

SECTION 729 TRAFFIC PAINT

SCOPE

729.01.01 Material Covered. These specifications cover ready mixed traffic line paint to be applied to either asphaltic or Portland cement concrete pavements.

REQUIREMENTS

729.02.01 General. Provide paint free from foreign materials, such as dirt, sand, fibers from bags, or other material capable of clogging screens, valves, pumps, or other equipment used in a paint striping apparatus.

Grind the paint pigment and properly disperse in the vehicle. The dispersions shall be of such nature that the pigment does not cake or thicken in the container, and does not become granular or curdled. Any settlement of pigment in the paint shall be a thoroughly wetted, soft mass permitting the complete and easy vertical penetration of a paddle. Settled pigment shall be easily redispersed, with minimum resistance to the sideways manual motion of the paddle across the bottom of the container, to form a smooth uniform product of the proper consistency.

The specified amounts and materials used in each formula for achieving satisfactory pigment wetting and suspension, may be varied or changed to suit the vendor's method of manufacture. Paint made with any deviations in antissettling, wetting agents, or stabilizers shall still be required to conform to the characteristics of the finished paint and all other requirements of these specifications.

729.02.02 Packaging. Prepare manufactured paint at the factory ready for application. Do not add thinner or other material to the paint after the paint has been shipped.

All shipping containers must comply with Department of Transportation Code of Federal Regulations, Hazardous Materials Regulations Board, Reference 49 CFR.

Properly seal all containers with suitable gaskets and which show no evidence of leakage.

Label all containers of paint showing the exact title of the specification, manufacturer's name, date of manufacture, and manufacturer's batch number.

Show precautions concerning the handling and application of paint on the label of the paint container.

The lining of the containers shall be of such character as to resist the solvent of this paint and to prevent skins being loosened into the body of the paint.

729.02.03 Certificates.

(a) Approval for Epoxy Paint Formulation. Use epoxy paint formulations listed in the QPL.

The manufacturer must submit the following documentation for each formulation within 15 working days after the contract is awarded for approval:

1. Infrared spectra of each component for each color.
2. Documentation of previous successful installation at least 2 years old and covering a minimum of 60 km (37 mi).
3. Documentation certifying that the Contractor has functional, appropriate equipment to install epoxy pavement marking materials.

(b) Epoxy Paint Material Shipments. Ship the material to the job site in containers that are substantial and plainly marked with the manufacturer's name and address, the color of the material, date of manufacture, and batch number.

The material manufacturer shall furnish a notarized certification that the material complies with the provisions of this specification. It shall not be inferred that the provisions of a certification of compliance waives Department inspection, sampling or testing.

Supply a copy of the infrared spectra of each component on each lot number along with the certification papers. This infrared spectra must match the infrared spectra submitted for each component in subparagraph

(d) **Approval for Polyurea Paint Formulation.** Use polyurea paint formulations listed in the QPL.. Copies of the infrared spectrums need not be supplied for the epoxy paints listed in (a) above, which already have their components' infrared spectrums on file at the Department's Materials Division.

(e) Glass Beads. Furnish certifications which shall include or have attached specific results of tests performed for roundness, refractive index, flow characteristics, and gradation. The certifications shall show the quantity and lot number.

(f) Polyurea Paint Material Shipments. Ship the material to the job site in containers that are substantial and plainly marked with the manufacturer's name and address, the color of the material, date of manufacture, and batch number.

The material manufacturer shall furnish a certification that the material complies with the provisions of this specification. It shall not be inferred that the provisions of a certification of compliance waives Department inspection, sampling or testing.

Supply a copy of the infrared spectra of each component on each lot number along with the certification papers. These infrared spectra must match the infrared spectra submitted for each component in subparagraph (d) of this subsection. Copies of the infrared spectrums do not need to be supplied for the polyurea paints listed in (d) above, which already have their components' infrared spectrums on file at the Department's Materials Division.

(g) Glass Beads and Reflective Elements for Polyurea. Furnish certifications, which shall include or have attached specific results of tests performed for roundness, refractive index, flow characteristics, and gradation. The certifications shall show the quantity and lot number.

PHYSICAL PROPERTIES AND TESTS

729.03.01 Sampling and Testing. Samples will be taken after delivery. The Department reserves the right to have an inspector present to observe the manufacturing process. Furnish a complete formulation record of the manufacturing process to the Materials Division. Tests will be performed according to ASTM, Federal Test Method Standards No. 141a and methods designated by the Materials Division of the Department.

