

SECTION 755 – PAVEMENT MARKING MATERIALS**755.01 White and Yellow Traffic Paint**

(A) **General.** White and yellow traffic paint color determinations and specifications shall conform to requirements of the FHWA Color Tolerance Charts or alternate requirements specified in appendix to 23 CFR Part 655, Subpart F.

Premixed retroreflective white and yellow traffic paint shall include pigment, binder, solvent, and glass spheres. Paint shall be suitable for use as traffic markings on concrete and HMA pavements and shall be applied without addition of solvent.

Binder shall be defined as pigment and vehicle alone (not including glass spheres). Spheres shall be defined as glass spheres incorporated in premixed compound.

Premixed retroreflective white and yellow traffic paints shall be factory-mixed and shall be ready for application using spray machines, without thinning, at spreading rate indicated in Table 755.01-1 - Spreading Rate.

Traffic paints shall be ground and mixed well, to uniform consistency, and shall not exhibit skinning, settling, thickening, or livering. Paint shall be applied through spray machine, without clogging.

Spreading rate for 4-inch-wide stripe shall conform to Table 755.01-1 - Spreading Rate.

TABLE 755.01-1 - SPREADING RATE

Premixed Retroreflective	17 gallons/mile
Instant Dry Premixed Retroreflective	16 gallons/mile plus 2 pounds drop-on beads/gallon
Instant Dry	14 gallons/mile plus 6 pounds drop-on beads/gallon

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32 Paints shall be dried to elastic adherent finish. Paints shall not show
 33 appreciable darkening or discoloration with age. Volatile material shall have
 34 minimum solvent action on asphalt, and gums and nonvolatile components of
 35 vehicle shall dissolve entirely in volatile material. Volatile material shall not
 36 precipitate from solution on standing..
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38 **(B) Tests.** Tests shall conform to the following:
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40 **(1) Composition.** Paint with composition, formulation, and milling
 41 identical to sample shall be furnished and manufacturer's certificate of
 42 formulation shall be submitted.
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TABLE 755.01-2 - TRAFFIC PAINT COMPOSITION			
	Premixed Retroreflective	Instant Dry Premixed Retroreflective	Instant Dry With Drop-On Beads
Wet Hiding Power ¹	Completely Hides Black	Completely Hides Black	Completely Hides Black
Weight per Gallons (lbs.) ²	± 0.5 lbs of Orig. Submittal	± 0.5 lbs of Orig. Submittal	± 0.5 lbs of Orig. Submittal
No Pick-Up Time, (minutes) ³	2 - 30	2 - 30	2 - 30
Consistency, (K.U.) ⁴	70 - 90	70 - 90	70 - 90
Glass Sphere Content Premixed Paint, (lbs./gal.)	4.0 minimum	3.0 minimum	-
Specific Gravity of Drop-On Beads ⁵	-	2.40 - 2.60	2.40 - 2.60

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**TABLE 755.01-2 - TRAFFIC PAINT COMPOSITION
(CONTINUED)**

- 1 Wet Hiding Power.** Paint binder shall be applied with 0.008 inch Bird Film Application on Wet Hiding Power Form 10H, as supplied by the Leneta Company, 15 Whitney Road, Mahwah, New Jersey 07430-3129.
- 2 Weight Per Gallon.** Paint shall weigh within ± 0.5 pound of weight of sample that was submitted for prequalification.
- 3 No Pickup Time.** Paint shall be tested in accordance with ASTM D 711, except apply wet film to glass with 0.005 inch Bird Film Applicator.
- 4 Consistency.** Consistency shall be tested in accordance with ASTM D 562. Paint shall have consistency determined by the Stormer Viscosimeter and expressed as Krebs unit at 77 degrees F.
- 5 Specific Gravity of Drop-On Beads.** Specific gravity of beads shall be in range of 2.40 - 2.60 when tested in accordance with the following procedures:
 - (a)** 100 grams of beads shall be placed in oven at 230 degrees F for one hour.
 - (b)** Beads shall be removed and placed in desiccator until sample is cool.
 - (c)** About 60 grams of beads shall be removed from desiccator and weighed accurately.
 - (d)** Beads shall be poured slowly in clean 100 ml graduated cylinder containing 50 ml of isopropyl alcohol. Air shall not be entrapped among beads.
 - (e)** Volume of beads minus 50 is total volume.
 - (f)** Specific gravity shall be calculated as follows:
Specific Gravity = Weight of Sample / Volume of Sample

TABLE 755.01-3 – GLASS SPHERES ¹								
Premixed Retroreflective Paint		Instant Dry Premixed Retroreflective With Drop-On Beads				Instant Dry With Drop-On Beads		
		Pre-Mixed		Drop-On				
Sieve Size	Percent Passing	Sieve Size	Percent Passing	Sieve Size	Percent Passing	Sieve Size	Percent Passing	Sieve Size
#70	100	#70	100	#16	100	#16	100	
#80	85-100	#80	85-100	#20	90-100	#20	90-100	
#140	15-55	#140	15-55	#40	10-35	#40	10-35	
#230	0-10	#230	0-10	#50	0-10	#50	0-10	
-	-	-	-	#100	0-5	#100	0-5	

¹ Glass spheres shall be colorless, clean, transparent, and free from milkeness and air bubbles. Less than 20 percent of glass spheres shall be irregular or fused-spheroids when tested in the State Laboratory. Beads shall have index of refraction of at least 1.50 when tested by liquid immersion method at 77 degrees F. Glass spheres shall have gradation indicated herein when tested with U.S. Standard Sieves in accordance with ASTM D 1214.

