other states replying, two purchase solely on a composition basis and six purchase solely on a performance basis. According to these results, the survey indicates that purchase on a cost per gallon basis is of minor importance in most of the states. This is consistent with the enthusiastic

TABLE 5

## EFFECT OF BEADS ON FILM LIFE OBTAINED

	Shorter Life for Beaded Paints (States)	Same Average Life for Beaded and Non-Beaded Paints (States)	Longer Life for Beaded Paints (States)
Whites Only	-	2	4
Whites and Yellows	1	7	6
Yellows Only	-	1	1
Total States	1	10	11

might cause significant variations in service obtained. The replies received are summarized in Table 4. These results indicate that average non-beaded applications may be serviceable for about six months, while the beaded paints are serviceable for slightly longer periods.

An analysis of the specific replies as to the effect of glass beads on the service life of the films is tabulated in Table 5 according to the effects reported for white and yellow paints.

The Table 5 results confirm in part the averages reported in Table 4 but indicate that the Table 4 data are not

consistently applicable. The differences of opinions listed in Table 5 probably result from the effects of formulation and service variables. They also probably indicate the possibility of obtaining misleading indications in a too-brief summary of the variety

white and yellow paints applied without beads. These comparisons are listed in Table 6.

These opinions indicate that the color of the traffic paints did not consistently affect the service of the films. Six of the other states reporting use

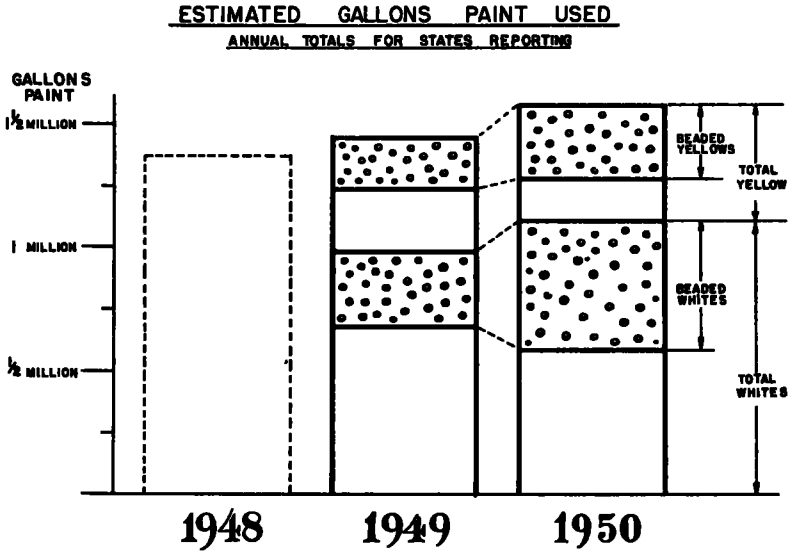


Figure 1

TABLE 6

RELATIVE FILM LIFE OF NON-BEADED WHITE AND YELLOW PAINTS

Same Average Film Life for White and Yellow Non-Beaded Paints	14 States
Longer Average Film Life for White Paint Stripes	2 States
Longer Average Film Life for Yellow Paint Stripes	3 States

of estimates condensed for the Table 4 values. The net result of the Table 5 summation is to indicate that beads affected a shorter film life in one state, had no significant effect in ten states, and effected longer film life in 11 states. Four of the other states reporting indicated no comparisons of film life, three did not use beads, and five used beaded paints only.

The estimates given by the individual states on film life also offered comparisons of the relative service periods of

TABLE 7

TYPE OF TRAFFIC PAINT MADE DURING 1949

Color of Product	Number of Manufacturers	Ratio of Total Replies Percent
White	173	99+
White with Beads	40	23
Yellow	145	83
Yellow with Beads	32	18
Other	57 <sup>a</sup>	33
Produced White Paint Only	24	14
Produced No White Paint	2	1
Produced White and Yellow Only	115	66
Produced Other Colors (Green, Red, Orange, Black)	34 <sup>a</sup>	20

<sup>a</sup>Some of those replying did not indicate which colors were produced

white paint only, three use yellow paint only, and three did not indicate the color of the paint used. Three of the

six using white paint use only beaded paints.