729.03.02 Materials. The raw materials for use in the paint formula shall conform to the specifications designated by Federal serial number or paint material code number hereinafter specified. Subsequent amendments to the specifications quoted shall apply to all raw materials and finished products.

Paint shall also comply with the paint formulation requirements of either Subsection 729.03.03, 729.03.04 or 729.03.05.

729.03.03 Blank.

Add 729.03.04 Epoxy Paint Marking Material. 2. Composition. The component A for organic yellow shall be within the following limits:

Pigments

- Titanium Dioxide, ASTM D476 Type II or III 16-25%
- Organic Yellow 5-9%

Binder
• Epoxy Resin

70-75%

15. Infrared Spectra Comparison. The infrared spectrum of each component shall correlate a minimum of 92% with the reference infrared spectrum on file with the Department's Materials Division. Carded 02/11/04

729.03.04 Epoxy Paint Marking Material.

1. Formulation. The epoxy paint marking material shall consist of a 100% solid two-part system formulated and designed to provide a simple volumetric mixing ratio of two components (e.g. two volumes of Part A to one volume Part B).

2. Composition. The component A shall be within the following limits:

	WHITE	YELLOW
Pigments		
• Titanium Dioxide, ASTM D476 Type II or III	18-25%	—
• Chrome Yellow, ASTM D211 Type III	—	23-30%
Binder		
• Epoxy Resin	75-82%	70-77%

3. Epoxide Number. The epoxy number of the epoxy resin shall be 0.40 ± 0.1 as determined by ASTM D-1652 for both white and yellow Component A on a pigment free basis.

4. Amine Number. The amine number of the curing agent (component B) shall not be less than 400 as per ASTM D-2074.

5. Toxicity. Upon heating to application temperature, the material shall not exude fumes which are toxic or injurious to persons or property.

6. Viscosity. Formulations of each component shall be such that the viscosity of both components shall coincide, within 10%, at a recommended spray temperature. Component B shall be formulated so as to have a steady and constant viscosity at temperatures recommended for spray application.

7. Color and Weather Resistance. The mixed epoxy compound, both white and yellow, when applied to 75 x 150 mm (3 x 6 in.) aluminum panels at $380 \mu\text{m}$ (15 mils) $\pm 25 \mu\text{m}$ (1 mil) in thickness with no glass beads and exposed in a Q.U.V. Environmental Testing Chamber as described in ASTM G53, shall conform to the following requirements. (The test shall be conducted for 75 hours at 50 °C (122 °F), 4 hours humidity and 4 hours U.V., in alternating cycles. The prepared panels shall be cured at 25 °C (77 °F) for 72 hours before exposure). The color of the white epoxy paint system shall not be darker than Federal Standard Color No. 17778 as shown in Table VIII of Federal Standard No. 595B. The color of the yellow epoxy system shall be reasonably close to Federal Standard Color No. 13538 as shown in Table IV of Federal Standard No. 595B. The gloss values of both samples shall not be less than 70 (prism geometry of 60) after the test.

8. Drying Time. The epoxy paint pavement marking material, when mixed in the proper ratio and applied at $380 \mu\text{m}$ (15 mils) $\pm 13 \mu\text{m}$ (0.5 mil) wet film thickness at 25 °C (77 °F) ± 1 °C (2 °F) and with the proper saturation of glass spheres, shall exhibit no tracking time when tested according to ASTM D711 in less than 45 minutes.

9. Curing. The epoxy paint materials shall be capable of fully curing under a constant surface temperature of 4 °C (40 °F) or above.

10. Adhesion to Concrete. The catalyzed epoxy paint pavement marking materials, when tested according to ACI Method 503, shall have such adhesion to the concrete surface that there shall be a 100% concrete failure in the performance of this test. The concrete specimens for the test shall be equivalent to Portland Cement Concrete Pavement per Section 409 with a minimum Compressive strength of 28 MPa (4,000 psi). The prepared specimens shall be conditioned at 25 °C (77 °F) ± 1 °C (2 °F) for a minimum of 24 hours and a maximum of 72 hours before the performance of the tests indicated.

11. Hardness. The epoxy paint pavement marking materials, when tested according to ASTM D2240, shall have a Shore D Hardness greater than 75. Samples shall be allowed to cure at 25 °C (77 °F) ± 1 °C (2 °F) for a minimum of 24 hours and a maximum of 72 hours before performing the indicated test.