(2) Chemical Analysis. The State will perform a chemical analysis of paints to check formulation by accepted method.

(C) Packing, Marking and Batching. Paints shall be delivered in clean, open-head drums. Each container shall bear label that includes the following information:

- (1)** Name and address of manufacturer.
- (2)** Shipping point.
- (3)** Trademark or trade name.
- (4)** Type of paint.
- (5)** Formula.
- (6)** Number of gallons.

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68 (7) Date of manufacture.

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70 (8) Batch number.

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72 **(D) Sampling and Testing.** At least two paint samples from each paint
73 batch, in one quart sealed containers, shall be furnished to the Engineer for
74 testing.

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76 Paint shall not be used until laboratory tests are completed, and paint
77 is accepted by the Engineer.

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79 **(E) Qualification of Traffic Paint.** Only those traffic paints on current list
80 of prequalified paints shall be used. The Engineer will establish qualified
81 paint list.

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83 **755.02 Pavement Markers.** Markers shall have shapes, dimensions, and
84 tolerances indicated in the contract documents. Markers shall be of uniform
85 composition, free from surface irregularities, cracks, checks, chipping, and other
86 physical damages that affect appearance or application.

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88 **(A) Type of Markers.**

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90 (1) Type A - Nonretroreflective White Markers.

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92 (2) Type C - Red-Clear Retroreflective Markers.

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94 (3) Type D - Two-Way Yellow Retroreflective Markers.

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96 (4) Type DB - Two-Way Blue Retroreflective Markers.

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98 (5) Type G - One-Way Clear Retroreflective Markers.

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100 (6) Type H - One-Way Yellow Retroreflective Markers.

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102 (7) Type J - Nonretroreflective Yellow Markers.

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104 **(B) Nonretroreflective Markers.** Types A and J pavement markers shall
105 conform to the following:

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107 **(1) Composition of Markers.** Markers shall be ceramic and shall
108 include heat-fired, vitreous, ceramic base, and heat-fired, opaque,
109 glazed surface to produce properties required in these specifications.
110 Markers shall be made of suitable combination of mixed clays, shales,
111 talcs, flints, feldspars, or other inorganic material that meets properties
112 required. Markers shall be aged thoroughly and evenly and shall be
113 free from defects that affect appearance or serviceability.

115 **(2) Properties of Markers.**
116

117 **(a) Finish.** Markers shall have convex top surface with
118 gradual changes in curvature. Top, bottom, and sides of
119 markers shall be free of objectionable marks or discolorations
120 that will affect adhesion or appearance.

121 Ceramic marker bottoms shall have areas of integrally
122 formed protrusions or indentations that shall increase the
123 effective bonding surface area of adhesive. Areas of
124 protrusion shall have faces parallel to bottom of marker and
125 shall project approximately 0.040 inch from bottom surface.
126

127 **(b) Bond Strength.** Ceramic markers shall have minimum
128 bond strength of 700 pounds per square inch when tested in
129 accordance with California Test 669.
130

131 **(c) Glaze Thickness.** Thickness of glazed marker surface
132 shall be greater than 0.007 inch at points located more than 1/4
133 inch from edge of marker circumference. Glaze thickness shall
134 be measured on fractured edge with microscope of at least 25
135 power with a calibrated reticule.
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137 **(d) Moh Hardness.** Glazed marker surface shall have
138 minimum Moh hardness of 6. Moh hardness of glazed marker
139 surface shall be determined relative to the mineral orthoclase,
140 which has Moh hardness of 6. Using moderate hand pressure,
141 it shall not be possible to scratch glazed marker surface with
142 orthoclase.
143

144 **(e) Luminance Factor (Type A markers only).** Glazed
145 surface of markers shall have minimum daytime luminance
146 factor of 75 when tested in accordance with ASTM E 1349.
147

148 **(f) Yellowness Index (Type A markers only).** Glazed
149 surface of markers shall have maximum yellowness index of 7
150 when tested in accordance with ASTM E 313.
151

152 **(g) Color (Type J markers only).** Glazed marker surface
153 shall have chromaticity coordinates that fall within color box as
154 specified in California Test 669.
155

156 **(h) Water Absorption.** Ceramic markers shall have
157 average water absorption not to exceed 2 percent of dry weight
158 of test piece when tested in accordance with ASTM C 373.
159

(i) Artificial Weathering. Xenon Arc light apparatus conforming to ASTM G 155 and condensate cycle described in Cycle 1 of Table X3.1 shall be used to provide artificial weathering for this test. Initial yellowness index on marker top surface shall be measured in accordance with ASTM E 313. Top surface of marker shall be exposed in Xenon Arc apparatus for 500 hours. After prescribed exposure, maximum yellowness index shall be 20.

(j) Compressive Strength Test. Random sample of five markers of each type shall be selected for load test. Each sample marker shall be tested to support minimum load of 1,500 pounds, when load is applied in the following manner:

- Marker base shall be centered down and over open end of vertically positioned steel ring, 1-inch high, with internal diameter of 3 inches, and wall thickness of 1/4 inch.
 - At rate of 0.2 inch per minute, load shall be applied to top of solid metal plug placed on top of marker, as necessary to break marker. Breakage of marker at load of less than 1,500 pounds shall constitute failure of the compressive strength test.

(k) Sampling. Twenty markers selected at random shall constitute representative sample for each lot of markers. Lot size shall not exceed 25,000 markers. However, if batch represents fewer than 100 markers, sampling shall be deleted and marker acceptance shall be based on certificate of compliance and certified test results.

