Section 4183. Traffic Paints and Pavement Markings

4183.01 DESCRIPTION.

These specifications cover pavement marking tape and two types of fast dry traffic paint: VOC compliant solvent borne, and waterborne. Article 2527.03, A, 2, lists the temperature and date restrictions for the use of these paints.

4183.02 FAST DRY, VOLATILE ORGANIC CONTENT COMPLIANT, SOLVENT BORNE TRAFFIC PAINT.

A. General Requirements.

1. This paint is intended for use in the early and late part of the construction season when the temperature is too cold for waterborne traffic paint.

2. Use a VOC compliant solvent borne paint that:

- Is capable of being heated and spray applied up to a temperature of 122°F (50°C) without damaging the paint or the striping equipment.
- Is not damaged or deteriorated when reheated or if held under heated conditions for 6 hours.
- Provides proper anchorage and refraction for glass beads when the beads are applied at a rate of 6 pounds of beads per gallon (0.72 kg/L) of paint.
- Shows no evidence of excessive settling, gelling, skinning, spoilage or livering upon storage in sealed containers within a 12 month period in the sealed delivery container.

B. Specific Requirements.

1. Composition.

Use VOC compliant solvent borne paint with a volatile organic content of 1.25 pounds per gallon (150 g/L) or less. Ensure yellow pigment is free from lead, chrome, and other heavy metals as defined by the EPA.

a. Pigment Constituents.

1) **Titanium Dioxide:** comply with the latest revision of the specification for titanium dioxide pigments, ASTM D 476, Type II, Rutile.

2) **Organic Yellow:** pigment yellow C.I. #75 or pigment yellow C.I. #200.

3) **Calcium Carbonate:** comply with the latest revision of the specification for calcium carbonate pigments, ASTM D 1199, Type GC, Grade I with minimum of 95% calcium carbonate.

4) **Magnesium Silicate:** comply with the latest revision of the specification for magnesium silicate pigments, ASTM D 605.

5) **Silica:** at least 99.5% SiO_2 in the 30 to 40 micron (30 µm to 40 µm) size range.

6) **Yellow Iron Oxide:** meet the latest revision of ASTM D 768.

7) **Rheological Additives:** one of the following self-activating organic clays:

Benton SD-2	NL Chemicals, Inc.
Claytone APA or HY	Southern Clay Products
Tixogel MP-250	United Catalyst, Inc.

b. Vehicle Constituents.

1) Resins: acrylic copolymer. Use either of the two listed in Tables 4183.02-1 and 4183.02-2 or any combination of the two to achieve the desired properties:

Table 4183.02-1: Resin 1
Poly (methyl methacrylate/n-butyl methacrylate/methacrylic acid) [MMA/NBMA]

Appearance		White, non-dusting beads
Percent Nonvolatiles		98.5% minimum
Acid Value (mgKOH/g)		3.0 maximum
Molecular Weight		60,000
Glass Transition Temperature		122ºF (50ºC)
Properties of Solution (40% by weight (mass) in toluene)	Color (Gardner)	2 maximum
	Viscosity @ 77°F (25°C)	300 - 400 cps (0.3 - 0.4 Pahs)

Table 4183.02-2: Resin 2
I-butyl methacrylate-diethyl aminoethyl methacrylate copolymer

Appearance	White, non-dusting beads
Percent Nonvolatiles	99.0% minimum
Acid Value (mgKOH/g)	0.7 - 1.7
Molecular Weight	60,000
Glass Transition Temperature	122°F (50°C)
Viscosity (40% by weight (mass) in toluene) @ 77°F (25°C)	300 - 400 cps (0.3 - 0.4 Pahs)
Color, Gardner (20% by weight (mass) in toluene)	2 maximum

2) Soya Lecithin: of suitable quality for use in the manufacturing of paint.

3) Acetone: comply with the latest revision of the specification for acetone ASTM D 329.

4) Plasticizer: Dioctal Phthalate or other suitable plasticizer giving similar results.

5) Chlorinated Paraffin: comply with the latest revision of Military Specification MIL C-429, Type I.