12. Abrasion Resistance. The abrasion resistance shall be evaluated on a Taber Abrader with a 1,000 gram load and CS-17 wheels. The duration of test shall be 1,000 cycles. The wear index for the catalyzed material shall not be more than 80 as calculated based on ASTM D4060. The tests shall be run on cured samples of material which have been applied at a film thickness of 380 µm (15 mils) ± 13 µm (0.5 mil). The samples shall be allowed to cure at 25 °C (77 °F) ± 1 °C (2 °F) for a minimum of 24 hours and a maximum of 72 hours before performing the indicated tests.

13. Tensile Strength. When tested according to ASTM D638, the epoxy paint pavement marking materials shall have a tensile strength of not less than 41 MPa (6,000 psi). The Type IV Specimens shall be cast in a suitable mold and pulled at a rate of 6 mm (1/4 in.) per minute by a suitable dynamic testing machine. The samples shall be allowed to cure at 25 °C (77 °F) ± 1 °C (2 °F) for a minimum of 24 hours and a maximum of 72 hours before performing the indicated tests.

14. Compressive Strength. When tested according to ASTM D695, the catalyzed epoxy paint pavement marking materials shall have a compressive strength of not less than 83 MPa (12,000 psi). The cast sample shall be conditioned at 25 °C (77 °F) ± 1 °C (2 °F) for a minimum of 72 hours before performing the indicated tests. The rate of compression of these samples shall be no more than 6 mm (1/4 in.) per minute.

729.03.05 Rapid Dry Waterborne Paint Material.

1. Scope and Classification.

a. Scope This specification covers the specific requirements for rapid dry, high performance 100% acrylic waterborne white and yellow traffic line marking paint for application on Portland cement concrete and bituminous pavements. It shall be easily and uniformly applicable with mechanical airless or air assisted spray marking equipment at paint temperatures up to 38 °C (100 °F). The paint shall serve as a binder for glass beads in such a manner as to produce maximum adhesion and reflection.

b. Classification. Furnish the paint as Type I or Type II as specified in the proposal.

2. Quality Assurance Provisions.

a. Products Listed in the QPL. Use waterborne paint formulations listed in the QPL. Preliminary samples from the manufacturer need not be submitted for formulations listed in the QPL.

b. Products Not Listed in the QPL. Submit a 3.8 L (1 gal) preliminary sample from the manufacturer of the intended white and yellow formulations to the Engineer for approval at least 20 days before any paint is delivered to field locations. Furnish the batch formulation which will be used in manufacturing of the paint, a test report, Material Safety Data Sheet, and all product specification data along with the preliminary sample.

The Engineer will forward the preliminary sample and required documentation to the Headquarters Materials Division. The Materials Division will verify that the formulations meet the specifications and develop baseline requirements for subsequent paint shipment to field locations.

3. Sampling and Testing. Take samples after delivery. Any water added to the containers by the manufacturer shall be considered part of the formulation and shall be mixed with the paint after delivery and before sampling. The Department reserves the right to have an inspector present to observe the manufacturing process.

Also, the Department reserves the right to require test reports of samples delivered to field locations from the manufacturer.

4. Composition Requirements.

a. Materials. The nonvolatile portion of the vehicle shall be composed of a 100% acrylic resin as determined by infrared spectral analysis.

b. Acrylic Emulsion. The acrylic emulsion shall be one of the approved acrylic emulsions on file at the Department's Materials Division. Other acrylic emulsions may be submitted for approval if the following requirements are met:

(1) The proposed emulsion is chemically and physically equal to the approved acrylic emulsions.

(2) The paint formulated with the proposed acrylic emulsion will perform equal or better than the paints formulated with the approved acrylic emulsions.

c. Performance Equality Requirements. Performance equality must be verified by comparative road service tests between the paint formulated with the approved and proposed acrylic emulsions on both asphalt and concrete surfaces. The Contractor or a third party may conduct road tests. However, the submission of the required test data is the responsibility of the Contractor. Road test shall include:

(1) Auto—No Track Time.

(2) Appearance.

(3) Durability.