(I) Tolerances.

1. Three test specimens shall be selected randomly from sample for each test, except as specified in Subsection 755.02(B)(2)(j) - Compressive Strength Test. Specimens shall be tested. If any one of the initial test specimens fails to conform to requirements of the contract documents, double the initial number of specimens shall be tested. Failure of any one of the additional samples shall be cause for rejection of entire lot or shipment represented by sample.

206 **2.** At the Engineer's discretion, resampling may be
207 performed consisting of double the number of samples
208 originally taken. Tolerances for new samples shall be in
209 same ratio as specified in Subsection 755.02(B)(2)(l)1.
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211 **(m) Packaging.** Shipments shall be in containers
212 acceptable to common carriers. Shipments shall be packaged
213 to ensure delivery in undamaged condition. Damaged
214 shipments shall be replaced. Each package shall be marked
215 clearly with name of manufacturer, type, color, quantity
216 enclosed, lot or batch number, or both, and date of
217 manufacture.

218 **(C) Retroreflective Pavement Markers.** Retroreflective pavement
219 markers shall be nominal 4 inches by 4 inches or nominal 3.5 inches by 4
220 inches.

221 Retroreflective pavement markers shall be prismatic reflector type with
222 methyl methacrylate or suitably compounded acrylonitrile-butadiene-styrene
223 (ABS) shell, filled with mixture of inert thermosetting compound and filler
224 material. Exterior surface of shell shall be smooth and contain one or two
225 retroreflective faces of specified color.

226 Markers shall have retroreflective lens containing no voids or air
227 space. Back of lens shall be metallized.

228 Shell of methyl methacrylate shall be molded in accordance with
229 Federal Specification L-P-380C, Type I, Class 3. Mold shall provide
230 mechanical interlock between thermosetting compound and shell.
231 Thermosetting compound shall bond directly to backside of metallized lens
232 surface.

233 Base of marker shall be flat (deviation from flat surface shall not
234 exceed 0.05 inch), rough textured, and free from gloss or substances that
235 may reduce its bond to adhesive. Presence of soft or resin-rich film on
236 surface of base will be cause for rejection.

237 Unless otherwise specified, retroreflective markers shall conform to
238 the following requirements when tested in accordance with California Test
239 669:

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(1) Retroreflectance.

TABLE 755.02-4 – RETROREFLECTANCE TEST (AFTER STEEL WOOL ABRASION PROCEDURE)			
Incidence Angle	Specific Intensity		
	Clear	Yellow	Red
0	3.0	1.5	0.75
20	1.2	0.60	0.30
After one-year field evaluation	0.30	0.15	0.08

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(2) **Color.** Color of retroreflectors, when illuminated by white light from sealed-beam automobile headlight as defined by SAE Standard J 578, shall be an accepted clear, yellow, red, or blue color, as designated. Off-color reflection shall constitute grounds for rejection. Daylight color of marker body shall be compatible with color of primary lens and shall be subject to acceptance by the Engineer.

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(3) **Compressive Strength Test.** Random sample of three markers of each type shall be selected for load test. Each sample marker shall be tested to support minimum load of 2,000 pounds when load is applied as specified in Subsection 755.02(B)(2)(i) - Compressive Strength Test.

Deformation of marker of more than 0.125 inch at loads of less than 2,000 pounds or delamination of shell and filler material of more than 0.125 inch regardless of load required to break marker shall be cause for rejection of markers as specified in Subsection 755.02(B)(2)(l) - Tolerances.

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(4) **Bond Strength.** Retroreflective markers shall have minimum bond strength of 500 pounds per square inch when tested in accordance with California Test 669.

(5) **Sampling.** Sampling shall be performed in accordance with Subsection 755.02(B)(2)(k) - Sampling.

(6) **Tolerances.** Tolerances shall be as specified in Subsection 755.02(B)(2)(l) - Tolerances.

(7) Packaging. Packaging shall be as specified in Subsection 755.02(B)(2)(m) - Packaging.

(D) Temporary Retroreflective Pavement Markers. Temporary reflective pavement markers shall include acrylic plastic shell containing one or two hermetically sealed prismatic air cell reflective lenses to reflect incident light from single or opposite directions, as required. Markers shall be approximately 4 inches by 4 inches by 3/4 inch, with each reflecting lens face sloping at approximately 45 degrees. Markers shall be smooth, with rounded corners, except for purposes of identification. Outer surface of marker shell shall be of same color as reflective face. Off-color reflection will constitute grounds for rejection.

Unless otherwise specified in this subsection, temporary reflective pavement markers shall conform to requirements for optical performance, color, compressive strength, sampling, tolerance, and packaging specified in Subsection 755.02(C) - Retroreflective Pavement Markers.

(E) Certification. Certificate of compliance and certified test results shall be submitted for pavement markers.

755.03 Adhesives for Pavement Markers. Epoxy adhesive or bituminous adhesive shall be used in accordance with Section 629 - Pavement Markings.

(A) Epoxy Adhesives. Epoxy adhesives shall be furnished in two components that shall be mixed at work site, and shall be either Rapid Set Type or Standard Set Type.

Adhesives shall consist of white epoxy component A and black curing agent component B. Each component shall be packaged separately. Adhesives shall have compositional specifications, together with test requirements. No volatile solvents or thinners shall be present in epoxy adhesives.