Table 7 summarized the replies received from several hundred paint manufacturers of whom 175 reported that they produce road marking paints. With some, this is a major part of their business. With others, it is of relatively minor importance even though the quantity produced may exceed that of a smaller company engaged mainly in traffic paint production. Data given in this paper, however, do not consider the relative quantities produced by the individual companies.

markings, and a summation of these results is given in Table 8. While it may appear that the highway departments might have more complete information on the relative effects of the several variables, they are probably no more interested than the manufacturers. Indeed, much of the business obtained by the manufacturers might depend upon their proper evaluation of the various factors. Their replies were listed according to first choice, second, third, etc. The total weighted votes for each item, listed in the middle column in Table 8, were determined and

TABLE 8

PAINT MANUFACTURERS' OPINIONS ON THE RELATIVE IMPORTANCE  
OF VARIOUS FACTORS TO THE SERVICE LIFE OF THE FILM

Factors Cited	Number of First Choices	Total Weighted Votes <sup>a</sup>	Relative Order of Preference
Type of Vehicle	108	744	1st
Film Thickness	18	360	2nd
Application Variables	16	327	3rd
Type of Pavement Surface	15	296	4th
Type of Hiding Pigment	4	250	5th
Type of Extender Pigment	1	229	6th

<sup>a</sup>Where five choices were indicated, the first choice was weighted as five votes, the second as four, etc. The totals given in this column represent the resulting sums for the respective items.

Almost all of the 175 traffic paint manufacturers reported that they produce white marking paints; 83 percent reported the production of yellow traffic paints; 66 percent reported the production of whites and yellows only; and 33 percent reported the production of other colors, such as green, red, orange or black. Only 23 percent of the companies produce beaded white paints, and only 18 percent produce beaded yellows. This might indicate that the highway departments had taken the initiative on expanding the use of beaded paints, or it might indicate that they preferred to add the beads at the time of paint application rather than purchase paints containing glass beads.

The paint manufacturers were asked to list their opinions on the relative importance of half a dozen factors influencing the service life of the road

these values were found to agree in relative order with the order of preference indicated by totals of the first choices.

Of the 163 manufacturers replying to this section of the questionnaire, more than half selected the type of vehicle as being the most important factor in service life of the film. There was much less agreement as to the second most important factor but it was generally agreed that film thickness, application variables, and type of pavement surface were all fairly important factors.

The relatively low position of importance assigned to the effects of the hiding pigments on service life is somewhat surprising. There have been occasions when our customers have expressed contrary opinions about the effects of some of the hiding pigments.

The results summarized in Table 9 represent the replies received from the states and the manufacturers regarding the pigments used. The questionnaire sent to the highway departments asked for an indication of the opaque and extender pigments preferred in white traffic paints, beaded and

the opaque pigment when beads are used, and two change the extender pigments when beads are used. The percentages indicated in the left-hand column in Table 9 are for the non-beaded paints but the replies regarding the use of beads did not materially change the ratios and, therefore, are not indicated

TABLE 9

## WHITE PIGMENTS PREFERRED BY HIGHWAY DEPARTMENTS AND BY PAINT PRODUCERS

	Frequency of Choice (States) Percent	Frequency of Choice (Manufacturers)		Average Order of Preference
		No Beads Percent	Beaded Percent	
<b>White Opaque Pigments</b>				
Titanium Dioxide	50	61	71	1st
Titanium-Calcium	44	59	55	2nd
Zinc Oxide	29	49	55	3rd
Lithopone	18	35	13	4th
<b>Extender Pigments</b>				
Magnesium Silicate	56	80	90	1st
Diatomaceous Earth	15	39	47	2nd
Whiting	18	33	29	3rd
Pumice	18	21	8	4th
Other (Extenders Only)	18	13	16	5th

non-beaded types. The paint manufacturers' questionnaire contained a similar list of questions but they were asked to indicate those pigments that were used in substantial percentages in traffic paints made by their company in 1949. Thirty-four states and 175 producers of traffic paint replied, and the frequencies of preferences are indicated in Table 9. It will be noted that the respective percentages for each group total more than 100 percent, signifying the use of more than one pigment in the formula.

Three of the states replying used only yellow marking paints in 1949 and 1950. Of the 31 states using white paints, five indicated no preference in the opaque pigments or in the extender pigments used. Considering the differences indicated between the non-beaded and the beaded paint formulas, three of the states reported that they used only beaded paints, 25 reported that the same pigment combinations are used both with and without beads, four change

FREQUENCY OF CHOICE—WHITE OPAQUE PIGMENTS  
USED IN NON-BEADED TRAFFIC PAINTS

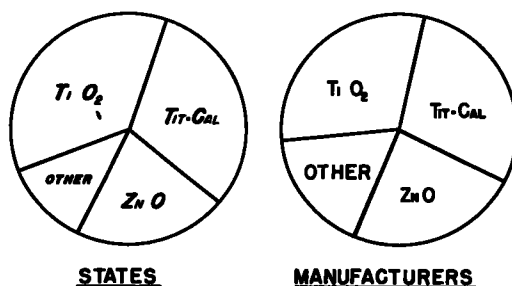


Figure 2

in the table.

As the Table 9 results indicate, the titanium pigments have first preference, followed by zinc oxide and lithopone, both among the traffic paint manufacturers and among the highway departments. In the non-beaded paints, the manufacturers seem to be more cognizant of the advantages of zinc oxide

than are the states, and they further increase the use of this reinforcing pigment for the beaded formulas. More changes are made also in other pigments used by the manufacturers when formulating for the retro-reflective road markings than are made by the states when beads are used. The increased use of titanium dioxide and of zinc oxide by the manufacturers when formulating for beaded paints is evidence that cost is not the most important factor in designing the formula.