(4) Night Visibility or Retroreflectivity.

d. Alternate Paint Formulation Requirements. Paint formulated using an alternative acrylic emulsion must meet all the specifications for waterborne traffic paint. Also, alternative paint formulations require approval by the Department prior to their use.

e. Prohibited Material. The manufacturer shall certify that the product does not contain mercury, lead, hexavalent chromium, toluene, chlorinated solvents, hydrolyzable chlorine derivatives, ethylene based glycol ethers and their acetates, nor any carcinogen, as defined in 29 CFR 1910.1200. When tested as specified in 7a, the lead content shall not exceed 0.06% by weight of the dry film and the test for chromium content shall be negative.

5. Quantitative Requirements of Mixed Paint. The paints shall meet the quantitative requirements specified in the following Table I:

Requirement Number	Requirement	White	Yellow
1	Pigment: Percent by Weight	62.0 ± 2	62.0 ± 2
2	Total Solids: Percent by Weight, minimum	77.0	77.0
3	Nonvolatile Vehicle: Percent by Weight Vehicle, minimum	40.0	40.0
4	Consistency: Krebs-Stormer Shearing rate 200 rpm, Equivalent K.U.	80-95	80-95
5	Density: kilogram/Liter (lb/gal), minimum	1.65 (13.75)	1.60 (13.35)
6	Fineness of Grnd: hegman gauge, North Standard Scale, minimum	3	3
7	Drying Time, No-Pick-Up; Minutes, maimum	7	7
8	Directional Reflectance: minimum	89	58
9	Volatile organic Content, VOC: g/L (lb/gal), maiximum	150 (1.25)	150 (1.25)
10	Dry-Through, Early Washout: Minutes	,125	,125
11	Dry Opacity, Type I: minimum Dry Opacity, Type II: minimum	0.92 0.95	0.92 0.95
12	Bleeding Ratio: minimum, 125 µm (5 mils) wet	0.97	0.97

13	Total Solids: Percent by Volume, minimum	60	58
14	Wet Opacity: minimum, 125 μm (5 mils) wet	0.90	0.90
15	Mud Cracking at 0.024 mm (60 mils) wet, For Type II Paints Only	PASS	PASS

6. Requirements of Mixed Paint.

a. Condition in Container. When tested, as specified in subparagraph 7b, the paint, as received, shall show no evidence of biological growth, corrosion of the container, livering or hard settling. The paint shall be dispersible by hand stirring for 5 minutes to a smooth and homogeneous consistency, exempt of gel structures, persistent foam or air bubbles.

b. Appearance. When tested as specified in subparagraph 7c, the paint shall produce a film which is smooth, uniform, free from grit, undispersed particles, craters and pinholes.

c. Accelerated Package Stability. After storage as specified in subparagraph 7d, the sample shall conform to the requirements of subparagraphs 6a and 6b. The sample shall show no change in consistency greater than 5 K.U. from the value in Table I.

d. Flexibility. When tested as specified in subparagraph 7e, the paint shall not crack, chip or flake after the test panel is bent 180 degrees over a 13 mm (1/2 in.) mandrel.

e. Water Resistance. When tested as specified in subparagraph 7f, the paint film shall not soften, blister, wrinkle, lose adhesion, change color or show other evidence of deterioration.

f. Freeze-Thaw Stability. When tested as specified in subparagraph 7h, the paint shall show no coagulation or flocculation, change in consistency greater than 10 K.U. from the value in Table I, nor a decrease in scrub resistance by more than 10% of the requirement in subparagraph 6m.

g. Color Requirements.

(1) Color Match. For all colors except white and yellow, when tested as specified in subparagraph 7i(3), the paint shall match the specified Federal Standard 595B color number within \pm of 6.0 CIELAB units.

(2) Daylight Directional Reflectance. When tested as specified in subparagraph 7i(2), the white paint shall have the daylight directional reflectance specified in Table I.

(3) Yellow Color Match. The yellow traffic paint shall be an approximate color match to Federal Standard 595B color number 33538 when tested according to subparagraph 7i(4).

h. Heat-Shear Stability. When tested as specified in subparagraph 7m, the sample shall not show signs of gelling or other instability. The consistency shall be in compliance with Table I.

i. Skinning. The paint shall not skin when tested as specified in subparagraph 7n.

j. Dry-Through, Early Washout. The paint, when tested as specified in subparagraph 7o, shall have a drythrough time less than 125 minutes.

k. Abrasion Resistance. When tested as specified in subparagraph 7g, both baked and weathered paint films shall require not less than 150 liters (40 gal) of sand to abrade the paint film through to the substrate.