Adhesives shall not be used before sampling and testing unless allowed by the Engineer or unless certificate of compliance is submitted and accepted in accordance with Subsection 755.03(A)(3) - Sampling.

Tests shall be conducted in accordance with latest ASTM test methods, Federal Test Method Standard No. 141, and test methods in use by the State.

Each component shall be packaged in containers of size proportional to quantity of that component in mix. One container of each component shall be used in mixing one batch of epoxy. Containers shall be of such design that contents can be readily removed. Containers shall be sealed well to prevent leakage and shall meet U.S. Department of Transportation's Hazardous Material Shipping Regulations for containers and labeling.

328 Containers shall be of material or shall be lined with material of such
329 character as to resist action by epoxy components. Each container shall be
330 labeled clearly, including the following information:

- 331 (1) Authorized modifications.
332 (2) Designation (Component A or B).
333 (3) Type (Standard or Rapid).
334 (4) Manufacturer's name.
335 (5) Date of manufacture.
336 (6) Batch number (Batch shall consist of single charge of
337 components in mixing chamber).
338 (7) Directions for use (as specified elsewhere).
339 (8) Such warnings or precautions concerning contents as may be
340 required by State or Federal Laws and Regulations.

341 Certificate of compliance from manufacturer of finished epoxy
342 components and copy of label for each material shall be submitted.
343 Certificate of compliance shall include list, by Title and Section, of the State
344 and Federal packaging and labeling laws and regulations that manufacturer
345 has complied with.

346 Materials that show evidence of crystallization, or permanent increase
347 in viscosity, or settling of pigments that cannot be readily redispersed with
348 paddle; or that have exceeded manufacturer's recommended shelf life, shall
349 be replaced at no increase in contract price or contract time.

350 Unless otherwise specified, components A and B shall be mixed at
351 temperature between 60 degrees F and 85 degrees F. If applicable,
352 adhesive components shall be heated using indirect heat. Immediately
353 before applying, each component shall be mixed thoroughly with paddle, in
354 one-to-one ratio by volume, unless otherwise recommended by epoxy
355 manufacturer. Separate paddles shall be used to stir each component.
356 When automatic proportioning and mixing machine is used, temperature of
357 components shall be maintained by indirect heating or cooling so that
358 adhesive will meter, mix, and extrude properly. Proper temperature, after
359 proper mixing, shall be maintained to prevent excess flow of adhesive from
360 under marker. Properly mixed adhesives shall appear a uniform gray color,
361 approximately that of color No. 26152 of Federal Standard No. 595B, without
362 black or white streaks. Solvent shall not be added to epoxy.

375 After mixing, epoxies shall be placed in the work, together with
 376 overlaying or inserted material that is to be bonded to the work by the epoxy,
 377 before thickening of epoxy has begun. Surfaces shall be free of rust, paint,
 378 grease, asphalt, and loose and deleterious material.

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 380 **(1) Rapid Set Epoxy Adhesive.** Rapid set epoxy adhesive with
 381 high viscosity paste formulated primarily for use in bonding pavement
 382 markers to portland cement concrete and HMA shall include the
 383 following components:
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**TABLE 755.03-1 - RAPID SET EPOXY ADHESIVE
COMPONENTS**

Component A	Parts by Weight
Epoxy Resin ¹	90.00
Orthocresol Glycidyl Ether ²	10.00
Titanium Dioxide (ASTM D 476)	3.00
Talc ³	50.00
Oleophilic Fumed Silica ⁴	4.50 ⁹
Component B	Parts by Weight
High Functionality Polymercaptan Hardener ⁵	60.00
2, 4, 6-Tri (Dimethylaminomethyl) Phenol ⁶	7.00
Polysulfide Polymer ⁷	35.00
Furnace Black ⁸	0.10
Talc ³	52.00
Oleophilic Fumed Silica ⁴	3.50 ⁹
Silicone Anti-Foam, Type DB 100, 100% Solids	0.005

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**TABLE 755.03-1 - RAPID SET EPOXY ADHESIVE
COMPONENTS (CONTINUED)**

¹	Di glycidyl ether of bisphenol A, viscosity, 100 – 160 poise at 77 degrees F; weight per epoxide equivalent 180 – 200. Color, Gardner 19 max.
²	Viscosity at 77 degrees F, 5 – 10 centipoise. Weight per gallon 9.00 – 9.10 pounds. Weight per epoxide equivalent 180 – 200.
³	Specific Gravity 2.68 to 2.86 Oil Absorption, ASTM D 281 26 to 33 pH 8.9 to 9.6 Hegman Rating 3 to 5 Particle Shape Platey Maximum Particle Size, microns 55 Percent Passing U.S. No. 325 Screen, Minimum 99 Dry Brightness, minimum 93
⁴	High purity fumed silica, surface treated with silicone oil, with the following properties: Appearance, fluffy powder; surface area, N ₂ B.E.T. method, 100±20 m ² /gram; pH, 4 grams dispersed in 100 ml of 20/80 volume mixture of ethyl alcohol and distilled water, 4.7; weight percent carbon, 5.0 minimum; ignition loss (dry basis) 2 hours at 1,832 degrees F, 6 to 7; specific gravity, 1.8.
⁵	Liquid polymercaptan resin, viscosity 100-130 poise at 77 degree F; specific gravity 1.14-1.16; mercaptan value, 3.6 meq/gram. Color, Gardner 1933, 1 maximum. Match curve on file in the Transportation Laboratory.
⁶	Formula weight 265; specific gravity at 77 degrees F/77 degrees F, 0.973; refractive index 1.514 at 77 degrees F; distillation range 96 percent at 266 degrees F to 320 degrees F (0.5-1.5mm); flash point, Tag Open Cup, 300 degrees F minimum; water content 0.06 percent maximum.
⁷	Specific gravity, 1.24-1.30 at 68 degree F/68 degree F; viscosity, 700-1200 centipoise, Brookfield at 77 degrees F; pH water extract 6.0-8.0; moisture content, 0.1 percent maximum; pour point, 15 degrees F; average molecular weight, 1,000; flash point, degree F, Cleveland Open Cup, 390 minimum; sulfur content, percent 36-40; color, Hellige, 9-12. Product shall be difunctional mercaptan made from 98 mole percent of bis (2-chloroethyl) formal and 2 mole percent of trichloropropylene.
⁸	Surface area, m ² /gram, 115-130; particle diameter, millimicrons, 18-30; pH, 7.0-8.5; fixed carbon (moisture free), percent, 96-98; volatile matter, percent, 1-4; oil absorption, stiff paste endpoint, ccs/gram, 0.80-0.90.
⁹	Range of 4.0 to 5.0 parts shall be permitted in Component A and 3.0 to 4.0 parts in Component B, to achieve required viscosity and thixotropy. Small reproduction batches shall be prepared to determine oleophilic silica level best suited for manufacturing equipment used.

