

PAINT PERFORMANCE TESTING

FINAL REPORT

by

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Traffic delineation devices, such as painted traffic stripes aid drivers by improving their ability to perceive roadway conditions. These markers increase public safety and convenience, and thus demand continued improvement in their placement and performance.

1.1 HISTORICAL USE OF PAINTED MARKINGS

According to the National Highway Research Publication, "Pavement Traffic Marking - Materials and Application Affecting Serviceability", the historical use of painted traffic stripes can be summarized as follows:

- The first known application of a painted roadway marker was in 1921 on University Avenue in Madison, Wisconsin.
- By 1923, a motorized paint striper was developed in Wisconsin.
- Early paints were often lacquer-based and frequently dissolved the pavement surface. Problems with bleeding were prevalent. By 1931, the California Dept. of Transportation had developed a better paint with a dry time of less than 30 minutes.
- In 1933, a patent was awarded for the use of glass beads to improve the reflecting properties of painted stripes.

- By 1950, alkyd resin paint was the most prevalent paint type used, followed by phenolic resin varnish and phenolic dispersion resin paints. Some copolymer-chlorinated paraffin paints were also reported.
- Heated paints were well-developed by the mid-50's and were in general use in the early 60's.
- In 1971, the majority of 32 states participating in a survey were using some form of heated traffic paint. A small fraction of states reported using a cold-applied fast-dry paint. By 1970, modified alkyd resins and chlorinated rubber-alkyds were the most frequently used vehicles in traffic paints. This remains true today.
- In the last ten years, several promising new products have been thoroughly tested on public roads. These include epoxy, epoxy-thermoplastic, and polyester marking materials. Tests generally have shown these products to be much more durable than conventional solvent-based paints.
- Water-emulsion (latex) traffic paints are expected to see wide-spread future use due to increasingly strict air quality regulations.

Within the Alaska Department of Transportation and Public Facilities (DOT/PF) there are three major users of pavement marking paints. Of these three, the Maintenance and Operations Division accounts for the bulk of the paint purchased. The Division of Design and Construction is probably the second main user and has control over paint used on new highway construction projects. The third user is the Division of Aviation which has control over paint used on newly-constructed airfields. Presently each division uses mutually exclusive paints.

In 1977, the maintenance and operations division in the central and southeastern regions used an AASHTO M248 paint (alkyd-based). At the same time, maintenance personnel in the interior and southcentral regions used a product developed by the California Department of Transportation. In 1978, at least three different paint types were used. Maintenance personnel in the southeast region continued using the AASHTO M248 paint, while maintenance personnel in the interior and southcentral regions continued using the California formula. Maintenance personnel in the central region used a third paint type, apparently based on an ASTM standard. Since 1979, each region within the state uses the same paint although the formulation may vary from year to year. This policy was brought about by establishing a term contract modeled after a Washington State specification. These paints are chlorinated rubber-based and dry so quickly that traffic passing over a freshly-applied stripe will not track or smear after 25 seconds. This latter characteristic is often referred to as its "no track" time or "no-pick-up" time.

Painted markings on new construction projects must meet the requirements of the Alaska Standard Specifications which references AASHTO M248 Type IIIIF. This specification is similar to that used by some maintenance crews until 1978. Maintenance supervisors have indicated that, historically, the Standard Specifications are revised to reflect satisfactory experience of the maintenance division. Several DOT/PF individuals from different divisions have expressed the opinion that the same paint should be used by all divisions except where advantages of using a different paint type can be demonstrated.

The Alaska Division of Aviation specifies an acrylic product (latex) for newly-constructed airfield pavements. These latex paints are nearly always placed by contractors and not by state crews. Restriping of these pavements is done by state maintenance crews using the chlorinated-rubber maintenance paint. The Federal Aviation Administration encourages use of water-emulsion products on new pavements because they are said to minimize asphalt bleeding, have minimal amounts of photochemically-reactive solvents, and result in a

flexible stripe which reduces edge cracking. However, under heavy roadway traffic, water-emulsion paints are generally less durable than alkyd or chlorinated rubber-based paints (Drisko - 1978).

1.2 PURPOSE OF THE STUDY

The purpose of this study was to develop traffic paint specifications which will allow the State of Alaska to purchase quality paint having lasting durability in cold climates.

1.3 STUDY APPROACH

Prior to the initiation of the project, it was concluded that a road service test should be conducted in order to study paint durability under accelerated roadway wear. From the results of such tests, it was felt that it would be possible to compare the durability of several competing products with the paint presently used by state maintenance personnel. Concurrent with the road service test, contact was to be established with selected highway agencies to obtain background information. These contacts were expected to provide an overall view of paint procurement policies and to suggest areas where improvements can be made.

In the initial phase of this project a literature search was conducted to provide background information on previous studies and practices involving painted markings.

Initial interviews with DOT/PF maintenance and materials personnel were conducted in connection with a study on pre-formed thermoplastic markers. These interviews were supplemented by discussions held with representatives of the Division of Aviation and the Supply & Services branch. These supplemental discussions permitted us to assess the volume of paint used on new airfield construction and to obtain copies of Aviation's paint specifications. Through Supply & Services we obtained copies of previously-used contract documents and discussed paint procurement policies.

Letters were sent to selected manufacturers of traffic paints requesting samples of their products for comparative evaluation. This eventually resulted in 12 different paint products being obtained. To expedite shipments of paint, telephone contact was made with these manufacturers, many of whom offered excellent suggestions for the evaluation process. Comparative road service tests of the paint samples were then performed. Except in Fairbanks where paint was applied by a contractor, paint was applied by maintenance personnel from each district. Stripes at each of the test sections were evaluated and ranked from best to worst after an extended period of wear.

Letters were also sent to selected northern-state highway agencies. Included with this letter was a series of questions. Replies to this questionnaire provided information on recent developments in other states and copies of their paint specifications for review.

2.1 LITERATURE SEARCH, QUESTIONNAIRES, AND INTERVIEWS

Articles pertinent to this study were obtained from a number of sources. For example, through DOT/PF's Research Section we obtained a computer-generated list of abstracts prepared by the Transportation Research Information Service. Our staff librarian generated a computerized listing of recent NTIS articles and conducted a search of Woodward-Clyde's library for pertinent resource information. Based on these efforts, several articles and publications were identified and obtained for review. Information from selected publications provided background for this report.

Questionnaires were sent to 18 highway departments in northern states to obtain copies of their paint specifications and other current information. All of the states receiving the questionnaire responded. Following are the five basic questions asked:

1. What type of traffic paints are used in your state?
2. Has any research concerning traffic paint performance recently been conducted in your state?
3. Are road service tests conducted in your state? If so, how are they conducted?
4. Does your state use a reflectometer?

5. Are any types of paint excluded from use in your state?

Table 1 summarizes the responses concerning paint characteristics and procurement policies. From this table it can be noted that heated traffic paints are used in about half of the responding states. Nearly all of the participating states use a slower drying paint than Alaska, except in heavily-trafficked areas. Responses also indicated that the use of reflectometers appears to be increasing and they seem to be generally gaining acceptance. However, at least one state (California) indicated unsatisfactory performance with the unit they operate.

A 1981 study by the Pennsylvania Department of Transportation developed a relationship between retro-reflectance and durability, and confirmed a relationship between retro-reflectance and night-time visibility (Davidson - 1981). This study also concluded that the use of a reflectometer was far superior to any visual rating technique used in evaluating paint performance. Davidson states that the different geometric configurations used in the construction of commercially-available meters dramatically affect the measured readings. Minimum service levels must be defined for the particular brand of meter used and are not valid for other brands.

2.2 COMPOSITION AND PERFORMANCE OF AVAILABLE PAINTS

Commonly-used pavement marking paints have three components: pigments, solvents (volatile vehicle), and resins (nonvolatile vehicle). Pigments provide opacity and color, and to some extent determine the paint's hardness and weathering characteristics. Solvents are necessary to dissolve the roadway film and regulate drying time. The resin portion, which includes plasticizers and drying oils, generally determines the paint's flexibility and durability.

Several new products have appeared on the market in the last ten years, including some epoxy paints and polyesters which do not fit

into a solvent-based classification system. Reported advantages and disadvantages of these newer products are described in the following paragraphs.

Epoxy thermoplastics are batched and heated to temperatures up to 450°F before spraying. Applications have been successful on roadways in below-freezing temperatures, resulting in a longer striping season. This product has been extensively tested and its average service life has been reported to be the equivalent of five paintings. Stripe protection should not be necessary since a "no track" drying time of five seconds has been observed. Bead retention is reported as excellent. Disadvantages to be expected include difficult and costly equipment conversions and higher initial material and placement costs. Illinois recently spent \$53,000 in converting a conventional striper to apply this product.

Two-part epoxy resins are another type of product which shows promise. Epoxies have been tested under the harsh winter conditions of Minnesota with excellent results (Gillis - 1980). These studies have been conducted since 1969 and have led to epoxy products being adopted for general use. Excellent durability and bead retention have been reported. Wet pavements are not a problem and should result in less time lost due to rainy weather. However, special application equipment is required and coning is necessary because drying time is relatively slow.

Polyester products are the third major type of pavement marker currently being developed. Somewhat caustic, polyesters can pose a hazard to improperly-equipped workers. No-track times of over ten minutes should be expected. These products, however, offer several advantages which may outweigh their disadvantages. Excellent durability and the ability to apply markings in below-freezing temperatures are two major ones.

Many conventional solvent-based paints use a modified drying oil (such as ortho-phalate alkyd resins) for the non-volatile vehicle

portion. For these paints, it is generally accepted (Drisko - 1978) that the slower-drying products will remain more flexible and more durable. Paint technology may be overcoming some of these concerns. Drisko speculates that the use of isophthalate alkyd resins will result in a much more flexible alkyd paint. Some recent performance studies (Davidson - 1981), including this one, did not note a direct correlation between durability and drying time.

Most white traffic marking paints use titanium dioxide (rutile) as their primary pigment; calcium carbonate and silicates are also used. Severe shortages of titanium dioxide were experienced during the late 1970's and greatly inflated the price of these paints for a period of time. Chrome yellow is the most commonly used pigment for yellow traffic-marking paints. The Department of Highways in Maine recently studied several alternative yellow pigments (Leyland - 1979) and concluded that certain other pigments are acceptable substitutes.

Paints are often classified by drying time or "no-track" time as determined by ASTM D711. This term is a measure of the time it takes for the paint to dry sufficiently so as not to track when traffic passes over the freshly-painted stripe. This report uses the following definitions to describe paints by their "no-track" time as published in the Highway Research Board - Synthesis No. 17.

PAINT DRYING TIME

Instant-dry	Less than 30 seconds
Quick-dry	30-120 seconds
Fast-dry	2-7 minutes
Conventional	Over 7 minutes

Drying time greatly controls the application process. Quick-dry and instant-dry paints usually do not require setting cones for stripe protection. Setting cones is costly, since it requires additional men and equipment and restricts the speed at which the striper can move. Drying time also determines how the reflective

glass beads are applied. When a paint rapidly skins over, gravity-fed beads will not adhere and must be applied pneumatically.