l. Accelerated Weathering. When tested as specified in subparagraph 7j, the colored samples after weathering shall be in conformance with subparagraph 6g. The directional reflectance of white paint shall meet the requirement in Table I. After performing the scrub resistance test according to subparagraph 7i, the paint shall be in conformance with subparagraph 6m.

m. Scrub Resistance. When tested as specified in subparagraph 7l, it shall not take less than 500 cycles to remove the paint film.

n. Titanium Dioxide Content. When tested according to subparagraph 7p, the yellow colored paint shall contain a maximum of 23.7 g/L (0.20 lb/gal) Rutile titanium dioxide. The white paint shall contain a minimum of 120 g/L (1.00 lb/gal) Rutile titanium dioxide.

o. Wet Opacity. The paint when tested as specified in 7q, shall have a wet opacity of 0.90.

p. Mud Cracking, Type II Paint Only. The paint when tested as specified in 7r, shall not contain any cracks.

q. Dry to No Pick Up. When applied at ambient temperature of 10 to 38 °C (50 to 100 °F), the paint shall dry to a no pick up condition under traffic when applied at 380 µm (15 mils) ± 25 µm (1 mil) wet film thickness in 40 to 90 seconds.

r. Material Safety Data Sheet. Submit a Material Safety Data Sheet (MSDS) according to FED-STD-313 unless otherwise specified.

7. Test Methods. Samples will be tested as specified in the following Table II. Unless otherwise specified, tests will be performed at standard conditions, which are 25 °C (77 °F) ± 1 °C (2 °F) and 50% ± 5% relative humidity. Test results will be evaluated for conformance to requirements.

The sample shall be unacceptable if any test result is not in conformance with the corresponding requirements in subparagraph 6 and Table I.

TABLE II—TEST METHODS

Characteristic	Requirement Subparagraph	FED-STD 141C	ASTM Method	Test Subparagraph
Lead Content	4e	-	D3335	7a(1)
Chromium Content	4e	-	D3718	7i(20)
Condition in Container	6a	-	-	7b
Appearance	6b	-	-	7c
Accelerated Package Stability	6c	-	D1849	7d
Flexibility	6d	-	D522	7e
Water Resistance	6e	-	-	7f
Freeze-Thaw Stability	6f	-	D2243	7h
Color	6g	-	D2244	7l
Directional Reflectance	6g(2)	-	E1347	7i(2)
Yellow Color Match	6g(3)	-	D1729	7i(4)
Heat-Shear Stability	6h	-	-	7m
Skinning	6i	3021	-	7n
Dry-Through, Early Washout	6j	-	D1640	7o
Abrasion Resistance	6k	-	D968	7g
Accelerated Weathering	6l	2013	G53	Yj
Scrub Resistance	6m	-	D2486	7l
Volatile Organic Content	Table I	-	D2369	-
Nonvolatile Vehicle	Table I	-	D2369	-
Consistency	Table I	-	D562	-
Total Solids by Volume	Table I	-	D2697	-
Dry Opacity	Table I	4121	-	7k
Dry Time, no-Pick-Up	Table I	-	D711	-
Fineness of Dispersion	Table I	-	D1210	-
Bleeding Ratio	Table I	-	D969	-

Pigment, % by Mass	Table I	-	D3723	-
Titanium Dioxide	6n	-	D1394	7p
Denisy	Table I	-	D1475	-
Wet opacity	Table I	-	-	7q
Mud Cracking, Type II Paint Only	Table I	-	-	7r

a. Prohibited Materials. Lead-Free Yellow and White.

(1) Lead Content. Determine lead according to ASTM D3335 or by the use of an x-ray fluorescence spectrometer according to the manufacturer's manual. The x-ray method shall be used in case of dispute. Evaluate for compliance with subparagraph 4e.