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388 Testing shall be performed in accordance with California Test
389 434 and shall comply with requirements of Table 755.03-2 - Rapid Set
390 Epoxy Component Characteristics.

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392 Components shall possess the following characteristics:
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755.03-2 - RAPID SET EPOXY COMPONENT CHARACTERISTICS		
Test	Requirements	
	Component A	Component B
Brookfield Viscosity, Helipath Spindle TE at 5 rpm, Poise at 77 degrees F	3000 to 4000	3000 to 4000
Shear Ratio Minimum at 77 degrees F	2.0	2.0
Density lbs. per gallon at 77 degrees F	11.90 to 12.20	11.90 to 12.20
Skinning,(Original Container)	None	Slight
Percent Air, Maximum	2.0	2.0
Infrared Curves	Components A and B shall match curves specified in California Test 434.	
Storage Stability	Components A and B shall not change in viscosity and shear ratio by more than ± 15 percent when stored for 2 weeks in closed containers at 115 degrees F ± 2 degrees F, measurements at 77 degrees F using same spindle and apparatus as in Brookfield Viscosity Test. Adhesive shall meet requirements for density, skinning, percent air, and infrared curves for 12 months from date of manufacture. No settling of fillers that cannot be easily dispersed with paddle will be allowed.	

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Combined components shall have the following characteristics:

**TABLE 755.03-3 - RAPID SET EPOXY COMBINED
COMPONENT CHARACTERISTICS**

Gel Time, minutes (minimum)	7
Bond Strength to Concrete, Time, minutes (maximum) to reach not less than 200 psi at 77 degrees F \pm 2 degrees F at 50 degrees F \pm 2 degrees F at 30 degrees F \pm 2 degrees F	35 45 85
Slant Shear Strength, psi (minimum) 24 hours at 77 degrees F \pm 2 degrees F 24 hours at 77 degrees F \pm 2 degrees F plus water soak	1000 800
Tensile Adhesion and Cohesion, psi (minimum) Ceramic Marker Bottom Ceramic Marker Bottom, including post cure Retroreflective Pavement Marker Bottom	700 700 500
Color of Mixed Components	Approximately that of Color No. 26152 of Federal Standard No. 595B.
Sag Test ¹	No Sag
¹ 7-inch long by 2-1/2-inch wide by 1/4-inch thick layer of mixed adhesive shall be applied to glazed surface of Leneta Chart, Form 2-A opacity, surface leveled, with thickness controlled by 1/4-inch thick shims. Shims shall be removed and chart immediately hung vertically until epoxy hardens. Test shall be performed at 77 degrees F.	

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(2) Standard Set Epoxy Adhesive. Standard set epoxy adhesive with high viscosity paste formulated primarily for use in bonding pavement markers to portland cement concrete and HMA shall include the following components:

TABLE 755.03-4 - STANDARD SET EPOXY COMPONENTS

Component A	Parts by Weight
Epoxy Resin ¹	87.00
Aliphatic Glycidyl Ether ²	13.00
Titanium Dioxide (ASTM D 476)	3.00
Oleophilic Fumed Silica ³	6.50 ⁸
Talc ⁴	34.00
Component B	Parts by Weight
N-Aminoethyl Piperazine ⁵	23.20
Nonylphenol ⁶	52.00
Furnace Black ⁷	0.10
Oleophilic Fumed Silica ³	6.50 ⁸
Talc ⁴	65.00
Silicone Anti-Foam, Type DB 100, 100% Solids	0.005

¹ Di glycidyl ether of bisphenol A, viscosity, 100-160 poise at 77 degrees F; weight per epoxide equivalent 180-200. Color, Gardner 1933, 3 maximum.

² Aliphatic mono functional reactive glycidyl ether, derived from aliphatic alcohol. Viscosity 1-15 centipoise. Weight per epoxide equivalent 220 - 250. Specific gravity 0.88-0.95.

³ High purity fumed silica, surface treated with silicone oil, with the following properties: Appearance, fluffy white powder surface area, N₂ B.E.T. method, 100±20 m²/gram; pH, 4 grams dispersed in 100 ml of 20/80 volume mixture of ethyl alcohol and distilled water, 4.7; weight percent carbon, 5.0 minimum; ignition loss (dry basis) 2 hours at 1,832 degrees F, 6 to 7; specific gravity, 1.8.