The performance of paint is dependent on several factors, including:

- Paint formulation and quality of manufacture in compounding and grinding;
- The type and condition of the substrate, including surface preparation;
- The type of application equipment used and skill of the operator;
- Environmental and climatic conditions, especially temperature and humidity during the application and curing process;
- The age and past handling of the paint;
- Applied paint thickness;
- Environment. (Paint applied in the fall will generally deteriorate more rapidly than paint applied in the spring. Differences in life are related to differences in the environment which includes the use of chemical de-icing agents, studded tires, and chains.)

Roadway marking paints usually deteriorate by chipping. This phenomenon is well documented in the literature (Drisco - 1979). Chipping is defined as the breaking away of small fragments from the substrate and tends to be accelerated by the addition of glass beads. Other frequently-noted failures are erosion and abrasion. These are identified as a general thinning of the material.

2.3 TYPES OF PAINT SPECIFICATIONS

Purchases of traffic paint are based on a composition or a performance specification. Either method has proven satisfactory when properly administered. States participating in our survey were almost evenly split between the two. In the past, however, composition specifications were more frequently used.

Proponents of composition specifications often argue that this method provides the purchaser with a paint of known composition; hence the quality of the paint is nearly always consistent. However, carelessness in manufacturing, especially in the compounding and grinding process, can result in an inferior product which still meets even the most exacting compositional requirements.

Proponents of performance specifications argue that this type of specification encourages manufacturers to introduce new materials and technology, thus rewarding successful research and development. Opponents point out that road service (performance) tests are difficult and time consuming to perform. Moreover, they argue that the paint materials delivered could easily be altered from that originally tested. While these arguments have merit, it is noteworthy that Utah recently discovered that paint purchased and used over several years did not meet their composition specifications. Their experience points out that this deficiency is not limited to performance specifications and highlights the need for chemical and physical testing regardless of what purchasing policy is used. Most paint testing laboratories are equipped with spectroscopic equipment by which components can be identified. ASTM Test Method D2743 was developed with this purpose in mind, and can generally detect adulterations or extraneous materials.

Some other advantages of using a performance specification include:

- Manufacturers are usually better able to forecast fluctuations in the price of raw materials than state agencies. If predicted sufficiently far in advance, the manufacturer can reformulate the paint to minimize costs while maintaining quality;
- At least one comparative study cited by Fullerton concluded that a lower average bid price was obtained by States using performance specifications.

Representative examples of a performance specification and of a composition specification are found in Appendices A and B.

2.4 ENVIRONMENTAL RESTRAINTS

Almost all organic solvents used in paints can be considered photochemically reactive, and their use may be restricted under Section 109 of the Clean Air Act (as amended in 1971 and 1979). Restrictions would apply in "non-attainment" areas where primary air quality standards are not being met. In these areas, the state would be required to develop and implement a plan of corrective action, and paint types could be restricted to water-emulsion (latex) paints, epoxies, or paints using minimal amounts of organic solvents.

According to a local representative of the Environmental Protection Agency, no area within Alaska is presently classified as a non-attainment area. Hence, no legislated restriction on the use of organic solvents exists. Nevertheless, a plan presently being developed could result in some restrictions in the future.

Pollution of land and water resources has not been considered a problem with normal application practices.

2.5 REVIEW OF PROCUREMENT SPECIFICATIONS

2.5.1 Maintenance Specifications

During our review we noted that several test methods cited in Alaska's current maintenance paint specifications are obsolete. Most of the listed requirements for physical properties are based on test methods described in Federal Test Method Standard No. 141A. This Standard was extensively revised in 1979, and is now referred to as Standard No. 141B. Nearly all of the test methods cited in the Alaskan Specification were cancelled and replaced with ASTM test methods.

The following table cross-references the newly-adopted ASTM Standards with the former Federal Test Method.

REPLACED STANDARD TEST METHODS

	<u>FTMS No.</u>	<u>ASTM No.</u>
Viscosity	4281	D562
Weight per Gallon	4184.1	D1475
Contrast Ratio	4121	D2805
Day Light Reflectance	6121	E97
Non Volatile Content	4041.1	D2369
Pigment Content	4021	D2805
Dispersion	4411	D1210

In our review, we also noted that the present specifications rely solely on laboratory tests to determine the quality of paints. It is generally recognized that both laboratory and field tests are necessary to determine quality (see Chaiken - 1969, and discussion in ASTM Test Procedure D2205). As a result, we have developed guide specifications which can prequalify a number of products using both laboratory and field testing procedures. In addition, a procedure is developed in these guide specifications which will allow contractors to apply the same paint used by State maintenance personnel without

continued revision of the Alaska Standard Specifications for New Highway Construction.

The guide specifications presented in Appendix C address only the technical requirements which must be met in advance of an invitation to bid. This should simplify the procurement procedure since only manufacturers of prequalified paints would be invited to submit bids. General conditions to the contract can be prepared using present state guidelines, although we urge that a formula-approach be used to determine the apparent low bid rather than the lowest unit cost as is presently done. Contracts awarded using the lowest unit bid tend to favor the cheapest pre-qualified product. In some instances, a more durable product may exist whose initially higher price is more than recovered from its longer life. Awarding the contract on the basis of cost per foot per day of useful life overcomes this problem and is recommended (a detailed procedure is described in ASTM D713).

Alaska has unique logistical problems and shipping expenses vary widely. The cost used should be based on a weighted average of the paint delivered to the various receiving points. In instances where paints have markedly different application rates, equipment usage, or requirements for stripe protection, these factors must also be considered and contracts should not be awarded solely on the basis of material costs. Where paint characteristics are different, total costs, including equipment and labor costs should be used.

Presently, paint used by the maintenance section is required to be stable for various stated periods of time from the date of shipment. The guide specifications developed as part of this study suggest that storage requirements be modified to begin with the date the shipment is received. Other parts of our suggested stability requirements deserve special attention in the review process; a product warranty of at least 6 months is suggested for paint stored outdoors. Additional input from State Maintenance personnel is needed on this question.

2.5.2 Specifications for New Construction

It is interesting to note that the AASHTO M248 specification used in new highway construction is an alkyd-based paint which would be excluded from use by the maintenance department. More consistency between the paint requirements is desirable. Drying time may not be as critical of a requirement on new construction projects as it is for highway maintenance since traffic can be closed-off or rechanneled. Hence, requirements for drying time could be relaxed for painted stripes applied over newly-constructed pavements. The guide specification presented in Appendix C would allow the contractor to choose a pre-qualified paint meeting his particular job requirements.

The use of a pre-qualification procedure would also allow the paint contractor a choice between a number of products of proven quality, many of which can be expected to be carried in stock by local vendors. This would tend to reduce the need for contractors to carry large paint inventories. Quality assurance on the job site can be maintained by sampling the delivered paint on a spot basis and checking their similarity to the control samples submitted in the prequalifying tests. The net effect of these changes should allow a number of products to be used, depending on their availability and price. Some suggested modifications to the Standard Specifications for Highway Construction are presented in Appendix D.

2.5.3 Bulk Storage

Present state specifications require paint to be supplied in 55-gallon containers. Illinois recently switched to a bulk storage system (Fullerton - 1981) and expects large savings. Bulk storage facilities may result in significant savings as a result of:

- Elimination of the cost of purchasing and disposing of steel drums;
- Minimization of paint discarded in the drums;

- Reduced storage area needs;
- More efficient handling.

Due to the potential for savings, Illinois and Idaho should be contacted for details on their experiences with bulk storage systems. Consideration should be given to providing this storage capability at major maintenance facilities such as in Anchorage and Fairbanks.

2.6 FIELD TESTS

During this study, traffic paint samples were solicited from various manufacturers for the purpose of road service testing. During the autumn of 1982, paint was applied at heavily-trafficked test sites located in Fairbanks, Anchorage, and Juneau. No limitations, except being compatible with application equipment were placed on any of the products. Paints tested included chlorinated rubber, alkyd, and epoxy products. The paint currently used by DOT/PF Maintenance and Operations, was applied as a control.

The road service tests followed the basic procedure outlined in ASTM Method D713 - Conducting Road Service Tests on Traffic Paint. Several suggested details of this standard, however, could not be achieved. Some of these variations include:

- Wet film thicknesses were outside of the suggested ± 0.5 mil tolerance;
- Inspections were limited to one or two observations;
- Glass beads were not applied.
- Application temperatures, while typical of Alaska weather conditions, were below 50° F and rains had occurred a day before the application at two of the test sites.

These variations from the Standard tend to restrict the conclusions regarding the results. Suggestions for improving testing

procedures are discussed as part of the conclusions. Compliance with the ASTM Standard is difficult to achieve in Alaska's climate.

Probably the most significant variation is from an uneven application of paint. One study conducted in Missouri (Girard, et al.) described changes in life-expectancy as a function of film thickness. A 30% increase in life was noted when the wet film thickness of a paint was increased from 10 mils to 20 mils. If consistent results are to be obtained in road service tests, it is necessary to standardize the application rate when attempting to determine the lifespan of paints. ASTM Test Method D713 suggests that the sprayer be adjusted such that the paint be applied at a wet-film thickness of 15 mils (± 0.5 mils). This close tolerance is probably not obtainable with normal production hand stripers. The State of Oregon uses a positive displacement striper which allows them to meet close tolerances.

Sites were selected on straight sections of roadway with free-rolling traffic and negligible grades. Bituminous surfaces were selected, since they make up nearly all of the pavement surfaces in Alaska.

As suggested in the ASTM procedure, 4-inch-wide test stripes were applied transversely. In Juneau, a 6-inch-wide stripe was also applied. Application of the paint was by maintenance personnel using hand stripers. One exception occurred in the Fairbanks district where equipment problems were experienced and replacement hand stripers were unavailable. A local paint contractor applied the painted stripes using equipment nearly identical to that used by DOT/PF.

After two to four months of wear, the lines were re-examined for daytime appearance, durability, and night-time appearance. These characteristics are defined as follows:

Appearance: As defined in ASTM D713, appearance is the complete impression conveyed when the stripes are viewed in the daytime from a minimum distance of 10 ft before any detailed inspection is made. Items such as cracking, discoloration, chipping and loss of brightness are rated.

Durability: The percent of paint remaining within a prescribed area in the wheel paths where the substrate is not exposed.

Nighttime Appearance (night visibility): The apparent brightness when viewed at night using a light-source from the side of the road.

A weighted performance rating, based on a 10-point scale for each property examined, was devised. Such a scale is particularly useful when several observers are evaluating the test stripes. In Anchorage, ratings were based on the following scale:

<u>Marking Evaluation Scale</u>	
10	Perfect condition, no failure
9	
8	Good condition, slight failure
7	
6	
5	Fair condition, intermediate failure
4	
3	
2	Poor condition, bad failure
1	
0	Complete failure

In Juneau and Fairbanks, DOT/PF personnel evaluated stripe appearance. These individuals used different 10-point evaluation scales. For this reason, scores should not be compared between sites.