(2) Chromium (Hexavalent) Content. Add 5 mL (0.17 ounce) of 25% aqueous KOH to 0.5 g (8 grains) of the extracted pigment contained in a centrifuge tube. Agitate by shaking and centrifuge. A yellow color in the supernatant liquid indicates the presence of hexavalent chromium. If the results of the above test are inconclusive, then use the procedure in ASTM D3718 to test for chromium content. Evaluate results for compliance with subparagraph 4e.

b. Condition in Container. Before stirring the contents of the container in which the material was originally packaged, check for evidence of biological growth and corrosion. Then lower a spatula into the container and determine whether the paint has livered or developed hard settling. Disperse the paint with the spatula for 5 minutes and examine for compliance with subparagraph 6a.

c. Appearance. Draw down the paint on a clear glass panel to a wet film thickness of 0.33 mm (0.013 in.), and allow to dry for 24 hours at standard conditions. Evaluate for conformance with subparagraph 6b.

d. Accelerated Package Stability. Fill a 473 mL (1 pint) resin-lined friction-top can with the sample.

Ensure that the bulk sample from which the cans are filled is well stirred and uniform, that the containers used are clean, and that the lids are applied promptly to the cans to prevent evaporation losses. Store at a temperature of 52 °C (126 °F) for 2 weeks. Evaluate following the procedure in ASTM D1849, except allow hand stirring for 5 minutes to ensure uniform distribution. Evaluate the consistency for conformance with Table I. Drawdown the paint as in subparagraph 7c. Evaluate for conformance with subparagraph 6c.

e. Flexibility. Determine flexibility according to Method B of ASTM D522. Draw down the paint to a wet film thickness of 0.13 mm (0.005 in.) on clean bare cold rolled steel panel. Air dry the panel for 24 hours at standard conditions, then bake for 5 hours at 105 °C (221 °F) ± 2 °C (4 °F), and finally condition the panel for 30 minutes at standard conditions. Bend over a 13 mm (1/2 in.) diameter cylindrical mandrel and examine under a magnification of 7 diameters for compliance with subparagraph 6d.

f. Water Resistance. Prepare a 10 x 15 cm (4 x 6 in.) concrete panel as specified in Method 2051 Procedure B of Fed. Test Method Standard No. 141. Draw down the paint to a wet film thickness of 0.33 mm (0.013 in.), and allow to dry in a horizontal position at standard conditions for 24 hours. Immerse one-half of the painted panel in distilled water at 25 °C (77 °F) ± 1 °C (2 °F). After 18 hours, remove the panel from the water and allow it to dry for two hours at standard conditions. Evaluate for conformance with subparagraph 6e.

g. Abrasion Resistance.

(1) Sample Preparation. Draw down the paint on 4 glass panels measuring approximately 100 x 200 mm (4 x 8 in.) to a dry film thickness of 0.102 to 0.107 mm (4 to 4.2 mils).

(2) Baked Films. Air dry two of the panels for 24 hours at standard conditions and then bake for 5 hours at 105 °C (221 °F) ± 2 °C (4 °F). After baking, condition the panels for 30 minutes at standard conditions and then run the abrasion test as specified in subparagraph 7g(4).

(3) Weathered Films. Air dry the other two panels for 48 hours at standard conditions. Then subject the panels to accelerated weathering according to subparagraph 7j. Remove the panels and condition for 24 hours at standard conditions, and then run the abrasion test as specified in subparagraph 7g(4).

(4) Test. Subject the panels to the abrasion test according to ASTM D968, Method A, except that the inside diameter of the metal guide tube shall be from 18.97 to 19.05 mm (0.74 to 0.75 in.). Five liters (1.3 gal) of unused sand shall be used for each test panel. The test shall be run on two test panels. Five liters (1.3 gal) of sand is approximately 7.94 kg (17.5 lb). Evaluate for compliance with subparagraph 6k.

h. Freeze-Thaw Stability. Test according to ASTM D2243 for 3 freeze-thaw cycles. Perform the consistency test according to ASTM D562 and the scrub resistance test as described in subparagraph 7i. Check for conformance with subparagraph 6f.

i. Color.

(1) Sample Preparation. Use the test panels prepared for the accelerated weathering test subparagraph 7j(1).

(2) Daylight Directional Reflectance. For the white paint, determine the directional reflectance before and after weathering according to ASTM E1347. Evaluate for conformance with Table I.

(3) Color Match. For colors other than white and yellow, determine the color difference of the paint before and after weathering according to ASTM D2244 using CIE Illuminant D65 with the 10 degree standard observer. Evaluate for conformance with subparagraph 6g.

(4) Yellow Color Match. Determine the color match for yellow paint before and after weathering according to ASTM D-1729 with the daylight illumination represented by CIE Illuminant D-75 or D-65. Evaluate for conformance with subparagraph 6g(3).

j. Accelerated Weathering.