**TABLE 755.03-4 - STANDARD SET EPOXY COMPONENTS
(CONTINUED)**

⁴ Specific Gravity	2.68 to 2.86
Oil Absorption, ASTM D 281	26 to 33
Ph	8.9 to 9.6
Hegman Rating	3 to 5
Particle Shape.....	Platey
Maximum Particle Size, microns	55
Percent Passing U.S. No. 325 Screen, Minimum.....	99
⁵ Color (APHA) 50 maximum; amine value 1250-1350 based on titration that reacts with three nitrogens in molecule; appearance clear and substantially free of suspended matter.	
⁶ Color (APHA) 50 maximum; hydroxyl number 245-255; distillation range, at 760 mm first drop, 563 degrees F minimum, 5 percent 568 degrees F minimum, 95 percent 617 degrees F maximum; water, percent (K.F.) 0.05 maximum.	
⁷ Surface area, m ² /gram, 115-130; particle diameter, millimicrons, 18-30; pH, 7.0-8.5; fixed carbon (moisture free), percent, 96-98; volatile matter, percent, 1-4; oil absorption, stiff paste endpoint, ccs/gram, 0.80-0.90.	
⁸ Range of 6.0 to 7.0 parts is permitted in Component A and Component B to achieve required viscosity and shear ratio.	

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405 Testing shall be performed in accordance with California Test
406 434 and shall comply with requirements of Table 755.03-5 - Standard
407 Set Epoxy Component Characteristics. Components shall have the
408 following characteristics:
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TABLE 755.03-5 - STANDARD SET EPOXY COMPONENT CHARACTERISTICS

Test	Requirements	
	Component A	Component B
Brookfield Viscosity, Helipath Spindle TE at 5 rpm, Poise at 77 degrees F	3000 to 4000	3000 to 4000
Shear Ratio, Minimum	2.0	2.0
Density, Lbs. per gallon at 77 degrees F	11.0 to 11.3	11.3 to 11.6
Skinning, (Original Container)	None	None
Percent Air, Maximum	2.0	2.0
Infrared Curves Components A and B	Shall match curves specified in California Test 434.	
Storage Stability Components A and B	Viscosity and shear ratio shall not change by more than ± 15 percent when stored for 2 weeks in closed containers at 115 degrees F ± 3 degrees F. Measurements shall be made at 77 degrees F using same spindle and apparatus as in Brookfield Viscosity Test. Adhesive shall meet all other specified requirements for 12 months from date of manufacture. There shall be no settling of the fillers that cannot be easily redispersed with a paddle.	

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Combined components shall have the following characteristics:

TABLE 755.03-6 - STANDARD SET EPOXY COMBINED COMPONENT CHARACTERISTICS	
Gel Time, Minutes (minimum)	8 to 13
Bond Strength to Concrete, Hours (maximum) to reach not less than 200 psi, at 77 degrees F \pm 2 degrees F	3.5
Slant Shear Strength, psi (minimum) 24 hours at 77 degrees F \pm 2 degrees F 24 hours at 77 degrees F \pm 2 degrees F plus water soak	2200 1500
Tensile Adhesion and Cohesion, psi (minimum) Ceramic marker bottom Ceramic marker bottom, including post cure Retroreflective pavement marker bottom	700 700 500
Note: Color of mixed components shall be approximately that of Color No. 26152 of Federal Standard No. 595B .	

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(3) Sampling. The Engineer will take quart samples of components A and B for each batch of adhesives delivered for testing. If fewer than 5 gallons of adhesive is delivered, sampling requirement will be deleted and material will be accepted by certificate of compliance.

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420 (B) Bituminous Adhesive. Bituminous adhesive shall conform to the
 421 following requirements:

422 (1) Properties and Test Methods.

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TABLE 755.03-7 - BITUMINOUS ADHESIVE PROPERTIES AND TEST METHODS			
Property	Min	Max	Test Method
Softening Point, degrees F	200	-	ASTM D 36
Penetration, mm, 100g, 5 sec., 77 degrees F	1.0	2.0	ASTM D 5
Filler Content, percent by weight (Insoluble in 1, 1, 1 Trichloroethane)	65	75	ASTM D 2371
Brookfield Thermosel Viscosity, centipoise, No. 27 Spindle, 20 RPM, 400 degrees F	3000	6000	ASTM D 4402
Flash Point, C.O.C., degrees F	550	-	ASTM D 92

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(2) Filler Properties. Filler material used in bituminous adhesive shall be Type PC, Grade III, calcium carbonate conforming to ASTM D 1199, and shall conform to fineness specified in Table 755.03-9 - Bituminous Adhesive Filler Fineness.

TABLE 755.03-8 - BITUMINOUS ADHESIVE FILLER FINENESS	
Sieve Sizes	Percent Passing
No. 100	100
No. 200	95
No. 325	75

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(3) Packaging And Labeling. Adhesive shall be packed in self-releasing, stacking, cardboard containers, approximately 10-inch cubes. Containers shall have net weight of about 62 pounds. Containers shall be labeled with manufacturer, quantity, and batch number. Words "Bituminous Adhesive for Pavement Markers" shall be printed in bold lettering on label.

(C) Certification. Certificate of compliance and certified test results shall be submitted for pavement marker adhesives.