Figure 2 represents the relative frequencies of choices for white opaque pigments used in non-beaded traffic paints by the states and by the manufacturers.

paint manufacturers than by states, but the frequency of use decreased slightly in the beaded formulas. "Other" types of extender pigments used included aluminum silicate, mica and various forms of barium sulfate. There is evidence that both the state highway departments and the traffic paint manufacturers are giving increasing attention to the use of barium sulfate in road marking paints.

Considering preferences for types of vehicles, 28 states voting on the types found to be most satisfactory and 175 traffic paint manufacturers voting on the types used by their companies in 1949 have indicated their respective

TABLE 10

PREFERENCES INDICATED FOR VEHICLE TYPES BY HIGHWAY DEPARTMENTS  
AND BY PAINT MANUFACTURERS

Vehicle Type	Frequency of Choice (States) Percent	Frequency of Choice (Manufacturers)		Average Order of Preference
		No Beads	Beaded	
		Percent	Percent	
Alkyd Resins	54	52	62	1st
Phenolics	29	34	32	2nd
Phenolic-Dispersion Resin	21	10	19	3rd
Copolymer-Chlorinated Paraffin	11	9	11	4th
Ester Gum	0	18	13	4th
Natural Gums	7	14	5	6th
Cumar (for Yellows)	3	4	-	-
Styrenated Oils	0	2	-	-
Other (All Types)	21	14	11	-

Considering the extender pigments, both the states and the manufacturers indicated a definite preference for magnesium silicate. The ratios of use by the states in non-beaded paints and in the beaded types were so similar that data for the beaded paint formulas are not given in Table 9. A considerably larger proportion of the traffic paint manufacturers indicated the use of magnesium silicate, both in the non-beaded and in the beaded paints. The manufacturers, however, also used other types of extenders more frequently, with the diatomaceous earth being the most favored. Whiting was also more generally used by traffic

choices. The frequency of choice for each vehicle type is listed in Table 10, data for the state highway department preferences being listed for the non-beaded paints and data for the manufacturers preferences being listed both for non-beaded and for beaded paints. Frequency of choice values for beaded paint vehicles preferred by the states are not listed in Table 10 because they are so similar to the values for the non-beaded types.

The relative orders of choice for the types of vehicles preferred in traffic marking paints place the alkyd resin type as definitely first choice by both groups reporting. Phenolic resin



varnish types are the second choice of both groups, and the phenolic-dispersion resin type is rated third in frequency of preference. No data are available on the total quantities of the respective types of vehicles that are used annually.

In the category of "other" vehicle types, the state highway departments reported the acceptance of pentaerythritol ester resins, chlorinated rubber, phenolic modified pentaerythritol, maleic modified phenolic, zinc resinate, and tung oil varnishes. Under the same classification, the manufacturers listed most of the types cited by the states.

and the report by one state that a different type vehicle was specified where glass beads are used than is specified for the non-beaded paints. Six states indicated no preferences as to the type of vehicle specified for their white and yellow road marking paints. No significant changes in types of vehicles used in 1949 versus 1950 were indicated in the preferences reported.

Of all the results indicated in this survey, perhaps the most interesting phases were those expressing the trends in opinions and preferences, as shown in Table 11. Some of these have been enumerated in the results previously

**FREQUENCY OF CHOICE - TYPES OF VEHICLES**  
**USED IN NON-BEADED TRAFFIC PAINTS**

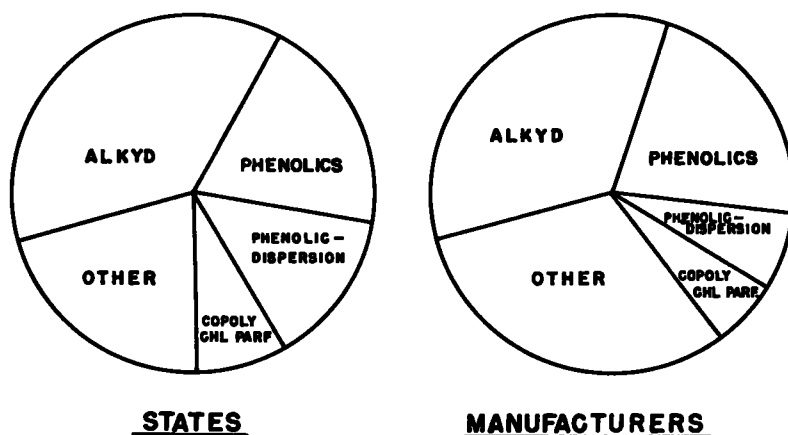


Figure 3

Comparisons of the relative frequencies of choice by the states and by the manufacturers for types of vehicles used in non-beaded traffic paints are shown in Figure 3.