2. Formulation Guide for White Paint.

Table 4183.02-3: Formulation Guide

	Pounds	Kilograms
Dioctal Phthalate	12	5.4
Xylene	60	27.2
Acetone	270	122.4
Soya Lecithin	10	4.5
Chlorinated Paraffin	20	9.1
Anti-Skin Agent	3	1.4
Acrylic Copolymer	170	77.1
Anti-Settle Agent	6	2.7
Calcium Carbonate	400	181.4
Magnesium Silicate	50	22.7
Silica	100	45.4
Titanium Dioxide	100	45.4
Total	**1201**	**544.7**

3. White Control Tolerances.

Table 4183.02-4: Tolerances

Property	Value	Test Method
Viscosity, KU	75 - 90	ASTM D 562
Density	11.90 ± 0.2 lb/gal (1.42 ± 0.02 kg/L)	Federal Test 141-4271
Reflectance	83% minimum	ASTM E 1349
Dry Opacity @ 6 mils (0.15 mm) wet	0.95 minimum	Federal Test 141-4121
Dry to no pick-up @ 6 mils (0.15 mm) wet	4 minutes maximum	ASTM D 711
Total Solids	71% minimum	Federal Test 141-4041
Percent Pigment	53 - 57%	Federal Test 141-4021
Non-volatile vehicle	37% minimum	Federal Test 141-4053
Hegman Grind	2 minimum	ASTM D 1210

4. Yellow Formulation Guide.

Table 4183.02-5: Formulation Guide

	Pounds	Kilograms
Dioctal Phthalate	12	5.4
Xylene	60	27.2
Acetone	270	122.4
Soya Lecithin	10	4.5
Chlorinated Paraffin	20	9.1
Anti-Skin Agent	3	1.4
Acrylic Copolymer	170	77.1

Anti-Settle Agent	4	1.8
Calcium Carbonate	400	181.4
Magnesium Silicate	50	22.7
Yellow Iron Oxide	2	0.9
Titanium Oxide	30	13.6
Organic Yellow	35	15.9
Silica	100	45.4
Total	**1166**	**528.8**

5. Yellow Control Tolerances.

Table 4183.02-6: Tolerances

Property	Value	Test Method
Viscosity, KU	80 - 90	ASTM D 562
Density	11.5 ± 0.2 lb/gal (1.38 ± 0.02 kg/L)	Federal Test 141-4271
Reflectance	50% minimum 59% maximum	ASTM E 1349
Dry Opacity @ 6 mils (0.15 mm) wet	0.92 minimum	Federal Test 141-4121
Dry to no pick-up @ 6 mils (0.15 mm) wet	4 minutes maximum	ASTM D 711
Total Solids	70% minimum	Federal Test 141-4041
Percent Pigment	50 - 55%	Federal Test 141-4021
Non-volatile vehicle	37% minimum	Federal Test 141-4053
Hegman Grind	2 minimum	ASTM D 1210
Color @ 2 degree Observer, Illuminant C, 45/0 or 0/45 geometry.	x 0.4706 - 0.5307 y 0.4282 - 0.4828	ASTM E 1164

6. Volatile Organic Content.
Ensure the volatile organic content of the finished paint contains less than 1.25 pounds (150 g) of volatile organic matter per gallon (liter) of total non-volatile paint material according to ASTM D 3960.

C. Field Service Requirements.

1. Paint Pigment.
- **a.** Use well ground pigment properly dispersed in the vehicle.
- **b.** Ensure the pigment does not cake or thicken in the container, and does not become granular or curdled.
- **c.** If pigment settles in the paint, the result is to be a thoroughly wetted, soft mass permitting the complete and easy vertical penetration of a paddle. Settled pigment is to 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.

d. Do not use paint that cannot be easily redispersed, as a result of excessive pigment settlement as described above, or any other cause.

2. Specified Properties.

a. Ensure the paint retains all specified properties under normal above freezing, outside storage conditions for 12 months after acceptance and delivery.

b. The vendor is responsible for all costs and transportation charges incurred in replacing paint that is unfit for use.

c. Ensure replacement paint properties remain satisfactory for 12 months from the date of acceptance and delivery.