When making the daytime appearance rating the entire length of the line was considered. Variations in brightness and color between stripes were generally found to be minimal, while variations in the width of the worn wheel track were quite noticeable. Stripes were grouped in categories based primarily on the overall width of wear in the wheel tracks, and then were judged on brightness of the individual lines.

A close-up evaluation of each stripe was made to evaluate whether chipping or erosion was the dominant failure mode. In each case chipping was the major failure mode observed. The durability rating was obtained in Anchorage by taking macrophotographs of a small section of each line about 24 inches from the point of greatest wear in the wheel track. Comparisons were made against photographic standards as indicated in ASTM D821, and an estimate of the percentage of intact paint was made. If erosion had been the dominant mode of failure, the use of photographic standards described in ASTM Method D913 would have been appropriate.

Night visibility was determined in a similar manner to the appearance rating, except that the rating was performed at night using the illumination of headlights from a car parked on the shoulder of the road.

2.7 RESULTS OF THE FIELD TESTS

Results of the field tests were entered into Tables 2, 3 and 4 as raw scores for each stripe observed. Photographs showing the overall appearance of each test section are presented in Appendix E. Photos showing different degrees of paint chipping are also included. The evaluation procedures described above are quite subjective and variations between individuals should be expected.

Brightness and color characteristics were good for all of the samples submitted. Some of the chlorinated rubber products, however, had a yellowish tinge after application. Except where some localized

bleeding occurred, the epoxy product was exceptionally bright and maintained this brightness throughout the study.

2.8 ANALYSIS OF FIELD DATA

2.8.1 Methods of Analysis

Methods used to analyze the results of the road service testing are similar to those described in ASTM D713. At the end of the study, an observer visited each site after several months and rated various characteristics on a 10-point scale. Paint in the wheel paths was generally more than 70 percent worn away or beyond its serviceable life as defined by the standard method. To account for this, macrophotographs were taken in an area slightly outside of the wheel path where wear was less pronounced. The durability rating thus obtained is higher than if taken directly in the wheel path. In order to adjust for this higher rating and to maintain a reasonable weighting between durability, daytime appearance, and night-time appearance, a reduction factor of $\frac{1}{2}$ was applied.

An overall weighted performance rating for each stripe was then calculated using the following formula from ASTM D713:

$$\text{Weighted performance rating} = 0.3(A) + 0.3(D) + 0.4(N)$$

where: (A) daytime appearance score rating
(D) durability rating, reduced as above
(N) night-time appearance rating

Tables 2, 3 and 4 present scores thus obtained for the individual stripes. Some variations from this method were made in Fairbanks and Juneau where DOT/PF personnel evaluated stripe performance. When at the site, lines could easily be grouped into classes where preferences between lines were small. Frequently a re-evaluation would re-order the rank within any one group, but not between groups.

Quality paints were judged by consistently high ratings at each of the sites evaluated. Variations in the applied paint thickness which could dramatically affect the performance at any one site were likely to balance out when all three sites are considered.

2.8.2 Results of the Analysis

Table 5 indicates groups of paints where the observer had difficulty in assigning a preference between the performance of individual lines. The weighted performance rating system, as described in the previous section was useful in ranking the paints from best to worst. The following paints consistently rated among the top five paints at two or more sites.

Maintenance and Operation Control Sample (Chlorinated Rubber Based)

Bradco Epoxy

Norris 1-W Formulation (Chlorinated Rubber Based)

PPG 11-4 Formulation (Alkyd)

The results of our road service tests showed that, as a group, the chlorinated rubber-based paints were rated higher than the alkyd products. One epoxy-based paint was evaluated and was rated nearly as high as the better chlorinated-rubber paints. Some localized bleeding, however, was noted during the application of the Epoxy paint. Paints were applied under adverse weather conditions in Anchorage and Juneau and the effects on the individual paints are not known. At least with the epoxy paint, additional test stripes are to be applied in future tests planned by the maintenance division in Anchorage.

CONCLUSIONS AND RECOMMENDATIONS

3.1 CONCLUSIONS FROM ROAD SERVICE TESTS

1. The chlorinated rubber-based paints and the epoxy-based paints outperformed the alkyd products in durability.
2. The single epoxy-base paint tested did not outperform the best chlorinated rubber products.
3. Brightness and color characteristics were good for all of the samples submitted.
4. The epoxy paint was exceptionally bright and maintained this brightness longer than the other products.
5. The paint presently used by the maintenance division was one of the more durable paints.
6. Comparative road service tests should be a necessary part of Alaska's paint procurement policy. If a composition specification is used, there is a need to periodically check performance against competing formulations. If performance specifications are used, road service tests become a fundamental part of evaluating paint performance.

3.2 CONCLUSIONS FROM REVIEW OF PROCUREMENT SPECIFICATIONS

1. It is generally recognized that laboratory tests alone give only a general indication of the suitability of traffic paint and are not a substitute for road service testing (see discussion in ASTM Method D2205 and Chaiken, 1969).
2. Obsolete test methods are cited in Alaska's current maintenance paint specification and indicate that a thorough review and updating is desirable.
3. No demonstrated advantage exists in using mutually-exclusive paints between the maintenance section and the Design and Construction sections.

3.3 RECOMMENDATIONS

3.3.1 General

1. Road service tests of competing products should be conducted at periodic intervals, possibly on a two or three-year cycle.
2. Both laboratory tests and road service tests should be used to evaluate paint quality. In Appendix C of this report we have presented guide paint specifications.
3. While field measurements of tracking characteristics are superior to laboratory tests of "no-track" time, they are unsuitable where several samples are to be evaluated as part of a road service test. Measured no-pick-up times for any paint will likely be different depending on the test method used and will need to be adjusted in the specifications.

4. Purchases of paint should not be based solely on the lowest unit cost. Awards based on the lowest cost per foot per day of useful life are preferable.
5. In instances where application procedures are noticeably different between competing paint products, the cost of application and equipment rates must also be considered in addition to material costs.
6. The paint specified in the State Standard Specifications for Highway Construction should be compatible with the paint used by the maintenance staff. Presently, the paints are mutually-exclusive.
7. Recommended changes to the Standard Specifications for Highway Construction are presented in Appendix D.
8. Use of bulk storage facilities should be evaluated as a means of reducing paint costs.

3.3.2 Further Research

1. Maintain close contact with other agencies who are performing relevant research.
2. Continue evaluation of new marking materials and heated paint products.
3. Explore alternative means of measuring paint film thickness under field conditions. A Nordson or Interchemical wet film thickness gauge such as described in ASTM D713, Method B, may prove simpler to use in the field. Alternatively, micrometer readings of dry-film thickness of paint applied to metal plates or use of meters such as described in ASTM E376 may be useful to field crews.

3.3.3 Future Road Service Tests

1. Utilize a retro-reflectometer to measure night visibility.
2. Utilize a positive-displacement sprayer similar to that used by Oregon to apply the paint.
3. Conduct the test in one region in order to minimize expenses of travel, mobilization, and equipment.
4. If possible, use three or more test sites within the region on roadways with different traffic volumes.
5. Use macrophotography as a means of evaluating bead retention.
6. Test methods D713 (Conducting Road Service Tests on Traffic Paint) and D2205 (Standard Recommend Practices for Testing Traffic Paints) should be used as the basis for developing future tests.
7. A two-to-three-year cycle for conducting road service testing is likely to prove most economical.

SUMMARY OF RESPONSES TO SURVEY

<u>State</u>	<u>Paint Type Used</u>	<u>Drying Time</u>	<u>Use a Heated Paint?</u>	<u>Type of Specification</u>	<u>Use a Reflectometer?</u>	<u>Remarks</u>
California	Modified Alkyd	4-7 min	Yes	Composition	Yes	● Poor performance reported on reflectometer it uses
Colorado	Modified Alkyd	30 min	No	Composition	Yes	● Frequently conducts road service tests
	Chlorinated Rubber	10 min	No	Composition		
	--	20 sec	Yes	Performance		
Idaho	--	40-90 sec	No	Performance	No	● Do not perform road service tests ● Use bulk storage
Maine	Alkyd	20-60 sec	Yes	Composition	Yes	● Recently researched performance on yellow pigments
Minnesota	Alkyd	3 min	Yes		Yes	● Have conducted extensive field tests
Montana	Alkyd	10-30 min	No	Performance	No	
New York	Alkyd	--	Yes	--	No	● Conducting extensive road tests - will probably change paints
North Dakota	Alkyd	--	No	Composition	No	
	Chlorinated Rubber	4 min				
Ohio	--	30 min	--	Performance	Yes	● Recently researched Polyester Products
	--	90 sec	--	Performance		
Oregon	--	6½ min	Yes	Performance	No	
Pennsylvania	--	90 sec	--	Performance	Yes	● Presently conducting a federally-funded study of comparative performance of reflectometers
	--	60 sec	Yes	Performance	Yes	

TABLE 1 (Continued)

<u>State</u>	<u>Paint Type Used</u>	<u>Drying Time</u>	<u>Use a Heated Paint?</u>	<u>Type of Specification</u>	<u>Use a Reflectometer?</u>	<u>Remarks</u>
South Dakota	Chlorinated Rubber	20 min	No	Composition	No	
	Alkyd	30 min	No	Composition		
Utah	Chlorinated Rubber	60 sec	Yes	Composition	Yes	<ul style="list-style-type: none"> • Uses an airless spray system • Have extensive experience in chemical analysis of paint
	Chlorinated Rubber	4 min	Yes			
Vermont	Alkyd	30 min	Yes	Composition	No	<ul style="list-style-type: none"> • Airless spray • No road service tests reported
		20 sec	Yes	Composition		
Virginia	--	50 sec	Yes	Performance	Yes	
Washington	Chlorinated Rubber	15-35 sec	No	Performance	No	<ul style="list-style-type: none"> • Basis for present Alaska Specification
Wisconsin	--	2-7 min	Yes	Performance	No	
Wyoming	Alkyd	25 min	No	Composition	No	<ul style="list-style-type: none"> • Utilizes a cost adjustment formula for deviation from submitted samples
	Chlorinated Rubber	10 min	No	Composition		

TABLE 2

RESULTS OF ROAD SERVICE TESTS
IN ANCHORAGE
11-9-82

<u>Sample</u>	<u>Wet Film Thickness (mils)</u>	<u>Overall Performance Score</u>
CR 12-4-1	9.7	3.7
CR 7-1-7	---	3.6
CR 4-5-6	12.5	3.5
E 9-8-0	---	3.4
A 2-10-2	14.1	3.3
CR 10-6-8	12.1	3.2
A 6-9-4	2.4	3.1
A 8-2-0	---	3.0
CR 11-7-5	13.7	2.8
A 1-3-3	11.0	2.7

TABLE 3

RESULTS OF ROAD SERVICE TESTS
 IN FAIRBANKS
 11-22-82, DOT/PF Evaluation

<u>Sample</u>	<u>Wet Film Thickness (mils)</u>	<u>Overall Performance Score</u>
CR 12-4-1	11.4	6
CR 7-1-7	13.5	5
E 9-8-0	---	5
A 6-9-4	12.0	5
CR 10-6-8	13.7	5
A 8-2-0	---	4
CR 4-5-6	16.5	4
A 2-10-2	8.7	3
A 1-3-3	10.6	3
CR 11-7-5	9.9	3
A 5-0-0*	---	---
A 3-0-0*	---	---

*Paint found to be in thickened condition and would be rejected under normal procurement policies.