Pertinent details that may be of interest to the highway departments include the report by 16 states that the same types of vehicles are purchased for non-beaded and beaded marking paints, the report by three states that they apply beaded marking lines only, the report by two states that bead-containing paints are purchased for their retro-reflective markings,

discussed and some have been indicated by inference. Table 11 summarizes the replies received from identical lists of questions in both the state highway and the "producer" forms. The wording in the questionnaire was: "To aid us in the following trends, indicate on which properties you intend to place greater emphasis in the coming year . . ." Eight options were listed and it was requested that at least three of these, but not more than five, be numbered in order of importance.

The response received from both groups was most gratifying. Space does

not permit detailed analysis of the preferences reported but the orders of preference indicated in Table 11 are believed to be a fair presentation of the consensus. Comparisons of the choices indicated by some of the highway engineers with the traffic paint specifications for their respective states would indicate that revision or expansion of some of the specifications was badly needed. The results indicated that both for the state highway departments and for the traffic paint manufacturers the thinking regarding future trends was considerably in advance of present practice. Both groups are to be congratulated on their alertness to future possibilities in road marking paints.

Considering the individual returns, 34 state highway departments and 162 traffic paint manufacturers replied to this list of questions. For the states, 30 indicated their first, second, etc., choices. For the manufacturers, 148 indicated their choices in descending order of importance. A summation of the preferences on a weighted<sup>2</sup> basis agrees with the order of decreasing preferences that is indicated by the respective first-choice totals, both for the highway department replies and for the manufacturers replies.

In the individual replies, "Improved Service Life" was definitely the first choice of both groups for greater emphasis during the coming year. The relative ratings on "Rate of Dry" and "Storage Stability" were also in fairly good agreement, but the unanimity of

agreement on the importance of the other properties was less pronounced in the two groups. In general, the Table 11 comparisons probably indicate the concern on the part of the consumers for better service properties of the film without stress on the paint cost, and the concern on the part of the manufacturers for better liquid paint

TABLE 11

## RELATIVE ORDER OF PREFERENCE FOR FUTURE EMPHASIS ON PAINT PROPERTIES

Paint Properties	State Highway Departments	Traffic Paint Manufacturers
Improved Service Life	1st	1st
Night Visibility	2nd	6th
Rate of Dry	3rd	2nd
Storage Stability	4th	4th
Day Visibility	4th	7th
Cost per Gallon	6th	3rd
Bleeding Resistance	6th	4th
Other	Negligible	Negligible

and application properties at competitive costs. The de-emphasis of cost by the highway departments is a logical reaction to the great increase in interest in retro-reflective road markings, and it is probably coupled with their desire to keep such films on the road as long as is practical.

In conclusion, I again wish to express our deepest gratitude to all of those who participated in the survey, and to your committee who made this presentation of preferences possible. Limitations of space prevented comment on many of the details reported but these will be freely available to those interested, with the exception that the identity of those organizations making the comments manifestly cannot be revealed.

<sup>2</sup>Where five choices were indicated, the first choice was rated as five votes, the second four votes, etc. The resulting sums for each item determined the orders of preference listed in Table 11.

## APPENDIX A

Traffic Paint Formula T-4418-TAEI - White  
 Traffic Paint Formula T-5418-MEAI - Yellow  
 Traffic Paint Formula T-1451-MEAI - Yellow

## TRAFFIC PAINT FORMULA T-4418-TAEI

	Formula Percent	Representative Formula
<b>Pigment - 57-59 Percent</b>		
Titanium Dioxide (1) . . . . .	10	74 lb.
Lithopone (2) . . . . .	40	295 lb.
Zinc Oxide (3) . . . . .	10	74 lb.
Pumice (4) . . . . .	10	74 lb.
Magnesium Silicate (5) . . . . .	29	214 lb.
Aluminum Stearate . . . . .	1	7 lb.
<b>Vehicle - 43-41 Percent</b>		
Alkyd Resin Solution (6) . . . . .	65.6	44-7/8 gal.
V. M. and P. Naphtha . . . . .	33.3	29 gal.
Lead Drier (24 % Pb) . . . . .	0.9	5 pt.
Cobalt Drier (6 % Co) . . . . .	0.2	1 pt.
Yield . . . . .	100 gal.	
Non-volatile in Vehicle . . . . .	40 Percent	
Weight per Gallon . . . . .	12.7 lb.	
P. F. V. . . . .	52 Percent	

- (1) Rutile or anatase type may be used. Rutile provides better durability; anatase, better color and cleansing.
- (2) Albalith-351 (high consistency) or Albalith-73 (lower consistency).
- (3) XX-2, XX-50, XX-55, XX-503 or XX-601.
- (4) Should be added after paint is ground. Where application is by spray gun, use No. 0-1/2, 1/2 or 0-3/4. When application equipment permits the coarser pumice, No. 1 or 1-1/2 may be used. If glass beads are to be used, the pumice may be omitted.
- (5) Medium consistency fibrous type.
- (6) Glyptal 2475 (60 percent non-volatile) or any recommended alkyd that is compatible with zinc oxide may be used. If non-volatile is not 60 percent, adjustment should be made in quantity of alkyd and V. M. and P. Naphtha. If paint is to be applied under unfavorable conditions or more rapid drying is desired, a V. M. and P. Naphtha-alkyd solution should be used instead of a mineral spirits-alkyd solution.