3. Glass Spheres.

Ensure the glass spheres for use in VOC compliant, solvent borne traffic paint are uncoated and meet the requirements of Section 4184.

D. Inspection and Acceptance.

Comply with Materials I.M. 483.03 for inspection and acceptance of paint.

4183.03 FAST DRY WATERBORNE TRAFFIC PAINTS.

A. General Requirements.

1. Use paint that:

a. Is capable of being heated and spray applied up to a temperature of 140°F (60°C) without damaging the formulation or serviceability of the product and the traffic striping equipment.

b. Is not damaged or deteriorates when reheated or if held under heated conditions for 6 hours.

c. Provides proper anchorage and refraction for glass beads when the beads are applied at the rate of 6 pounds per gallon (0.7 kg/L).

d. Is free of heavy metals as defined by the US EPA.

e. Free of skins, pigment agglomerates, and foreign matter.

f. Shows no evidence of excessive settling, gelling, skinning, spoilage, or livering upon storage in sealed containers under normal above freezing temperatures within a 12 month period in the sealed delivery container.

2. When the air temperature is below the freezing point (32°F (0°C)), ship or store the paint in an insulated vehicle or storage building with heating capability to ensure the inside temperature is held above freezing.

B. Specific Requirements.

1. Composition.

The composition of the paint is left to the discretion of the manufacturer as long as the finished product meets the following requirements and applicable Federal, State, or local regulations for products of this type.

a. Pigment Content.
Percent pigment by weight (mass) of the finished product to be from 45.0% to 55.0% by weight (mass) for white and 55.0% to 58.0% by weight (mass) for yellow as tested by ASTM D 3723.

b. Resin Solids.
Composed of 100% acrylic emulsion polymer (Rohm & Haas E 3427, Dow Chemical DT 250, or an approved equal). Low Temperature Paint to use Rohm & Haas XSR Resin.

c. Nonvolatile Vehicle.

1) No less than 43.0% by weight (mass) for white paint and no less than 45.0% by weight (mass) for yellow paint.

2) Use the the following formula for calculating nonvolatile vehicle (NVV):

NVV= (N-P)/(100-P)

Where:

N = the percent by weight (mass) of non-volatiles as determined by ASTM D 2369

P = the percent weight (mass) of pigment as determined by ASTM D 3723

d. Volatile Organic Compounds.
Not to exceed 1.25 pounds per gallon (150 g/L) excluding water and VOC exempt solvents. Use ASTM D 3960 to determine the level of VOCs.

e. Flash Point.
Closed cup flash point is to be no less than 100°F (38°C) as tested by ASTM D 56.

f. Density.
A minimum of 12 pounds per gallon (1400 g/L), with the density of the production batches not varying by more than ± 0.2 pounds per gallon (25 g/L) from the density of the qualification samples. Use ASTM D 1475 to measure density.

2. Laboratory Test Requirements.

a. Color.

1) For white, the color after drying is to be a flat white, free from tint, furnishing good opacity and visibility under both daylight and artificial light.

2) For yellow, the color is to be within the following CIE chromaticity limits when measured with an instrument having a 2 degree observer, using a standard C illuminant, and 45/0 or 0/45 geometry.

Table 4183.03-1: CIE Chromaticity Limits

CIE Data Limits	Y	x	y
Minimum	0.5400	0.462	0.428
Maximum	0.5910	0.501	0.455

3) The yellow color chip with chromaticity readings can be obtained from the Office of Materials for correlation.

b. Viscosity.

1) For white: no less than 80 or no greater than 90 Krebs Units at 77°F (25°C).

2) For yellow: no less than 75 Kreb Units or no greater than 85 Krebs Units at 77°F (25°C).

3) Use ASTM D 562 to measure viscosity.

c. No-Pick-Up Time.

1) Less than 5 minutes.

2) Test according to the requirements of ASTM D 711, except with a test stripe having a wet film thickness of 6 mils (150 µm) as measured by an Interchemical et film thickness gage and no air movement.

d. Directional Reflectance (without Glass Spheres).

1) For white: 84.0% minimum.

2) For yellow: 50.7% minimum.

e. Dry Opacity.