755.04 Preformed Pavement Marking Tape.

(A) General. Preformed pavement marking tape shall include film with glass beads on conformable backing precoated with pressure-sensitive adhesive. Tape shall adhere to HMA or portland cement concrete without use of heat, solvents, or other additional adhesive means and shall be immediately ready for traffic after application.

Tape shall be made so that a person cannot remove beads easily when scratching material surface with thumbnail. Preformed pavement marking tape shall contain pigments blended to provide standard highway colors of white or yellow. Uniform color shall be maintained under both day and night lighting conditions throughout its expected life.

Preformed words and symbols shall conform to applicable shapes and sizes outlined in latest edition of MUTCD.

Tape shall be stored in cool, dry area indoors. Tape shall be suitable for use a minimum of one year after date of purchase.

(B) Classification. Preformed pavement marking tape of various types and compositions and for applications specified shall conform to the following:

(1) Temporary Preformed Pavement Marking Tape. Unless otherwise specified, temporary tape shall be used for construction work zones and shall be capable of performing for duration of construction.

(a) Type I. Type I temporary tape shall be readily removable when markings are no longer applicable.

(b) Type II. Type II temporary tape shall be used in areas that require wet condition retroreflectivity. Tape shall be readily removable when markings are no longer applicable.

(c) Type III. Type III temporary tape shall not be readily removable and shall be used in areas where temporary tape will be obliterated by over-paving or removal of pavement on which it is placed.

(2) Permanent Preformed Pavement Marking Tape.

(a) Type I. Type I permanent tape shall be of highly durable, retroreflective, pliant polymeric material designed for longitudinal and word or symbol markings, or both, subjected to high traffic volumes and severe wear conditions, such as shear action from crossover or encroachment on typical longitudinal configurations such as edge and lane lines.

(b) Type III. Type III permanent tape shall be of highly durable, retroreflective, pliant polymeric material designed for transverse, channelizing, symbols, and legend markings, subjected to high traffic volumes and severe wear conditions, such as repeated shear action from crossover or encroachment on channelization lines and stop, start, or turn movements.

(C) Retroreflectance. White and yellow preformed pavement marking tape shall have initial minimum retroreflectance values as specified in Table 755.04-1 - Initial Minimum Retroreflectance Values, when measured in accordance with ASTM D 4061, unless otherwise specified. Photometric quantity to be measured shall be specific luminance (SL) or coefficient of retroreflective luminance (RL), expressed as millicandelas per square foot per foot-candle.

Sample size shall be 2 feet by 2-1/2 feet, and test distance shall be 50 feet. Angular aperture of photoreceptor and light projector shall be 6 minutes of arc. Reference center shall be geometric center of sample, and reference axis shall be perpendicular to test sample.

TABLE 755.04-1 - INITIAL MINIMUM RETROREFLECTANCE VALUES**Temporary Preformed Pavement Marking Tape**

Specific Luminance (mcd/ft²/fc)
(except RL = Coefficient of Retroreflective Luminance)

	White			Yellow		
Entrance Angle (degrees)	86.0	86.0	86.5	86.0	86.0	86.5
Observation Angle (degrees)	0.2	0.5	1.0	0.2	0.5	1.0
Type I	1770	1270	750	1310	810	450
Entrance Angle (degrees)	88.76			88.76		
Observation Angle (degrees)	1.05			1.05		
Type II	750 (RL)			450 (RL)		
Entrance Angle (degrees)	86.0	86.0	86.5	86.0	86.0	86.5
Observation Angle (degrees)	0.2	0.5	1.0	0.2	0.5	1.0
Type III	1360	760	500	820	510	350

Permanent Preformed Pavement Marking Tape

Specific Luminance (mcd/ft²/fc)

	White			Yellow		
Entrance Angle (degrees)	86.0	86.5	88.8	86.0	86.5	88.8
Observation Angle (degrees)	0.2	1.0	1.05	0.2	1.0	1.05
Type I	1110	700	500	800	500	300
Entrance Angle (degrees)	86.0	86.0	86.5	88.8	86.0	86.0
Observation Angle (degrees)	0.2	0.5	1.0	1.05	0.2	0.5
Type III	700	500	400	250	410	250
					157	120

- 518 (D) **Temporary Preformed Pavement Marking Tape.**
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- 520 (1) **Type I.**
- 521
- 522 (a) **Composition.** Tape shall include glass beads
523 embedded in white or yellow film with thin, flexible,
524 conformable backing that is precoated with pressure-sensitive
525 adhesive. Structured, interlaced medium shall be incorporated
526 to facilitate tape removal.
- 527
- 528 (b) **Thickness.** Film, without adhesive, shall have minimum
529 thickness of 0.06 inch.
- 530
- 531 (c) **Removability.** Tape shall be removable from HMA and
532 portland cement concrete surfaces, intact or in large pieces,
533 either manually or with roll-up device recommended by
534 manufacturer; at temperatures above 40 degrees F, without
535 use of heat, solvents, grinding, or sandblasting, and without
536 permanently scarring roadway surface.
- 537
- 538 (d) **Skid Resistance.** Surface of markings shall provide
539 initial minimum skid resistance value of 50 BPN when tested in
540 accordance with ASTM E 303.
- 541
- 542 (e) **Adhesion.** Manufacturer shall be required to
543 demonstrate that properly applied pavement marking adheres
544 to roadway under climatic and traffic conditions normally
545 encountered in construction work zone.
- 546
- 547 (2) **Type II.**
- 548
- 549 (a) **Composition.** Tape shall include highly retroreflective,
550 enclosed lens, white or yellow film with thin, flexible,
551 conformable backing that is precoated with pressure-sensitive
552 adhesive.
- 553
- 554 (b) **Retroreflectance.** Enclosed lens white and yellow films
555 shall have initial minimum retroreflectance values under dry
556 and wet conditions as specified in Table 755.04-1 - Initial
557 Minimum Retroreflectance Values. Photometric quantity to be
558 measured shall be RL. Dry condition values shall be measured
559 in accordance with ASTM D 4061.
- 560
- 561 Wet condition values shall be measured in accordance
562 with ASTM E 1720, using portable retroreflectometer capable
563 of measuring at 30 meters geometry. Wet test condition shall
564 be created using clean water poured from bucket of
565 approximately 2.5-gallon capacity, from height of approximately