The properties and cost of the paint may be varied by changing the composition of the pigment, the vehicle, or the proportions used.

Increasing the TiO<sub>2</sub> or zinc oxide content in the pigment increases the length of service obtained. High zinc oxide content is especially desirable when the paint is to be glass beaded. Substitution of water-ground mica for part of the magnesium silicate also increases the durability of the film. Replacing part of the lithopone by additional magnesium silicate lowers cost at a sacrifice in the service obtained; also replacement on an equal weight basis of the pumice and magnesium silicate by an inexpensive ground whiting lowers cost at a sacrifice in durability.

The use of high viscosity resins or high consistency pigments, which permit an increase in the vehicle content or volatile content in the vehicle, reduces cost, although generally accompanied by a decrease in service. Increasing the non-volatile vehicle usually results in improved service.

Note: The information contained herein is from sources which we believe to be reliable and is intended to offer helpful suggestions. We do not, however, guarantee the results to be obtained from its use.

## TRAFFIC PAINT FORMULA T-5418-MEAI

	Formula Percent	Representative Formula
<b>Pigment - 58 - 60 Percent</b>		
C. P. Chrome Yellow . . . . .	40	318 lb.
Zinc Oxide (1). . . . .	15	119 lb.
Lithopone (2) . . . . .	15	119 lb.
Magnesium Silicate (3) . . . . .	29	230 lb.
Aluminum Stearate . . . . .	1	8 lb.
<b>Vehicle - 42-40 Percent</b>		
Alkyd Resin Solution (4). . . . .	65.6	46-1/2 gal.
V. M. and P. Naphtha . . . . .	33.3	30 gal.
Lead Drier (24 % Pb) . . . . .	0.9	4 qt.
Cobalt Drier (6 % Co) . . . . .	0.2	1 pt.
Yield. . . . .	100 gal.	
Non-volatile in Vehicle . . . . .	40 Percent	
Weight per Gallon . . . . .	13.5 lb.	
P. F. V. . . . .	48.9 Percent	

- (1) XX-2, XX-50, XX-55, XX-503 or XX-601.
- (2) Albalith-351 (high consistency) or Albalith-73 (lower consistency).
- (3) Medium consistency fibrous type.
- (4) Glyptal 2475 (60 percent non-volatile) or any recommended alkyd that is compatible with zinc oxide may be used. If non-volatile is not 60 percent, adjustment should be made in quantity of alkyd and V. M. and P. Naphtha. If paint is to be applied under unfavorable conditions or more rapid drying is desired, a V. M. and P. Naphtha-alkyd solution should be used instead of a mineral spirits-alkyd solution.

The properties and cost of the paint may be varied by changing the composition of the pigment, the vehicle, or the proportions used.

The chrome yellow is the most expensive pigment constituent, especially on a volume basis. Pigmentations containing combinations of C. P. lead chromate, zinc oxide, lithopone and magnesium silicate provide more durable paints than those containing C. P. chrome yellow alone or in combination with inerts. All indications are that both zinc oxide and lithopone improve the durability of the paint and the limit on their substitution for chrome yellow is the inclusion of sufficient chrome yellow to assure the desired yellow color. High zinc oxide content is especially desirable if the paint is to be beaded. Replacement of a portion of the magnesium silicate by water-ground mica or by pumice improves the durability of the film.

Increasing the non-volatile content of the vehicle usually improves durability, while the use of high viscosity resins or high consistency pigments, which permit an increase in the vehicle content or an increase in the volatile content of the vehicle, reduces cost but usually with a sacrifice in the service obtained from the paint.

Note: The information contained herein is from sources which we believe to be reliable and is intended to offer helpful suggestions. We do not, however, guarantee the results to be obtained from its use.