1) For white: a minimum contrast ratio of 0.955

2) For yellow: a minimum contrast ratio of 0.930.

3) Test according to the requirements of Federal Test 141a Method 4121. Use a test stripe with a wet film thickness of 7 mil (178 µm) as measured by an Interchemical Wet Film Thickness Gage.

f. Flexibility.

No cracking or flaking shows when tested according to Federal Specification TT-P-1952b.

g. Pigment Particle Size.

Grind of no less than 3 on a Hegman Grind Gage when measured according to ASTM D 1210.

3. Field Service Requirements.

a. Paint Pigment.

1) Use well ground pigment properly dispersed in the vehicle.

2) Ensure the pigment does not cake or thicken in the container, and does not become granular or curdled.

3) If pigment settles in the paint, the result is to be a thoroughly wetted, soft mass permitting the complete and easy vertical penetration of a paddle. Settled pigment is to 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.

4) Do not use paint that cannot be easily redispersed as a result of excessive pigment settlement as described above, or any other cause.

b. Specified Properties.

1) Ensure the paint retains all specified properties under normal above freezing, outside storage conditions for 12 months after acceptance and delivery.

2) The vendor is responsible for all costs and transportation charges incurred in replacing paint that is unfit for use.

3) Ensure replacement paint properties remain satisfactory for 12 months from date of acceptance and delivery.

4. Packaging and Marking.

a. Ensure each container is plainly marked with the gross, tare, net weight, the lot number, producer's name, the date of manufacture, and the type of paint.

b. Provide MSDS.

c. Ensure each container is filled with the volume in liters corrected to 77°F (25°C) as specified in the contract documents.

C. Inspection and Acceptance.
Comply with Materials I.M. 483.03 for inspection and acceptance of paint.

4183.04 DURABLE PAINT PAVEMENT MARKINGS.

Meet the requirements of Materials I.M. 483.04.

4183.05 TESTING AND ACCEPTANCE.

A. Ensure the latest methods prescribed by ASTM, Federal Test Method Standard No. 141, or other recognized standard methods are used to test the ingredients and paints.

B. Infrared spectroscopy, gas chromatography, and x-ray spectroscopy may be used to confirm vehicle composition.

C. The material will be accepted if, upon analysis, the composition of ingredients of paint is found to be within ± 1% of the specified percentages.

4183.06 PAVEMENT MARKING TAPE.

A. Wet, Retroflective Removable ~~Marking~~ Tape Markings.
Comply with Materials I.M. 483.06 and meet the following requirements:

~~**1. Thickness.**~~
~~Average thickness of the film, including glass spheres, no less than 30 mils (0.76 mm) or more than 70 mils (1.78 mm).~~

~~**2. Retroreflectance.**~~
~~For white or yellow tapes, meet the following initial minimum retroreflectance values at 1.05 degree observation angle and 88.76 degree entrance angle, measured by a LTL 2000 retroreflectometer:~~

	~~White~~	~~Yellow~~
~~Specific luminance, mcd/sq.ft./ft.-cdl. (lux•m^2)~~	~~550~~	~~325~~

1. Ensure film is free of lead, chrome, and other heavy metals as defined by the EPA.

2. Precoat markings with pressure sensitive adhesive capable of adhering to the pavement at temperatures as low as 50°F (10°C) in accordance with the manufacturer's recommendations.

3. Retroreflectance.

a. Ensure white and yellow markings have initial expected retroreflectance values as shown in Table 1 under dry, wet, and rainy conditions.

b. Measure wet retroreflectance values under a "condition of wetness" according to ASTM E 2177. Test may be performed with marking installed on road. Perform laboratory measurements using a 3 to 5 degree lateral slope. Use wetting agent to improve wetting of pavement marking with water. Use of a 0.1% (by volume) liquid soap solution is recommended. Report measurements as an average for each roll tested, in a minimum of three locations.

c. Measure wet retroreflectance values under a "condition of continuous wetting" (simulated rain) according to ASTM E 2176, in a controlled laboratory environment while the marking is positioned with a 3 to 5 degree lateral slope. Use wetting agent to improve wetting of pavement marking with water. Use of a 0.1% (by volume) liquid soap solution is recommended. Report measurements as an average for each roll tested, in a minimum of three locations.