(1) Sample Preparation. Apply the paint at a wet film thickness of 0.33 mm (0.013 in.) to four 8 x 15 cm (3 x 6 in.) aluminum panels prepared as described in Method 2013 of Fed. Test Method Standard No. 141. Air dry the sample 48 hours under standard conditions.

(2) Testing Conditions. Test according to ASTM G53 using both ultraviolet light (UV-BPS-40) and condensate exposure, 300 hours total, alternating 4 hour UV exposure at 60 °C (140 °F), and 4 hours condensate exposure at 40 °C (104 °F).

(3) Evaluation. Remove the samples and condition for 24 hours under standard conditions. Determine the directional reflectance and color match using the procedures in subparagraphs 6i(2) and 6i(3).

Evaluate for conformance with the color requirements in subparagraph 6g. Using the procedure described in subparagraph 6l, run the scrub resistance test. Evaluate for conformance with subparagraph 6l.

k. Dry Opacity. Use Procedure B, Method B of Method 4121 of Fed. Test Method Standard No. 141. The wet film thickness shall be 0.13 mm (0.005 in.). Evaluate for conformance with Table I.

l. Scrub Resistance. Using the procedure of ASTM D2486 modified to use the 8 x 15 cm (3 x 6 in.) test panels from the accelerated weathering test, subparagraph 7j, evaluate for conformance with subparagraph 6m.

m. Heat-Shear Stability. One pint of the paint is sheared in a Waring Blender at high speed to 65 °C (149 °F). The blender should have tight fitting lid and be taped to minimize volatile loss. When the paint reaches 65 °C (149 °F), stop the blender immediately and apply cover. Let cool a minimum of 12 hours and examine for gelling or other signs of instability. Evaluate for compliance with subparagraph 6h.

n. Skinning. Place 710 mL (1.5 pints) of the paint in a 946 mL (2 pint) container, seal, and test according to Method 3021 of Fed. Test Method Standard 141. After 48 hours, examine for compliance with subparagraph 6i.

o. Dry-Through, Early Washout. Draw down the paint on a glass panel to a wet film thickness of 0.33 mm (0.013 in.). Immediately place in a humidity chamber maintained at 23 °C (73 °F) ± 2 °C (4 °F) and 90% ± 3% relative humidity. Test according to ASTM D1640 except that the pressure exerted shall be the minimum needed to maintain contact with the thumb and film. Check for compliance with subparagraph 6j.

p. Titanium Dioxide Content. Determine the titanium dioxide content using the Aluminum Reduction Method of ASTM D1394. Evaluate for conformance with subparagraph 6n.

q. Wet Opacity. Apply a coat of water-white mineral oil (U.S.P. Liquid Petroleum, Heavy) to a wet-film thickness of 0.037 mm (0.0015 in.) over each of the dried test panels prepared for determining dry opacity, Method 4121 of Fed. Test Method Std. No. 141, Procedure B. Allow the panels to stand horizontally in a dustfree atmosphere for 10 minutes at standard conditions, blot the excess oil, and perform the test.

r. Mud Cracking, Type II Paint Only. On a black-white Leneta chart, Form 2C-Opacity, draw down a stripe of paint 75 mm (3 in.) wide and at least 150 mm (6 in.) long, and having a 1.52 mm (60 mil) wet film thickness. Allow the paint to dry for 48 hours at standard conditions on a horizontal surface. After 48 hours, the paint film shall not contain any cracks.

8. Packaging.

a. Packaging, Packing and Marking. Package, pack and mark the paint according to PPP-P-1892, unless otherwise specified.

b. Special Marking.

(1) Shipping Container Markings. Each shipping container shall be marked: "PROTECT FROM FREEZING—STORE ABOVE 2 °C (35 °F)"

(2) Unit Container Markings. Each unit container shall be marked as follows: "PROTECT FROM FREEZING—STORE ABOVE 2 °C (35 °F)"

"After opening, maintain a thin layer of water on surface of paint during storage to prevent skinning."

"Use only in equipment designed for water based paints."

"This paint may be reflectorized by dropping glass beads conforming to Nevada Department of Transportation (NDOT) specifications onto the wet paint. The surface to be coated shall be free from dirt, oil, grease, other contaminants, and loose, peeling, or poorly bonded paint. The paint shall be applied to the surface at a wet film thickness of 0.41 mm (0.016 in.) minimum for Type I or 0.62 mm (0.025 in.) minimum for Type II, while air and surface temperatures are above 7 °C (45 °F) and rising."