## TRAFFIC PAINT FORMULA T-1451-MEAI

	Formula Percent	Representative Formula
<b>Pigment - 53-55 Percent</b>		
C. P. Chrome Yellow* . . . . .	40	265 lb.
Zinc Oxide (1) . . . . .	15	100 lb.
Lithopone (2) . . . . .	15	100 lb.
Magnesium Silicate (3) . . . . .	29	192 lb.
Aluminum Stearate . . . . .	1	7 lb.
<b>Vehicle - 47-45 Percent</b>		
Varnish (4) . . . . .	43	33-3/4 gal.
Dispersion Resin (5) . . . . .	28.7	21-3/4 gal.
Butanol . . . . .	4.5	3-3/4 gal.
V. M. and P. Naphtha . . . . .	23.3	21-1/2 gal.
Lead Drier (24 % Pb) . . . . .	0.31	1-1/2 pt.
Cobalt Drier (6 % Co) . . . . .	0.13	3/4 pt.
Manganese Drier (6 % Mn) . . . . .	0.06	3/8 pt.
•		
Yield . . . . .	100 gal.	
Non-volatile in Vehicle . . . . .	37 Percent	
Weight per Gallon . . . . .	12-1/4 lb.	
P. F. V. . . . .	41 Percent	

\*The chrome yellow is the most expensive pigment constituent, especially on a volume basis. Pigmentations containing combinations of C. P. chrome yellow, zinc oxide, lithopone and magnesium silicate provide more durable paints than those containing C. P. chrome yellow alone or in combination with inerts. All indications are that both zinc oxide and lithopone improve the durability of the paint and the limit on their substitution for chrome yellow is the inclusion of sufficient chrome yellow to assure the desired yellow color. High zinc oxide content is especially desirable if the paint is to be beaded.

- (1) XX-2, XX-50, XX-55, XX-503 or XX-601.
- (2) Albalith-351 (high consistency) or Albalith-73 (lower consistency).
- (3) Medium consistency fibrous type.
- (4) 25-gallon 80 percent tung oil-20 percent Z-3 dehydrated castor oil, modified phenolic resin varnish. (Bakelite EF-1368 traffic paint varnish or equal).  
Volatile - 49 percent, Viscosity - B-C, Weight per Gallon - 7.18 lb.  
This varnish must be compatible with zinc oxide.
- (5) Bakelite Dispersion Resin BK-16624 (50 percent K. V. O or equal).

Note: The information contained herein is from sources which we believe to be reliable and is intended to offer helpful suggestions. We do not, however, guarantee the results to be obtained from its use

## APPENDIX B

Traffic Paint - Summary Submitted with each Questionnaire  
 Questionnaire - Road Marking Traffic Paints - Form Sent  
 to Highway Departments  
 Questionnaire - Road Marking Traffic Paints - Form Sent  
 to Paint Manufacturers

## TRAFFIC PAINT

For a number of years, we have conducted extensive investigations on traffic paint, both as laboratory studies and as field service tests. The laboratory work included the preparation of varnishes from conventional and from new type ingredients, the making and testing of paints containing these varnishes, and the development of new test methods. Practical road tests have been made on a variety of road surfaces with varying traffic conditions. Also, cooperative road service tests have been run with paint laboratories and with highway departments in a number of states and cities. As a result, much information on pigments and vehicles has been developed and passed out to paint manufacturers, highway departments, and others interested.

In 1949, much more work was done. Pigment formulas previously found satisfactory in traffic paints were retested, vehicles that had been formerly accepted were rechecked, and new vehicles that had come before the public were put under test. Paints in both white and yellow were investigated and the performance of a number of beaded paints was observed. The road service tests were made on a concrete highway previously used for this purpose, a highway traversed daily by twelve to twenty thousand vehicles moving at high speed, with about one-third being heavy trucks. It is the purpose of this paper to comment on this work to date.

In the earlier work on the pigments, we found that paints made with Albalith (lithopone) and Cryptone BT (titanated lithopone) gave excellent whiteness and necessary hiding power. The presence of zinc oxide improved performance. White water-ground mica extended the life of the paint. Pumice, either coarse or fine, added measurably to the life of the paint, and the coarse grade, through adding roughness to the paint surface, greatly improved night visibility.

These conclusions were again substantiated in 1949. As a rule, anatase titanium dioxide paints had better whiteness and appearance than the rutile titanium dioxide or the calcium-base pigment paints, and were comparable in whiteness and visibility to Cryptone BT or lithopone paints. The calcium-titanium pigment formulas have consistently shown more dirt collection, poorer color, and poorer durability. In the yellow paints, when some of the chrome yellow was replaced by Albalith and/or zinc oxide, there was no degradation in color or durability - usually both were improved - and a reduction in cost was achieved.

The vehicles used in earlier investigations together with those tested in 1949 represented every type of standard or alternate state highway department specification. These white and yellow paints were formulated both with the specified pigmentations and with substitutions or modifications. In addition to the conventional type vehicles, several new types not in common use were included in the tests. Brief comments on several different vehicles are given without attempting to list the various pigment combinations found to be effective in each type.

Modified Phenolic Tung-Linseed Vehicle (Federal Specification TT-P-115)

This vehicle is one of the oldest in point of use that has had popular acceptance by the trade. It is of the modified phenolic resin tung-linseed oil varnish type. Our 1949 tests confirmed our former findings that, if the varnish is properly cooked, this vehicle gives paints of satisfactory performance. In looking over the states now specifying this vehicle, we find that it has lost some of its popularity to alkyds. Good quality white or yellow paints are equally durable in this vehicle.