TABLE 4
 RESULTS OF ROAD SERVICE TESTS
 IN JUNEAU
 2-14-83, DOT/PF Evaluation

<u>Sample</u>	<u>Wet Film Thickness (mils)</u>	<u>Overall Performance Score</u>
CR 12-4-1	4.2	5
A 2-10-2	7.0	3
A 6-9-4	9.7	2
A 1-3-3	11.7	2
CR 7-1-7	23.7	1
CR 10-6-8	13.4	1
A 11-7-5	8.8	1
A 4-5-6	21.2	1

TABLE 5
 PERFORMANCE GROUPS OF PAINT STRIPES
 ROAD SERVICE TEST SITES

<u>Site</u>	<u>Qualitative Ranking</u>	<u>Sample Code No.</u>	
Anchorage	Superior	CR 12-4-1	
		CR 7-1-7	
		CR 4-5-6	
		E 9-8-0	
	Excellent	A 2-10-2	
		Good	CR 10-6-8
			A 6-9-4
	Fair	A 8-2-0	
		CR 11-7-5	
		A 1-3-3	
	Fairbanks	Superior	CR 12-4-1
			Excellent
E 9-8-0			
A 6-9-4			
CR 10-6-8			
Good		A 8-2-0	
		CR 4-5-6	
Fair		A 2-10-2	
		A 1-3-3	
		CR 11-7-5	
Juneau		Superior	CR 12-4-1
			Excellent
	A 2-10-2		
	A 1-3-3		
	Good	CR 7-1-7	
		CR 10-6-8	
CR 4-5-6			
		CR 11-7-5	

Legend:

<u>Prefix</u>	<u>Paint Type</u>
CR	chlorinated rubber
A	alkyd
E	epoxy

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APPENDIX A

Representative Performance Specification (State of Wisconsin)

- Notice to Prospective Suppliers
- Specification for Performance Test
of Pavement Marking Paint
- Certificate of Performance
- Certificate of Compliance

NOTICE TO PROSPECTIVE SUPPLIERS:

The Department of Transportation, Division of Highways will conduct laboratory and road stripe tests of highway marking paints.

Paint manufacturers are invited to provide men and equipment to place their submitted paint samples. This should help to get the best possible test line to represent the sample. As in the past the Division of Highways will have men and equipment for placing paint test lines, for those manufacturers who do not wish to place their own or are unable to place the lines on the designated date.

To insure uniformity the Division of Highways will provide the glass spheres and will inspect all lines placed.

We anticipate the placement of the test lines to take two days, weather permitting. The line placement is scheduled for May 10 or May 11, 1983.

Traffic Control will be provided by the Department of Transportation.

The purpose of this test is to establish a list of qualified supplies whose product acceptably passes the test. Only such qualified bidders will be invited to submit bid requirements for fiscal years 1984, 1985 and possibly 1986.

The annual requirements are estimated at 90,000 gallons of white and 170,000 gallons of yellow. Only paints which can be applied at the medium heat range, 120° to 140° F, will be tested at this time. Only paints which will be available for purchase will be accepted for testing.

A copy of the specifications is attached. We suggest that you read these specifications carefully, with particular attention to these requirements:

- A. The sample required.
- B. The three (3) forms listed below which must be filled out and submitted.
 1. Certificate of Compliance, Form ET-204-7-71
 2. Statement of Characteristics, Form ET-203-71
 3. Certificate of Analysis
- C. Important Specifications:
 - (a) Viscosity of the hot paint @ 77° F shall not exceed 120 K.U.

Viscosity of the hot paint @ 130° F shall not be less than 70 nor more than 80 K.U.
 - (b) The color of the hot yellow paint shall conform to Federal Standard 595a-33538 central to light limit (V+) or central to strong limit (C+) as shown by Highway Yellow Color Tolerance Chart P.R. Color #1, June 1965 - USBPR. A color near the light limit or near the strong limit is preferred.

NOTICE TO PROSPECTIVE SUPPLIERS
Page 2

CIE data limits

	<u>Y</u>	<u>x</u>	<u>Y</u>
Maximum	.5910	.5133	.4631
Minimum	.5068	.4940	.4530

It is contemplated that only manufacturers will submit samples; however, a manufacturer may designate a sales division, subsidiary or distributor to submit samples for it. If samples of the same manufacturer's materials, even though having different brand names or made in a different plant of the manufacturer or in the plant of a subsidiary, are submitted by both the manufacturer and a sales division, subsidiary, or distributor, only the samples submitted by the manufacturer will be tested.

Sales division, subsidiaries, and distributors receiving invitations to submit samples should acquaint their manufacturers with the provisions of the preceding paragraph since not all manufacturers receive copies of the invitations.

Note that the samples are to be properly marked and identified and are to be sent to:

Wisconsin Department of Transportation
Materials Laboratory
3502 Kinsman Blvd.
Madison, Wisconsin 53704

The forms are to be similarly addressed.

Additional copies of "Statement of Characteristics" are furnished for use, in event that more than one set of samples is submitted for test. Forms may be reproduced if necessary.

If you desire to submit samples for test, it is necessary that the samples and the forms be received at the laboratory not later than February 1, 1983.

The tests conducted in the laboratory will be made first. It is anticipated that the road test stripes will be applied May 10-11, 1983.

If you wish to place your lines with your men and equipment or have a representative present when road stripes are applied, please advise Division of Highways, K. J. Engeldinger, at the above address, Telephone: 608-266-2871.

Since a maximum of only three (3) samples of each color may be submitted by any one company, you are cautioned that samples failing to meet the requirements of Part B or C of the specifications will not be included in the road test. Paints should be carefully tested to insure compliance with the specifications.

NOTE: Please insert the Inquiry Number on all sheets transmitted to the Division of Highways Laboratory

NOTICE TO PROSPECTIVE SUPPLIERS

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For further information concerning this Inquiry, please contact:

Stanley Leer
Purchasing Agent
DOT Purchasing
Telephone: 608-266-0893

DB:11118923

Enclosures:

Wis. DOT Spec. TDS-3R Dated November 1982
Certificate of Performance
Certificate of Compliance
Pavement Marking Paint Characteristics

WISCONSIN DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS AND TRANSPORTATION FACILITIES
SPECIFICATION FOR
PERFORMANCE TEST OF PAVEMENT MARKING PAINT

TDS-3R
November 1982

A. GENERAL

1. INTENT OF SPECIFICATION. It is the intent of this specification to describe the general and specific requirements for paints to be used by the Division of Highways in its pavement marking program, as well as to provide for the submission of samples and to describe the laboratory and service test procedure which will be used to rate the paints submitted for test. It is intended that samples will be received under this specification and the State Purchasing inquiry to which it is attached from any individual, company, or corporation desirous of furnishing traffic paints to the Division (subject to paragraph C2(c), that such samples will be subjected to appropriate laboratory and field service tests, and that State Purchasing will request competitive bids for the Division's requirements on such paints as prove satisfactory. It is expected that the field service test will require six months or more for completion.

This specification will be used for the testing and purchasing of reflecting white and reflecting yellow paints for application at 120° to 140° F, hereinafter called "hot paints".

2. TYPE OF PAINTS. This specification covers a ready-mixed paint product of spraying consistency which will be suitable for use as a reflecting traffic guide on concrete and bituminous pavement. The paint shall be a type in which glass spheres are dropped by suitable means into the wet paint as it is applied by the pavement marker (hereinafter designated as the drop-in type).
3. GLASS SPHERES. Glass spheres, for drop-in paints are not included in this specification and will be purchased directly from sphere manufacturers under separate purchase orders. Glass spheres will be provided to those who place their own test lines.
4. METHODS OF TESTING. The methods of sampling and testing all materials and products covered by these specifications shall be in accordance with the latest standards of the American Society for Testing Materials, or, in case there are no ASTM Standards which apply, applicable standards of the American Association of State Highway and Transportation Officials, or of the Federal Government or of other recognized standardizing agencies will be used.

B. PROPERTIES OF HOT PAINTS

1. CONDITION AND STABILITY. The paint shall be formulated and manufactured from first grade raw materials, shall be homogeneous, shall be well ground to a uniform and smooth consistency, and

shall not cake, liver, thicken, curdle, or gel in the container. The paint shall be capable of being broken up and mixed without difficulty by use of a paddle and shall show the desired characteristics at any time within a period of six months from date of delivery. The paint shall provide the proper anchorage for refraction and reflection by the glass spheres when applied as specified.

2. FOREIGN MATTER. The paint shall be free from skins, dirt, and other foreign matter and shall contain not more than 1 percent water. (Methods 4081, 4091, and 4092. Federal Test Method Standard No. 141a.)
3. SETTLING. The paint in full pint triple-sealed friction top unlined cans shall show no dense or hard settling when stored free of vibration at 120 degrees F air temperature for 5 days. At the end of that period the paint shall be cooled at room temperature for four hours before making examination. The degree of settling shall have a rating of 6 or better when evaluated in accordance with ASTM D-869.
4. SKINNING. The paint shall show no skinning either on the underside of cover or on the surface of the liquid after 48 hours when tested in accordance with ASTM D-154.
5. FINENESS. Coarse particles and skins in the finished paint, retained on a 325 sieve, shall not exceed 1.0% by weight of pigment.
6. SUITABILITY TO APPLICATION. The paint shall be suited to application at 120 degrees - 140 degrees F by means of the Division of Highway's spray-type pavement marking equipment using Binks #21 paint guns at pressures less than 100 psi, and when used with such equipment shall be capable of producing a solid, full width line of the required thickness.
7. DRYING TIME. (a) When the paint is tested in accordance with ASTM Designation D-711 at a temperature of 130 degrees F, it shall dry to no pickup in 2 to 7 minutes at a thickness of 15 mils \pm 10%.

(b) Each line in the road service test (see section C.5.) will be tested for drying time at the time of its application.