729.03.06 Polyurea Paint Marking Material. 1. Formulation. The polyurea paint marking material shall consist of a 100% solid plural component system formulated and designed to provide a simple volumetric mixing ratio of two components (e.g. two or three volumes of Part A to one volume Part B), that is free from heavy metals.

2. Toxicity. Upon heating to application temperature, the material shall not exude fumes that are toxic or injurious to persons or property.

3. Viscosity. Formulations of each component shall be such that the viscosity of both components shall coincide, within 10%, at a recommended spray temperature. Component B shall be formulated so as to have a steady and constant viscosity at temperatures recommended for spray application.

4. Colors and Weather Resistance. The mixed polyurea compound, white, yellow, and black, when applied to 75 x 150 mm (3 x 6 in.) aluminum panels at 380 µm (15 mils) ± 25 µm (1 mil) in thickness with no glass beads and exposed in a Q.U.V. Environmental Testing Chamber as described in ASTM G53, shall conform to the following requirements. (The test shall be

conducted for 75 hours at 50 °C (122 °F), 4 hours humidity and 4 hours U.V., in alternating cycles. The prepared panels shall be cured at 25 °C (77 °F) for 72 hours before exposure). The color of the white polyurea paint system shall not be darker than Federal Standard Color No. 17778 as shown in Table VIII of Federal Standard No. 595B. The color of the yellow polyurea system shall be reasonably close to Federal Standard Color No. 13538 as shown in Table IV of Federal Standard No. 595B. The color of the black polyurea system shall be reasonably close to Federal Standard Color No. 37038 as shown in Federal Standard No. 595B. The gloss values of both white and yellow samples shall not be less than 70 (prism geometry of 60) after the test.

5. Drying Time. The polyurea paint pavement marking material, when mixed in the proper ratio and applied at 380 µm (15 mils) ± 13 µm (0.5 mil) wet film thickness at 25 °C (77 °F) ± 1 °C (2 °F) and with the proper saturation of glass spheres, shall exhibit no tracking time when tested according to ASTM D711 in less than 10 minutes.

6. Curing. The polyurea paint materials shall be capable of fully curing under a constant surface temperature of 4 °C (40 °F) or above.

7. Adhesion to Concrete. The polyurea paint pavement marking materials, when tested according to ACI Method 503, shall have such adhesion to the concrete surface that there shall be a 100% concrete failure in the performance of this test. The concrete specimens for the test shall be equivalent to Portland Cement Concrete Pavement per Section 409 with a minimum compressive strength of 28 MPa (4,000 psi). The prepared specimens shall be conditioned at 25 °C (77 °F) ± 1 °C (2 °F) for a minimum of 24 hours and a maximum of 72 hours before the performance of the tests indicated.

8. Hardness. The polyurea paint pavement marking materials, when tested according to ASTM D2240, shall have a Shore D Hardness greater than 70. Samples shall be allowed to cure at 25 °C (77 °F) ± 1 °C (2 °F) for a minimum of 24 hours and a maximum of 72 hours before performing the indicated test.

9. Abrasion Resistance. The abrasion resistance shall be evaluated on a Taber Abrader with a 1,000 gram load and CS-17 wheels. The duration of test shall be 1,000 cycles. The weight loss for the catalyzed material shall be not more than 120 mg as calculated based on ASTM D4060. The tests shall be run on cured samples of material, which have been applied at a film thickness of 380 µm (15 mils) ± 13 µm (0.5 mil). The samples shall be allowed to cure at 25 °C (77 °F) ± 1 °C (2 °F) for a minimum of 24 hours and a maximum of 72 hours before performing the indicated tests.

10. Tensile Strength. When tested according to ASTM D638, the polyurea paint pavement marking materials shall have a tensile strength of not less than 24 MPa (3,500 psi). The Type IV Specimens shall be cast in a suitable mold and pulled at a rate of 6 mm (1/4 in.) per minute by a suitable dynamic testing machine. The samples shall be allowed to cure at 25 °C (77 °F) ± 1 °C (2 °F) for a minimum of 24 hours and a maximum of 72 hours before performing the indicated tests.

11. Infrared Spectra Analysis. The infrared spectrum of each component shall correlate a minimum of 92% with the reference infrared spectrum on file with the Department's Materials Division.