Alkyd Vehicles

Our 1949 tests again checked our previous work in indicating that alkyds performed remarkably well. With these vehicles, failure to dry to tack-free condition sometimes causes difficulty, but it is not insurmountable. A survey of the use of this type vehicle shows that half of the states and many of the cities use it in their standard or alternate specifications. It is equally good for whites or yellows.

## TRAFFIC PAINT (Continued)

### Manila Vehicles

The Manila gum type vehicle has been used quite extensively by some western states and has become identified as the "California Vehicle". We again found its performance poor in our climate, significant failure developing in less than a month. Paints made from it seem to have lost favor in some states formerly specifying it.

### Bakelite Varnish-Dispersion Resin Vehicle

This is a comparatively new-comer in the field and consists of a modified phenolic resin tung-linseed oil varnish plus dispersion resin. It has found favor in a few states. It has the advantage of quick drying, which is much to be desired, particularly for city use. Our 1949 tests with it were exploratory and did not permit drawing of final conclusions, but it appeared that satisfactory service could be obtained with yellow paints.

### Goodyear Phiolite-Chlorowax Vehicle

Another of the newer type of vehicle is the combination of Phiolite, a copolymer of butadiene and styrene, and chlorinated paraffin. It has been used in Texas and is finding some acceptance in other states. Paints made from it dried satisfactorily. Here again the work was exploratory and definite conclusions could not be drawn, but yellow paints appeared to give good service.

### Hercules Pentalyn 802A-Parlon Vehicle

This is probably the newest type traffic paint to be advocated in a large way. So far, it has gotten to the testing stage by states and cities. It is a combination of a Pentalyn 802A resin-tung oil varnish and a Parlon solution, the latter being a solution of chlorinated natural rubber. Paint made from it dries very fast and has aroused considerable interest. So far as our work has gone, the paint performance looks interesting.

### Yellow Paints

Aside from the differences in service properties of yellow pigmentations and white pigmentations in certain types of traffic paint vehicles, probably the most interesting indication of the 1949 tests was that the addition of either lithopone or zinc oxide to the yellow paints effected significant reductions in cost without harming road service and frequently improving it. These additions caused no noticeable degradation of the color, in fact, they effected better color retention and dirt elimination. Several states now specify white pigment additions to yellow traffic paints. The economies effected by the addition of these white pigments are substantial.

### Glass Beaded Paints

The recent widespread interest in glass beaded traffic stripes is of special interest because it focuses attention on the increased road service usually obtained by adding zinc oxide to traffic paint formulations. This improvement is evident in both the zinc sulfide and the titanium pigment paints. In the past, it has been of little interest to highway departments to gain a few months added road service by the addition of the zinc oxide when such improvement would merely extend the service period into the early winter months. Now the added cost of glass beaded lines makes an extension of the useful road service period very attractive, and extra cost that may be put into the paint is of minor importance in comparison with the improved service given. Although most of the vehicles tested with beads in 1949 and in previous years had good performance records, an important improvement is achieved if the life of the paint itself is extended, and if the vehicle is strengthened to hold the imbedded beads longer. Some users are now asking for sixteen months' service, as compared with previous interest in five to seven months.

The high cost of glass beads has resulted in interest in some states in extending the beads with cheaper materials. The rounded glass-like particles of Ottawa sand have been considered for this purpose. Our 1949 tests indicated that there may be some merit in this practice. The tests have also indicated that beads or bead-sand mixtures do not significantly improve the paint stripe durability. The apparently longer service obtained with beaded lines seems to be due solely to prolonged visibility at night of the worn lines. All results indicate that increased durability in the paint must originate in formulation modifications, such as vehicle improvement, reinforced pigmentation, or modified pigment-vehicle ratios.

TRAFFIC PAINT (Continued)

Because of the realization of possible differences of opinion as to the relative importance of road service versus other factors, no attempt has been made in this paper to suggest specific formulations. If those interested will indicate the factors that are of greatest importance in their specific requirements, we will be pleased to submit suggestions that we believe will be of most value under the specific requirements.

State Highway Department

June 1950

QUESTIONNAIRE

ROAD MARKING TRAFFIC PAINTS

Please estimate the quantities of road marking traffic paints used by your department:

	Gallons	
	1949	1950
White . . . . .	_____	_____
White reflectorized with glass beads . . . . .	_____	_____
Yellow . . . . .	_____	_____
Yellow reflectorized with glass beads . . . . .	_____	_____
Other _____	_____	_____

Please check on what basis paints are purchased for use by your department.

	Purchase Requirement
Cost per Gallon . . . . .	_____
Specification . . . . .	_____
Composition . . . . .	_____
Performance . . . . .	_____
Other _____	_____

What period of road service life is obtained from painted road stripes now used by your department?