(c) When the paint is applied in the field with the Division's regular marking equipment at normal rate at air temperatures between 60 degrees F and 90 degrees F, relative humidity of not over 75 percent, and paint temperature between 120 degrees F and 140 degrees F, it shall dry to no pickup under automobile traffic in not more than 3 minutes and shall dry hard to an elastic, opaque, adherent, durable and non-glossy finish after 15 minutes from application. The Division shall not be obligated to consider for purchase any material which has a dry-to-no-pickup time of more than 3 minutes in this test.
8. VISCOSITY. (a) The consistency of the paint shall not be less than 70 nor more than 80 Krebs Units at 130 degrees F, when tested in accordance with ASTM D-562. The paint shall be suitable for application without thinning.

(b) The consistency of the paint as received, shall not exceed 120 as determined on the Stormer Viscosimeter and expressed as Krebs Units at 77° F, for any type of paint. (ASTM Designation D-562).

(c) Any paint which changes consistency within 6 months after receipt by more than plus or minus 5 Krebs Units when tested at 130° F shall be considered to have failed this requirement.

9. COLOR. The paint shall conform to U.S. Bureau of Public Roads Federal Standard 595a-33538, Standard Yellow (central to light limit (V+) or central to strong limit (C+) but a color near the light limit or near the strong limit is preferred), or Federal Standard 595a-37875, Standard White, as required by the order. The color determination shall be made on the binder without beads after the paint has dried for 24 hours. The paint shall not contain any organic coloring matter and shall not discolor in sunlight.
10. BLEEDING. The paint shall not show bleeding sufficient to impair the color and visibility of the paint when applied to a suitably prepared and cured bituminous surface (Federal Specification TT-P-115c).
11. WET HIDING POWER. The paint shall have sufficient hiding power to adequately cover concrete or bituminous pavement when applied at a thickness of .015 inch.
12. DAY AND NIGHT APPEARANCE. The paint shall have a satisfactory appearance in the daytime and also in the nighttime when viewed from a vehicle with lighted headlights.
13. PAINTS LACKING DESIRED PROPERTIES. Any paint sample which fails to have the required properties listed in paragraphs 1 through 11 above shall be considered as unsuitable for further test, and the Division shall not be obligated to include it in the road service test, nor to consider it for purchase.

C. ROAD SERVICE TEST

1. INTENT OF SPECIFICATION. It is the intent of this portion of these specifications to describe a procedure to be followed by manufacturers and others in submitting samples for this test, and the procedure which will be followed by the Division in testing the paints submitted to determine the most economical paint for the State to purchase. Only paints submitted for performance test under these specifications and thereby found to be acceptable will be considered when bids are taken. It is therefore the responsibility of the manufacturer to submit for test samples of all colors of paints on which he later may wish to submit bids.
2. SAMPLES REQUIRED. (a) An invitation to submit samples will be issued several months in advance of the invitation to submit bids in order to permit evaluation of the service test results. All samples shall be properly identified with the manufacturer's code number (which shall be different for each type and color submitted), manufacturer's name,

address and brand to permit easy reference and identification of samples. If a manufacturer submits a sample which is identical to a sample submitted in a previous test, it shall have the same code number as in the previous test.

(b) Each sample shall consist of the following amounts of each paint which the manufacturer proposes to furnish:

Four (4) One-Gallon Cans of the Finished Product.

One of the four one-gallon cans will be selected at random for conducting the laboratory tests described in Part B of this specification.

(c) Upon receiving an invitation to submit samples a manufacturer may submit not more than three samples of each color of hot paint. Samples of each color of paint which the manufacturer desires to have tested shall be submitted since each color and sample will be tested separately even though of the same brand.

It is contemplated that only manufacturers will submit samples; however, a manufacturer may designate a sales division, subsidiary or distributor to submit samples for it. If samples of the same manufacturer's materials, even though having different brand names or made in a different plant of the manufacturer or in the plant of a subsidiary, are submitted by both the manufacturer and a sales division, subsidiary, or distributor, only the samples submitted by the manufacturer will be tested.

Sales divisions, subsidiaries, and distributors receiving invitations to submit samples should acquaint their manufacturers with the provisions of the preceding paragraph since not all manufacturers receive copies of the invitations.

3. CERTIFICATIONS REQUIRED. (a) Certificate of Compliance. The manufacturer shall submit for each sample a Certificate of Compliance on the form provided certifying that the sample meets all of the requirements in this specification.
- (b) Certificate of Analysis. The manufacturer shall submit a certificate showing the complete analysis of the paint sample. This certificate shall be for the confidential use of the department and the information therein will not be revealed to anyone by the department but will serve and assist in identifying paint furnished by the manufacturer.
- (c) Statement of Characteristics. The manufacturer shall submit with each sample a Statement of Characteristics on the form provided, giving weight per gallon, drying time, viscosity, percent pigment, percent non-volatile in vehicle, pigment volume concentration, the pounds of chrome yellow or titanium dioxide (or substitute) per gallon of yellow or white paint, respectively, pounds of glass spheres to be applied with each gallon of paint, type of solvent to be used for thinning, and requested rate of application of the paint. Said

statement shall be for the confidential use of the department, and the information therein will not be revealed by the department, but will serve and assist in identifying and testing paint furnished.

4. SUBMISSION OF SAMPLES AND CERTIFICATIONS. (a) Samples, certificate of compliance, certificate of analysis, and statements of characteristics shall be sent prepaid to the Division of Highways Laboratory, 3502 Kinsman Blvd., Madison, Wisconsin 53704. Unless the samples and corresponding certificates and statements of characteristics are received of such samples, the Division of Highways shall not be obligated to include the samples in the test nor consider them for purchase.

DO NOT SEND SAMPLES OR CERTIFICATES TO STATE PURCHASING

5. APPLICATION OF ROAD SERVICE TEST LINES. (a) Selection of test area, method and conditions of application and control of application rate will be in general agreement with ASTM Designation D-713.
- (b) The equipment used by WisDOT to apply the test samples will be a hand-guided pavement marker with standard type spray nozzle normally used for the application of such paint.
- (c) The test stripes will normally be applied transversely across the highway at an angle of approximately 90 degrees.
- (d) Test lines shall have a nominal width of four inches.
- (e) At least two lines of each test sample will be applied on a concrete surface and two on an asphalt surface. Samples will be located in various portions of the test section in order to reduce to a minimum any errors due to nonuniformity of traffic pattern or application.
- (f) The paint will be applied at a standard wet film thickness of 0.015 inch plus or minus 10 percent. If a manufacturer desires his paint applied at a wet film thickness which differs from the standard by more than 25 percent, a second series of lines may be applied at the option of the Division at the thickness recommended plus or minus 10 percent and the final evaluation of the paint will be based on the lines applied at the standard rate, with due consideration being given to the characteristics of the second series of lines.
- (g) Beads will be applied to drop-in paints at a standard rate of six pounds per gallon of paint plus or minus 10 percent. If a manufacturer desires his paint tested with beads applied at a rate which differs from the standard by 25 percent or more, a second series of lines may be applied with beads applied at the option of the Division at the recommended rate plus or minus 10 percent (these will be the same lines as those applied at the recommended wet-film thickness, if any) and the final evaluation of the paint will be based on the lines with beads applied at the standard rate with due consideration being given to the characteristics of the second series of lines. Beads used on the lines will be those purchased by the

Division of Highways for its regular use during the marking season.

(h) Quantitative measurements will be made of the rate of application of all test lines and the equipment will be adjusted to bring the rate of application within plus or minus 10 percent of that desired.

(i) All paints will be applied on the same day if that is at all feasible. The pavement shall be dry, normally free from dust or other unsuitable condition. The condition of the pavement and the atmosphere shall be reasonably uniform throughout the period of application of all samples.

(j) Records will be kept of the road conditions, humidity and temperature, rate of application, drying time, bleeding, and other factors which are significant in determining appearance and durability of the materials.

(k) Test lines of materials purchased for use in previous years will be included in the test to provide a comparison of the quality of the new samples with past materials.

(1) Manufacturer's representatives may witness the test application. The absence of manufacturers' representatives shall not be grounds for invalidating the test.

(2) Manufacturers may place their own submitted samples on the designated day using their men and equipment.

NOTE: If test line application must be postponed because weather conditions do not meet section C5(i) above, it may not be possible to notify manufacturers' representatives of such postponements.

6. EVALUATION OF ROAD SERVICE TEST LINE

(a) Periodic inspections will be made of the test section in accordance with ASTM D-713, D-821, D-913, and D-1011. Records will be made at each inspection of general daytime appearance, color, film condition, and night visibility.

(b) The test lines will be rated by two or more observers on each inspection.

(c) The items of general daytime appearance, color, film condition, and night visibility will all be considered in evaluating the lines.

(1) "General daytime appearance" is the complete impression conveyed when the painted surface is viewed at a distance of not less than ten (10) feet before any detailed inspection has been made and is measured purely in terms of satisfactory or unsatisfactory appeal to the observer.

- (2) "Color is the designation of comparison of the color of the test line under consideration with that of the original color specified. This comparison includes change due to yellowing, darkening, mottling, dirt collection, mold growth, etc. If the change is specifically due to one or more of these factors, the cause or causes shall be recorded. The determination will be made without any preliminary washing, polishing, or other modification of the test line.
 - (3) "Film condition" will be rated on the basis of the proportion of material remaining on the pavement when examined by close observation by the unaided eye.
 - (4) "Night visibility" will be determined using the Hunter Night Visibility Meter.
- (d) Area for Evaluation. Areas for comparative evaluation will be selected in the area of the wheel tracks where the paints are subjected to substantially the same amount of traffic wear.

7. FINAL EVALUATION OF ROAD SERVICE TEST

- (a) The rating (on a scale of zero to ten) of each sample at each inspection shall be the numerical average of the combined ratings of each test line by all observers for the items of film condition and night visibility, with general daytime appearance and color being given due consideration. Separate ratings will be given to the lines on concrete and asphalt surfaces.
- (b) The length of useful life is the length of time in days during which the general daytime appearance rating, the night visibility rating and the film condition rating are 3 or above. When a sample reaches a general daytime appearance rating, night visibility rating or film condition rating of less than 3 between inspections, the time at which the end of the useful life occurs shall be determined by interpolation. Hunter Night Visibility Meter readings will be converted to a zero to ten scale.
- (c) The test will be continued for a period of at least 160 days, and for such additional time as is necessary to make possible a reasonable determination of the life of the most durable material(s) to the point at which any factor (general daytime appearance, film condition, night visibility) reaches the limiting minimum value. If the additional test time required becomes excessive, and it becomes necessary to evaluate the samples before all test lines have reached the end of their useful life, the estimated length of useful life will be calculated from the following formula when the rating of every test line is 7 or less:

$$L = \frac{7D}{10-R} - N$$

Where: L = Length of useful life in days

D = Days of test to evaluation

N = Number of days at beginning of test during which general daytime appearance, night visibility, or film condition was rated at less than 3.

R = Rating of the line at the time of evaluation: General daytime appearance rating, film condition rating, or night visibility rating, whichever is lowest.

(d) Upon completion of the road service test and the determination of the successful bidder, the Division of Highways will furnish each manufacturer with the ratings of his own materials.