Table 4183.06-1: Expected Initial R_L under dry, wet, and rainy conditions

WHITE	**Dry, Wet, & Rainy**
Entrance Angle	88.76 degrees
Observation Angle	1.05 degrees
Retroreflected Luminance R_L [(mcd • ft^{-2}) • fc^{-1}] (R_L [(mcd • m^{-2}) • lx^{-1}])	150
YELLOW	**Dry, Wet, & Rainy**
Entrance Angle	88.76 degrees
Observation Angle	1.05 degrees
Retroreflected Luminance R_L [(mcd • ft^{-2}) • fc^{-1}] (R_L [(mcd • m^{-2}) • lx^{-1}])	100

4. Removability.

Pavement markings shall be removable from the pavement intact or in large pieces, at temperatures above freezing without the use of heat, solvents, grinding, or blasting; and with no permanent scarring of the roadway surface.

5. Patchability.

Pavement marking material shall be capable of being patched in accordance with manufacturer's instructions.

B. Regular Marking Tape.
Comply with Materials I.M. 483.06 and meet the following requirements:

1. Thickness.
Average thickness of the film, including glass spheres, no less than 15 mils (0.38 mm) or more than 50 mils (1.27 mm).

2. Retroreflectance.
For white or yellow tapes, meet the following initial minimum retroreflectance values at 1.05 degree observation angle and 88.76 degree entrance angle, measured by a LTL 2000 retroreflectometer:

	White	Yellow
Specific luminance, mcd/sq.ft./ft.-cdl. (lux●m^2)	550	325

C. Preformed Polymer Marking Material.
Comply with Materials I.M. 483.06 and meet the following requirements:

1. Color.
White or yellow, complying with standard highway markings.

2. Thickness.
Marking film thickness from 60 mils (1.52 mm) to 90 mils (2.29 mm), as measured to include adhesive and glass beads.

3. Retroreflectance.
For white or yellow tapes, meet the following initial minimum retroreflectance values at 1.05 degree observation angle and 88.76 degree entrance angle, measured by a LTL 2000 retroreflectometer.

	White	Yellow
Specific luminance, mcd/sq.ft./ft.-cdl. (lux●m2)	325	150

D. Removable, Preformed, Nonreflective Tape.
Comply with Materials I.M. 483.06 and meet the following requirements:

1. Color.
Dark grey or black in order to blend with the pavement surface color.

2. Thickness.
Average film thickness no less than 30 mils (0.76 mm).

3. Reflectance.
No nighttime reflective characteristics.

E. Profiled Pavement Marking Tape.
Comply with Materials I.M. 483.06 and meet the following requirements:

1. Color.
White or yellow, complying with standard highway markings.

2. Thickness.
Profiled surface. Thickness of the tape including glass beads no less than 30 mils (0.76 mm) or greater than 100 mils (2.54 mm). Height of

the profiles (measured from lowest point to highest point) no less than 35 mils (0.89 mm).

3. Retroreflectance.
For white and yellow films, meet the following initial minimum retroreflectance values at 1.05 degree observation angle and 88.76 degree entrance angle, measured by a LTL 2000 retroreflectometer.

	White	Yellow
Specific luminance, mcd/sq.ft./ft.-cdl. (lux●m2)	700	350

F. Intersection Marking Tape.
Intersection marking tape is intended for cross walks, gore lines, and symbols at intersections where marking tape is subjected to high shear from turning traffic. Comply with Materials I.M. 483.06 and meet the following requirements:

1. Color.
White or yellow, complying with standard highway markings.

2. Initial Skid Resistance.
Initial skid resistance a minimum of 55 British Pendulum Number (BPN) when tested according to ASTM E 303.

3. Retroreflectance.
For white or yellow tapes, meet the following initial minimum retroreflectance at 1.05 degree observation angle and 88.76 degree entrance angle, measured by a LTL 2000 retroreflectometer.

	White	Yellow
Specific luminance, mcd/sq.ft./ft.-cdl. (lux●m2)	150	100