Type of Stripe	Number of Months
White . . . . .	_____
White plus glass beads . . . . .	_____
Yellow . . . . .	_____
Yellow plus glass beads . . . . .	_____
Other _____	_____

To aid us in following trends, indicate on which paint properties you intend to place greater emphasis in the coming year. Please do so by numbering (e. g. 1, 2, 3, etc.) at least three but not more than five from the following list:

Bleeding Resistance . . . . .	_____
Storage stability . . . . .	_____
Rate of dry . . . . .	_____
Improved service life . . . . .	_____
Visibility	
Day . . . . .	_____
Night . . . . .	_____
Cost per gallon . . . . .	_____
Other _____	_____

What pigments do you prefer in white traffic paints? Please indicate by check marks in the following list.



QUESTIONNAIRE (Continued)

	Non-beaded type of paint	Beaded type of paint
<b>Opaque White Pigments</b>		
Titanium dioxide . . . . .	_____	_____
Titanium-calcium . . . . .	_____	_____
Lithopone . . . . .	_____	_____
Zinc Oxide . . . . .	_____	_____
No preference . . . . .	_____	_____
<b>Extender Pigments</b>		
Magnesium silicate . . . . .	_____	_____
Diatomaceous earth . . . . .	_____	_____
Pumice . . . . .	_____	_____
Whiting . . . . .	_____	_____
No preference . . . . .	_____	_____
Other _____	_____	_____

What vehicle types have you found most satisfactory for traffic paints? Please indicate by check marks on the following list.

	Non-beaded type of paint	Beaded type of paint
Alkyd . . . . .	_____	_____
Copolymer-Chlorinated Paraffin . . . . .	_____	_____
Phenolic-Dispersion Resin . . . . .	_____	_____
Other Phenolic Resins . . . . .	_____	_____
Ester Gum . . . . .	_____	_____
Natural Gum . . . . .	_____	_____
Styrenated Oils . . . . .	_____	_____
Cumar (for other than white paint) . . . . .	_____	_____
Other _____	_____	_____

Organization \_\_\_\_\_  
Address \_\_\_\_\_  
Name and title of individual \_\_\_\_\_

P. S. Please attach a copy of the latest issue of your specification.

Paint Manufacturer

June 1950

QUESTIONNAIRE

ROAD MARKING TRAFFIC PAINTS

Please check whether your company manufactured road marking traffic paints of the following types during 1949:

White . . . . .	_____
White for use with glass beads. . . . .	_____
Yellow . . . . .	_____
Yellow for use with glass beads . . . . .	_____
Other _____	_____

Which of the following pigments were used in substantial percentages in traffic paints made by your company in 1949?

QUESTIONNAIRE (Continued)

	Non-beaded type of paint	Beaded type of paint
Titanium dioxide . . . . .	_____	_____
Titanium-calcium . . . . .	_____	_____
Lithopone . . . . .	_____	_____
Zinc Oxide . . . . .	_____	_____
Magnesium silicate . . . . .	_____	_____
Diatomaceous earth . . . . .	_____	_____
Pumice . . . . .	_____	_____
Whiting . . . . .	_____	_____
Other _____	_____	_____

Which of the following vehicle types were used in traffic paints made by your company in 1949?

	Non-beaded type of paint	Beaded type of paint
Alkyd . . . . .	_____	_____
Copolymer-Chlorinated Paraffin . . . . .	_____	_____
Phenolic-Dispersion Resin . . . . .	_____	_____
Other Phenolic Resins . . . . .	_____	_____
Ester Gum . . . . .	_____	_____
Natural Gum . . . . .	_____	_____
Styrenated Oils . . . . .	_____	_____
Cumar (for other than white paint) . . . . .	_____	_____
Other _____	_____	_____

To aid us in following trends, indicate on which paint properties you intend to place greater emphasis in the coming year. Please do so by numbering (e. g. 1. 2. 3. etc.) at least three but not more than five from the following list

Bleeding Resistance . . . . .	_____
Storage stability . . . . .	_____
Rate of dry . . . . .	_____
Improved service life . . . . .	_____
Visibility	
Day . . . . .	_____
Night . . . . .	_____
Cost per gallon . . . . .	_____
Others _____	_____

Based upon your direct experience, what is the relative importance to service life of the factors listed below? Please rate their order of importance by numbering (e. g. 1, 2, 3, etc.) at least three but not more than five.

	Importance Rating
Application variables . . . . .	_____
Type of hiding pigment . . . . .	_____
Type of extender pigment . . . . .	_____
Type of vehicle . . . . .	_____
Film thickness . . . . .	_____
Type of pavement surface . . . . .	_____

Is traffic paint a substantial part of your business?                      Yes                      No

Company \_\_\_\_\_

Address \_\_\_\_\_

Name and title of individual \_\_\_\_\_  
Date \_\_\_\_\_