8. COST ANALYSIS. (a) In order to evaluate the samples in terms of cost per unit length of line per unit time of a useful life, the following formula shall be used. $C = \frac{P + A + (R \times B)}{L \times F}$

Where: C = cost per foot per day of useful life (service cost).

P = price per gallon of paint.

A = application cost per gallon of paint.*

L = length of useful life as determined by the field test, or if necessary, as calculated as described in paragraph 7(c) above.

F = feet of line covered in the test per gallon of paint.

R = rate of bead application in pounds per gallon.

B = cost per pound of beads.

* The value of "A" will be based upon the Division of Highways' experience during previous marking seasons.

NOTE: Additional credit and consideration may be given to paints evidencing high and uniform reflectance.

(b) The service cost will be calculated separately for the test lines placed on asphalt and concrete. These service costs will be averaged to provide an over-all service cost for each material. In this average, the service cost of the line placed on asphalt pavement will be given a weight of 60 percent and that on concrete a weight of 40 percent.

If the manufacturer submits different bids for different size containers, the total cost of the material will be divided by the total number of gallons of paint the state proposes to purchase to provide a weighted average bid for use in the above formula.

(c) The award of contract will be on the basis of the lowest cost per unit of length per unit of time under the foregoing formulae, except in the event that the state finds that other factors are deemed to establish that some other bid or bids are in the public interest and would provide better value to the state, in which case the state reserves the right to award the contract for all or a part of the quantity on the basis of such other bid or bids.

D. GENERAL INFORMATION ON PURCHASES OF PAINTS

1. **INSPECTION AND TEST.** The Division of Highways reserves the right to inspect and accept the paint and spheres either at destination or at the point of manufacture. In either case the manufacturer shall furnish whatever samples and formulae are required to ascertain that the finished paint complied with specifications. If factory inspection is required, the inspector shall be afforded all necessary facilities to make the inspection including one pint containers for shipment of samples to the Division of Highways' laboratory in Madison. At the time when contracts are awarded, it will be decided, unless otherwise indicated when invitations to bid are extended, whether the materials are to be inspected at the factory or at destination, or both. Any paint not meeting the specifications shall be promptly replaced with satisfactory paint, and all handling and transportation charges for such replacement shall be paid by the vendor.
2. **CERTIFICATE OF PERFORMANCE.** Each manufacturer shall submit with his bid a Certificate of Performance on the form provided, certifying that if awarded the contract he will furnish paint of the same composition and characteristics as that submitted for service test.

As determined by tests conducted by the Division of Highways' laboratory, characteristics of the paint furnished on the contract shall not deviate by more than the following amounts from the characteristics of the sample submitted for the service test, but in all cases, paint furnished on the contract shall comply with the detailed requirements of Part B as appropriate of these specifications:

Viscosity at 130°F	± 3 Krebs Units
Weight per Gallon	± 0.2 pounds
Percent Pigment	± 2 Percentage Points
Drying Time	Not less than 50% nor more than 120% of drying time of the service test sample.
Percent Nonvolatile in Vehicle	± 3 Percentage Points

3. CONTAINERS. Traffic paint shall be shipped in containers of the size indicated in the order meeting Interstate Commerce Commission specification for shipment by common carrier and the containers shall be labeled as required by the ICC. Containers shall be nonreturnable. All containers shall be of the open head type so that the entire top of the pail or drum may be removed. Any drum which is leaking at the time of arrival will not be accepted or paid for. The label of each container shall be the same color as the color of the paint (white for white paint, yellow for yellow paint, etc.) and shall bear the following statement in legible letters:

The State of Wisconsin, Division of Highways

White (of Yellow) Traffic Paint

State Purchase Order No. _____; Date of Manufacture _____

Manufacturer's Batch No. _____; Code Number _____

Manufacturer's recommended paint application temperature:

Optimum _____°F., Min. _____°F., Max. _____°F.

Type of thinner which may be used _____

4. PATENTED MATERIALS. The successful bidder will be required to assume all costs arising from the use of patented materials, equipment, devices, or processes used on or incorporated in the work, and shall agree to indemnify and save harmless the state and its employees from all suit or actions of any nature for or on account of the use of any patented materials, equipment, devices, or processes in connection with the reflective pavement marking materials furnished under these specifications.
5. TRUCK SHIPMENTS. Truck shipments will only be accepted at the Division of Highways' garages between 7:45 A.M. and 2:30 P.M. Monday through Friday. Some districts are on a four day week and are closed Fridays. Shipments arriving too late in the afternoon to be unloaded by 4:30 P.M. will be held for unloading the following work day. The vendor shall notify the destination garage at least 24 hours prior to arrival of each truck shipment, giving the quantity of paint and date of arrival, so that arrangements may be made to have personnel available for unloading.

PAVEMENT MARKING PAINT CHARACTERISTICS

TO: State of Wisconsin
 Department of Transportation
 Division of Highways & Trans. Facilities
 3502 Kinsman Blvd.
 Madison, Wisconsin 53704

Inquiry Number: _____

Name and Address of Company _____

SAMPLE SUBMITTED

Manufacturer (if other than above)	Brand Name	Code	Color	Type
				Drop-in
To be completed by company submitting sample:		Specifications	To be completed	Line
Weight per Gallon, Lbs.		TDS-3R Nov. 82	by State	No.
Drying Time, Minutes (15 mil)				
To Touch				
Hard				
To No Pickup				
D-711		2-7 Maximum		
Service Test, Concrete Surface				
Service Test, Asphalt Surface				
Viscosity, Krebs Units				
Original		@ 77°F : ≤ 120		
After 6 months shelf aging		@130°F : 70 - 80		
		@130°F : ±5 within 70-80		
		@ 77°F : ≤ 120		
Pigment, Percent				
Content				
Volume Concentration				
Vehicle				
Total Portion				
Nonvolatile, Percent				
Recommended Application Rate				
Paint of 4-inch line, Gal./Mi.				
Beads to be dropped, Lbs./Gal.				
Color				
Yellow, Lbs./Gal.				
CH Chrome Yellow or Substitute		F.S. 595a-33538		
Chrome Yellow Substitute Name		Central to Light		
		Limit (V+)		
		Central to Strong		
		Limit (C+)		
White, Lbs./Gal. (Type		F.S. 595a-37875		
TiO ₂ or Substitute		Standard		
TiO ₂ Substitute Name		White		
Recommended Solvent				
Cleaning Marker				
Thinning				
Condition in Container				
Skinning (ASTM D 154)		None		
Settling (ASTM D-869)		6 Minimum		
Bleeding (TT-P-115c)		None		
Date	Signature and Title of Authorized Representative of Company			

RECOMMENDATION OF MATERIALS LABORATORY

Recommended by _____ Date _____

_____ Sample _____ Sample
 _____ Satisfactory _____ Unsatisfactory

REFLECTORIZED PAVEMENT MARKING PAINT
Certificate of Compliance

State of Wisconsin / Department of Transp-

T1) Wisconsin Department of Transportation
DIVISION OF HIGHWAYS & TRANSPORTATION FACILITIES

Materials Laboratory
 3502 Kinsman Blvd.,
 Madison, Wisconsin 53704

State Purchasing Inquiry Number:

Name and Address of Company

[Empty box for Name and Address of Company]

SAMPLES SUBMITTED

Manufacturer	Brand Name	Code	Color	Type

As an authorized agent of the above-mentioned company I hereby certify that the above-named samples of reflectorized pavement marking paint have been tested and found to comply with the requirements as to physical and chemical characteristics as specified by the State of Wisconsin, Department of Transportation, Division of Highways.

Check applicable item:

This company is not a sales division, distributor, or subsidiary of any other paint manufacturer.

This company is a sales division, distributor, or subsidiary of

Name and Address of Company

[Empty box for Name and Address of Company]

and has been authorized by it to participate in this test.

Date	Signature of Authorized Representative	Title

APPENDIX B

Representative Composition Specification
(State of South Dakota)

COLD-APPLIED PAVEMENT MARKING PAINT

(CHLORINATED) RUBBER TYPE)

SPECIFICATIONS

I. SCOPE

This specification covers white and yellow pavement marking paint intended for application on portland cement and bituminous surfaced roadways using conventional pavement marking equipment capable of atomizing and applying the material at ambient temperatures. The paint shall provide anchorage and refraction for glass beads applied to the wet film immediately following the atomizing equipment. The specification governs the types and qualities of ingredient materials, their respective proportions in the finished paint, the general methods of manufacture, the required characteristics of the finished paint, inspection procedures, and packaging requirements.

Any material delivered that fails to meet these specifications shall be disposed of by the vendor and immediately replaced with acceptable material entirely at his expense, including handling and transportation charges.

II. MANUFACTURE AND QUALITY REQUIREMENTS

The finished paint shall be formulated and manufactured from first-grade materials. It shall be free from defects and imperfections that might adversely affect the serviceability of the finished product. It shall be completely free from dirt and other foreign material. Antisettling and antiskinning agents and stabilizers shall be added, so that when stored in unopened shipping containers, the finished paint shall not thicken appreciably, skin over, liver, settle out appreciably, or cake badly. It shall be capable of outdoor storage in the shipping container for a period of at least one year, and any settled portion shall be easily brought back into suspension by hand mixing. When the settled portion is brought back into suspension in the vehicle, the paint shall be homogeneous and shall not show a viscosity change of more than 5 K.U. from the original viscosity. Any paint that has settled within the period of one year after delivery to the degree that the settled portion cannot be easily brought into suspension by hand mixing shall be disposed of by the vendor and immediately replaced with acceptable material entirely at his expense, including handling and transportation charges. The paint, when applied by spraying methods to a bituminous pavement, shall not be discolored due to the solvent action of the paint on the bituminous surface.

III. INGREDIENT MATERIALS

A. Titanium Dioxide.

This material shall comply with the latest revisions of the Specifications for Titanium Dioxide Pigments, ASTM D 476, Titanium Dioxide Pigment, Type II, Rutile.

B. Medium Chrome Yellow.

This material shall comply with the latest revisions of the Specifications for Chrome Yellow Pigments, ASTM D 211, Medium Chrome Yellow, Type III, with minimum lead chromate of 90%.

C. Calcium Carbonate.

This material shall comply with the requirements of the Specifications for Calcium Carbonate Pigments, ASTM D 1199, Type GC, Grade I, with minimum of 95% Calcium Carbonate or Type PC, minimum 98% Calcium Carbonate.

D. Magnesium Silicate.

This material shall comply with the latest revisions of the Specifications for Magnesium Silicate Pigments, ASTM D 605.

E. Chlorinated Rubber.

This material shall be chlorinated natural rubber, prepared with suitable stabilizers, than when used, will produce a stable paint formulation. The chlorinated rubber shall have the following properties:

Color (Gardner, 20% by weight in toluene) 4 Maximum
Viscosity (20% by weight in toluene) 9 - 25 centipoises
Chlorine (by weight of rubber solids) 65% to 69%

F. Resin.

The alkyd resin shall be a medium pentaerythritol phthalic drying oil type containing a minimum of 29% phthalic anhydride and a minimum of 54% oil acids based on the alkyd solids. The oil fatty acids shall be of vegetable origin, either alkali refined soyabean oil or the fatty acids of soyabean oil having an iodine number between 115 and 130. No recovered oil, marine or soyabean food fatty acid derivatives shall be used. The alkyd resin shall have a maximum color of 6 (Gardner). The resin shall be reduced in toluene to a non-volatile content of not less than 60%. No rosin will be permitted when tested by the Liebermann Storch Test, and there shall be no dihydric alcohols present.

G. Chlorinated Paraffin.

This material shall comply with the latest revision of Military Specifications and Standards MIL Std. C-429C, Type I.

H. Toluene.

This material shall comply with the latest revision of the Standard Specifications for Industrial Grade Toluene, ASTM D 362.

I. Naphtha, Aliphatic (Lactol Spirits).

The naphtha shall be aliphatic and shall meet the requirements of both Type I and Type II of the Federal Specification T-T-N-95a, "Naphtha, Aliphatic".

J. Organo Montmorillonite (Bentone 38).

This pigment shall be finely divided hydrous aluminum silicate powder suitable for use in paint.

K. Driers.

The lead and cobalt driers shall comply with the latest revisions of the Specifications for Liquid Paint Driers, ASTM D 600, Class B, C, and D.

L. Antiskinning Agent.

This material shall be an antiskinning agent suitable for use in paints.

M. Methyl Alcohol.

This material shall comply with the latest revisions of the Specifications for Methyl Alcohol, ASTM D 1152.

N. Stabilizers.

(1) Propylene Oxide.

This material shall be of commercial grade, suitable for use in paints as a stabilizer.

(2) Diglycidyl Ether of Bisphenol-A.

This material shall be a commercial grade containing no modifiers or diluents.

Epoxide equivalent weight - 180-220
Viscosity at 25 deg. C. - 100-160 poises
Hydrolyzable Chlorine - 0.2% maximum
Weight, pounds per gallon - 9.55-9.75

(3) Or other acid acceptor type stabilizer that, when used will produce a stable pavement marking paint. (To be approved by the Engineer.)

O. Soya Lecithin.

This material shall be of suitable quality for use in the manufacture of paint.

IV. MANUFACTURE

All ingredient materials shall be delivered in the original containers and shall be used without adulteration.

Soyabean lecithin in an amount of 1%, based on the weight of the pigment, shall be added during the mixing of the pigment and vehicle. One and one-fourth (1-1/4) pounds of antiskinning agent shall be included in each 100 gallons of paint. The paint shall be prepared in such a manner that there will be no appreciable loss of volatile solvents or development of skins.

From 0.5 to 0.7% by weight of Organo Montmorillonite, based on weight of pigment, shall be added as a dispersing and suspending agent to prevent excessive settling. The Organo Montmorillonite shall be dampened with 33% of methyl alcohol containing 5% H2O.

The quantities of pigments and vehicles used in formulating the paint shall be based on the composition limits given in the specifications. The manufacturer shall furnish to the Department the batch formula which will be used in manufacturing the paint.

V. FORMULAS

The pigment vehicle proportions shall be as follows:

	<u>White</u>	<u>Yellow</u>
Pigment	50 to 52%	50 to 52%
Vehicle	48 to 50%	48 to 50%

The formulas used in the manufacture of the pavement marking paint shall be as follows:

<u>Pigment:</u>	(by weight)	<u>White</u>	<u>Yellow</u>
Titanium Dioxide		min. 17	
Medium Chrome Yellow			min. 15%
Calcium Carbonate		max. 43	max. 48%
Magnesium Silicate		max. 43	max. 40%
Organo Montmorillonite (Bentone)		0.5 to 0.7%	0.5 to 0.7%

Vehicle:

The vehicle shall consist of medium phthalic drying oil alkyd resin, chlorinated rubber, chlorinated paraffin, stabilizer, toluene, soya lecithin and aliphatic naphtha. The solution of 10 or 20 centipoise type chlorinated rubber with 1 - 3% of suitable stabilizer (by weight of chlorinated rubber) shall be made up using toluene. The paint shall be thinned to required consistency using toluene or a suitable mixture of toluene and aliphatic naphtha (Lactol).

The vehicle, as separated from the pigment, shall show a non-volatile content of at least 43%. The volatile portion of the vehicle may be modified with a small amount of high boiling aromatic thinner (boiling range 176.7 - 204.4 deg. C. (350 - 400 deg. F.). Kauri Butanol value 83 min.) with permission of the Department.

The total isolated vehicle solids shall consist of 69 to 74% by weight of alkyd solids, 4 to 8% by weight of chlorinated paraffin solids, 19 to 24% by weight of chlorinated rubber solids.

VI. PAINT PROPERTIES

The paint shall have the following properties:

A. Pigment Composition.

Analysis of the extracted pigment shall conform to the following requirements:

	<u>White</u>	<u>Yellow</u>
Lead Chromate		min. 13.5%
Titanium Dioxide	min. 15.5%	
Calcium Carbonate	max. 43%	max. 48%

B. Weight.

Weight per gallon at 25 deg. C. (77 deg. F.) shall not be less than 12.0 pounds (white) and 12.2 pounds (yellow).

C. Consistency.

This paint shall have a consistency of 80 K.U. \pm 6 K.U. The determination shall be made not sooner than 48 hours after the paint has been manufactured and placed in containers. The consistency shall be determined by a Stormer Viscosimeter with a paddle-type rotor at 25 deg. C. (77 deg. F.).

D. Fineness of Dispersion.

This paint shall have a fineness of dispersion minimum of two as determined on a Hegman gauge, having body dimensions of 3/4" x 2-1/2" x 8", using the North Standard scale 0 - 8 with path size of 1/2" x 6".

E. Color and Directional Reflectance.

The daylight directional reflectance of the paint (without glass spheres) shall not be less than 80% (white) and 50% (yellow) relative to magnesium oxide when tested in accordance with Federal Test Method Standard No. 141a, Method 6121. In addition, the color of the yellow paint shall visually match the Federal Highway Color Tolerance Chart, PR Color No. 1, December 1972.

F. Settling Test.

The paint shall, when tested for settling by ASTM Method D 1309 and evaluated by ASTM Method D 869, have a minimum acceptable rating of five.

G. Drying Time.

The paint shall have a no-pickup maximum drying time of 20 minutes, when tested according to ASTM D 711, using a wet film thickness of 0.015" and when applied and tested at 25 deg. C. (77 deg. F.).

H. Flexibility and Adhesion.

A paint film of 0.015" wet film thickness shall be applied to a tin panel 3" x 5" weighing 0.39 to 0.51 lbs/sq. ft. previously cleaned with toluene and lightly buffed with steel wool. After drying in a horizontal position at a room temperature of 23 deg. + 1.1 deg. C. (73.4 + 2 deg. F.) for eighteen hours, the panel shall be baked in an oven at 50 deg. + 2 deg. C. (122 deg. + 3.6 deg. F.) for two hours, removed and allowed to cool to room temperature. It shall then be bent rapidly, with the painted surface uppermost, over a 1/2" mandrel and examined without magnification. The paint shall adhere firmly to the panel and any evidence of cracking or flaking of the film shall be cause for rejection of the paint.

I. Water Resistance.

The paint shall show no softening or blistering when tested in accordance with the procedure as outlined below:

(1) Panels

The panels used in this test shall be glass plates 4" x 8". They must be thoroughly cleaned with a suitable solvent and thoroughly dried before paint is applied.

(2) Procedure

The paint shall be applied to the panels to a wet film thickness of 0.015". Allow the paint film to dry in a horizontal position at a room temperature of 23 + 1.1 deg. C. (73.4 + 2 deg. F.) for 72 hours, protecting the same against the accumulation of dust; then immerse a portion of the paint film on the glass panels in distilled water at room temperature for 18 hours. Allow to air-dry for 2 hours and then examine.

VII. SAMPLING AND INSPECTION

A. Sampling and Testing.

Unless otherwise provided, all materials shall be sampled and tested in accordance with the latest published standard methods of the American Society for Testing and Materials, and revisions thereof, in effect on the date of the invitation for bids, where such standard methods exist. In case there are no ASTM Standards which apply, applicable standard methods of the American Association of State Highway and Transportation Officials, or of the Federal Government, or of other recognized standardizing agencies shall be used.

The successful bidder shall at the time of manufacture, forward to the Engineer of Tests, Department of Transportation, Division of Highways, Pierre, South Dakota 57501, for test purposes one pint sample of paint from each lot or batch that is shipped. These shall include both white and yellow paints.

VIII. Packaging.

(See SPECIAL INSTRUCTION TO THE BIDDERS PARAGRAPH 12)

APPENDIX C

Guide Specifications for Prequalification of White and Yellow Traffic Paint

Guide Specifications
for Prequalification of
White and Yellow Traffic Paint

A. GENERAL

1. Scope: This specification describes minimum product requirements for non-heated traffic marking paints. The specification also outlines procedures used to conduct laboratory and road service tests which will be used to establish a list of qualified products. Only such qualified products will be acceptable for use on state highways. This specification is not a request for a bid.

2. Related Documents:
 - a) American Standard Test Methods (ASTM) 1982 Edition
 - b) Federal Test Method Standard No. 141B (FTMS No. 141)

3. Concept: Prospective suppliers, wishing to prequalify their products, are invited to submit samples for comparative evaluation. All products submitted will be considered a candidate for meeting the service requirements of highway contractors striping (Class A), while only those products with a dry time of 30-seconds, or less, at 70°F will be considered a candidate for meeting the requirements of highway maintenance (Class B).

4. Submittals and Samples: Suppliers seeking prequalification shall send, at no cost to the state, four (4) one-gallon containers of

each product to the location designated in the invitation to submit samples. Each container shall be plain, without distinguishing trade marks, and have an easily removable label with the following information:

- a) Name of manufacturer
- b) Identifying name or code number of the paint
- c) Color

The prospective supplier, shall also submit a letter certifying that:

- a) Products meet, or exceed, the laboratory test requirements as outlined in Part B of this specification.
- b) The vehicle portion of the paint meets all air pollution control regulations within the State of Alaska at the time the paint is delivered.

If any cleanup solvents, other than Chevron 51L is required, this shall be clearly indicated in the letter, along with a list of acceptable solvents.

In order to be considered for evaluation, all samples and submittals must be received no later than the close of the business day on (Desired Date). No more than two (2) products of each color (white and yellow) will be evaluated from any one manufacturer.

B. PRODUCTS

1. Paint Composition:

The choice of ingredients and method of manufacture are left to the discretion of the supplier within the broad limits described herein. Products however, must be of a consistency suitable for spraying without thinning and must be compatible with the application equipment.

2. Definitions:

Class A Paint - Ready-Mix Paints prequalified by procedures described in this specification and found acceptable for use on State-funded highway projects where striping is under the control of a party other than the State.

Class B Paint - Ready-Mix paints with a drying time of less than 30 seconds when applied without pre-heating and prequalified by procedures described in this specification. This class of paint is acceptable for use on State maintenance projects.

3. Methods of Testing: After receipt of the samples, the samples will be coded by the purchasing department, who will replace the supplier's label. Samples will then be transferred to the Materials Testing Section who will perform, or have performed, necessary tests to verify compliance with the following requirements.

- a) Viscosity - (Federal Test Method Std No 141, Method 4281)

<u>Temperature</u>	<u>Viscosity</u>
(°F)	(Krebs units)
50°	86 (max)
70°	70-75
122°	66 (min.)

b) No-Pickup Dry Time - (ASTM D711)

Class A: 30 min.

Class B: 30 sec.

c) Non-Settling Test - (ASTM D1309)

Minimum Rating of 6

d) Bleeding - (ASTM D969)

Minimum Rating of 8

e) Color - (Federal Standard 595a color chips)

White: No. 37886

Yellow: No. 33538

f) Coarse and Foreign Matter (ASTM D183)

Less than 1% of total paint

g) Flexibility (ASTM D1737)

Show no cracking, flaking, or loss of adhesion.

4. Road Service Tests: Samples meeting the initial laboratory tests will be applied on bituminous road surfaces at test sites selected by the State. Two transverse lines of each sample will be applied at each site to a wet film thickness of approximately 15-mils. Periodic inspection of these lines will be made to assess their visual effectiveness both by day and by night until the test is terminated. The test will be terminated when a majority of evaluators score the control sample as providing an ineffective marker.

Individual numerical scores from each evaluator will be averaged and combined to a single general performance rating using weighting factors which emphasize durability. Methods outlined in ASTM Test Method D713, and as modified by the state, will be used to conduct the test.

5. Laboratory Stability Tests

Samples meeting minimum standards of prequalifying laboratory testing and rated acceptable by road service evaluation will be tested for stability after a six-month period as follows:

- a) Viscosity: (Federal Test Method Std No. 141, Method 4281)

An increase of 10 Krebs Units over the original reported viscosity at 70°F will be cause for rejection.

b) Settling: (ASTM D869)

Minimum Rating of 6

C. EXECUTION

1. Prequalification Scoring: Each product will be prequalified when it passes all laboratory tests and has a general performance rating which is within the top 75% of all samples rated and receives a superior score to the control sample. With the concurrence of the Purchasing Section, Materials Section and Maintenance Section, the control sample shall automatically be prequalified.

2. Prequalified Class A Paints: A list of prequalified Class A paints will be maintained in the regional offices of the Dept. of Transportation and Public Facilities. Products shall be removed from the list if they fail to meet the performance criteria of any subsequent test evaluation.

Prequalified Class A paints will be considered an acceptable alternative to the requirements of Section 708-2.03 of the 1981 Standard Specifications for Highway Construction when so authorized by project specifications, provided they are free from fault and defect.

3. Prequalified Class B Paints: Manufacturers of Prequalified Class B paints will be notified of their eligibility to submit bids for

award of State maintenance paint purchases. Manufacturers will not be notified of the numbers or names of other prequalified paints. Award shall consider the life expectancy of the paint in addition to cost.

4. Quality Control and Storage Stability: The finished paint shall be consistently formulated and manufactured. It shall be free from defect and imperfection which could adversely affect either the performance life or workability of the product. Antisettling and antiskinning agent and stabilizers shall be added so that when stored in unopened shipping containers, the finished paint will not thicken appreciably, skin over, liver, settle-out, or cake badly.

There shall be no viscosity increase in excess of 10 krebs units over its initial viscosity after aging in the container. Where batch samples were not tested by the State, the initial viscosity shall be assumed to be the same as the sample submitted for prequalification. Field examinations of previously unopened containers shall not show evidence of undissolvable gelatinous vehicle separation, heavy skin formation, or any other evidence of decomposition.

Class B paint products, purchased by the State, shall be warranted against product defects for a period of one year from the date shipment is received. Containers allowed to freeze by the State shall reduce the warranty period to a period of six months from the date shipment is received.

5. Similarity of Samples: The State may conduct tests any time to establish the similarity of the delivered paint to the reference sample. Paints which do not parallel the standard when tested physically or chemically using vapor chromatography, infra-red spectrophotometry, X-ray diffraction, or atomic absorption shall be cause for rejection. The judgment of the Materials Engineer shall be final with respect to interpretation of test results.

In the event that the ingredients of the delivered paint vary more than two percent from the reference sample, the supplier shall replace it at his own expense, including all handling and transportation charges.

6. Confidentiality: Only those samples deemed acceptable will be identified as participating in the evaluation test.

APPENDIX D

Suggested Modification to 1981 Standard Specifications for
Highway Construction

SUGGESTED MODIFICATIONS FOR STATE STANDARD SPECIFICATIONS

708-2.03 Paint for Traffic Markings (General Requirements)

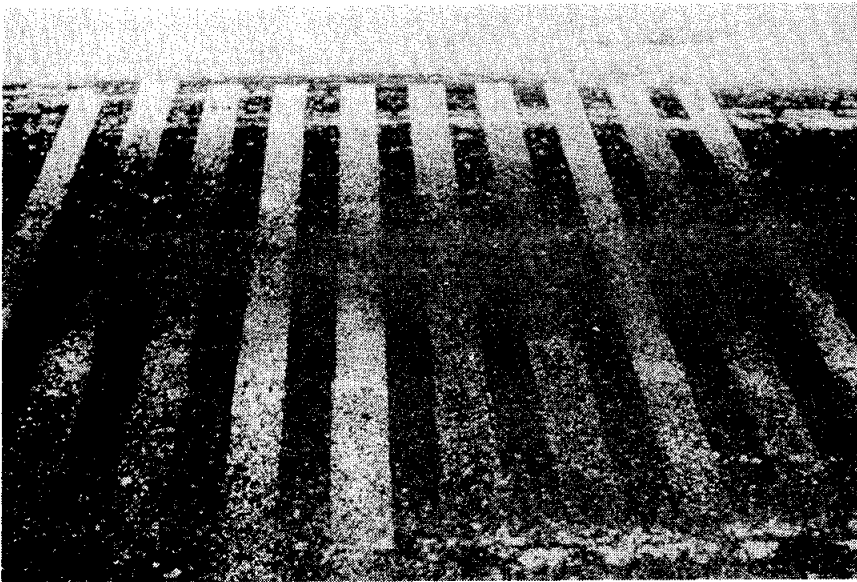
1. Formulation of traffic paint shall be a product prequalified for use by the department through comparative service tests. A list of approved products is maintained by the materials section.
2. Paint shall be delivered to the site as manufactured and in good condition. Paint shall not contain excessive amounts of foreign material and pigments shall be properly dispersed in the vehicle. Any settlement of pigment found in the paint shall be in a thoroughly wetted and soft condition which will allow the complete and easy penetration of a paddle. Paint found to be caked, curdled or thickened shall be cause for rejection. Container shall not be rusted or corroded.
3. The state reserves the right to establish similarity of delivered paint to the reference sample submitted for the prequalification tests.

APPENDIX E

Site Photographs



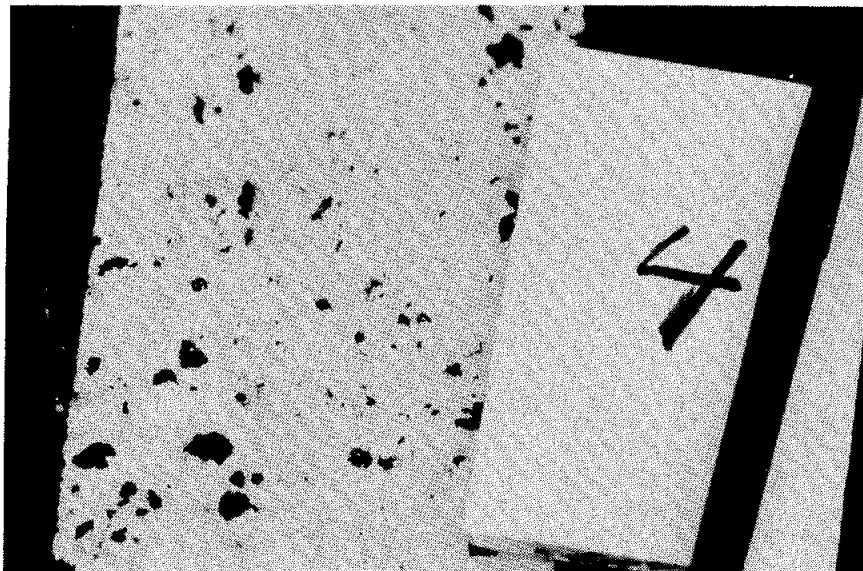
Photograph 1 - Anchorage Test Site at time of Application (9/23/82)



Photograph 2 - Overview Stripe Condition at Anchorage Test Site (11/9/82)



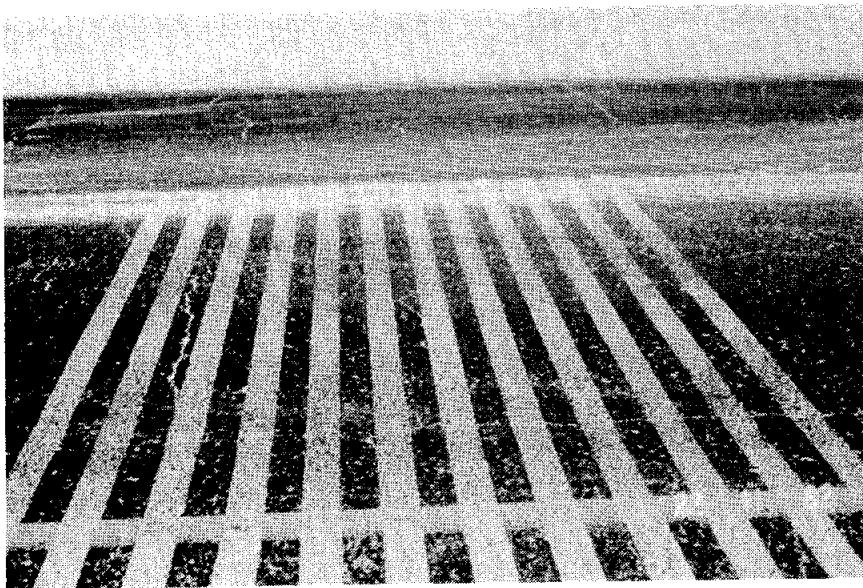
Photograph 3 - Representative Condition of Stripe Outside of Wheel Path
(Anchorage)



Photograph 4 - Less Severe Chipping on Stripe (Anchorage)



Photograph 5 - Fairbanks Test Site at Time of Application (9/21/82)



Photograph 6 - Overall Stripe Condition at Fairbanks Test Site (11-22-82)