566 20 inches above surface. Water shall be poured evenly along
567 test surface so that measuring field and its surrounding area
568 shall be momentarily flooded by crest of water. RL, in
569 condition of wetness, shall be measured under test condition
570 one minute after water has been poured.

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572 Visually, retroreflective performance shall be similar
573 under wet or dry conditions.

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575 **(c) Removability.** Tape shall be removable from HMA or
576 portland cement concrete, intact or in large pieces, either
577 manually or with roll-up device recommended by manufacturer;
578 at temperatures above 40 degrees F, without use of heat,
579 solvents, grinding, or sandblasting, and without permanently
580 scarring roadway surface.

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582 **(d) Skid Resistance.** Surface of markings shall provide
583 initial minimum skid resistance value of 50 BPN when tested in
584 accordance with ASTM E 303.

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586 **(e) Adhesion.** Manufacturer shall be required to
587 demonstrate that properly applied pavement marking adheres
588 to roadway under climatic and traffic conditions normally
589 encountered in construction work zone.

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591 **(3) Type III.**

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593 **(a) Composition.** Tape shall include white or yellow
594 retroreflective film on conformable metallic backing that is
595 precoated with pressure-sensitive adhesive.

596

597 **(b) Skid Resistance.** Surface of markings shall provide
598 initial minimum skid resistance value of 35 BPN when tested in
599 accordance with ASTM E 303.

600

601 **(c) Adhesion.** Manufacturer shall be required to
602 demonstrate that properly applied pavement marking adheres
603 to roadway under climatic and traffic conditions normally
604 encountered in construction work zone.

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606 **(d) Abrasion Resistance.** Samples of test material shall
607 not wear through to conformable backing surface in less than
608 25 cycles when tested in accordance with ASTM 4060, except
609 using H-22 wheel and 250-gram load.

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(E) Permanent Preformed Pavement Marking Tape.

(1) Type I.

(a) **Composition.** Type I permanent preformed marking tape shall include mixture of high-quality polymeric materials, pigments, and glass beads distributed throughout its cross-sectional area, with retroreflective layer of microcrystalline ceramic beads bonded to durable polyurethane topcoat surface. Patterned surface shall have approximately 50 percent \pm 15 percent of surface area raised and presenting near vertical face (B angle of 0 degree to 60 degrees) to traffic from any direction. Channels between raised areas shall be substantially free of exposed beads or particles.

Preformed patterned markings shall include white or yellow film with clear or yellow-tinted, or both, microcrystalline ceramic beads incorporated to provide immediate and continuing retroreflection. Film shall be manufactured without use of lead chromate pigments or other similar, lead-containing chemicals.

(b) **Bead Index of Refraction.** Microcrystalline ceramic beads bonded to polyurethane-coated, patterned surface of material shall have minimum index of refraction of 1.70 when tested using liquid oil immersion method. Glass beads mixed into pliant polymer shall have minimum index of refraction of 1.5 when tested by liquid oil immersion method.

(c) **Thickness.** Patterned material without adhesive shall have minimum caliper of 0.065 inch at thickest portion of patterned cross section and minimum caliper of 0.02 inch at thinnest portion of cross section.

(d) **Skid Resistance.** Patterned surface of retroreflective pliant polymer shall provide initial average skid resistance value of 45 BPN when testing in accordance with ASTM E 303, except values shall be taken in one direction and then at 45-degree angle from that direction. These two values shall then be averaged to find skid resistance of patterned surface.

(e) **Acid Resistance.** Beads shall show resistance to corrosion of their surface after exposure to 1 percent solution (by weight) of sulfuric acid. The 1 percent acid solution shall be made by adding 5.7 cubic centimeters of concentrated acid into 1000 cubic centimeters of distilled water. Concentrated acid shall always be added into water, not the reverse. Test shall be performed as follows:

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1. Sample 1 inch by 2 inches shall be taken and adhered to bottom of glass tray, with just enough acid solution placed to completely immerse sample.
 2. Tray shall be covered with piece of glass to prevent evaporation and to allow sample to be exposed for 24 hours under specified conditions.
 3. Acid solution shall be decanted (bead surfaces shall not be rinsed, touched, or otherwise disturbed).
 4. Sample shall be dried while adhered to glass tray in 150 degree F oven for approximately 15 minutes.
 5. Microscopic examination (20x) shall show no more than 15 percent of beads having formation of a very distinct opaque white (corroded) layer on their entire surface.
- (f) **Conformability and Patchability.** Tape shall conform to pavement contours, breaks, and faults through action of traffic at normal pavement temperatures. Tape shall be capable of being used to repair worn or missing areas with butt-spliced patches of same material.
- (g) **Retroreflectivity Retention..** Manufacturer shall test tape for retroreflectivity retention as follows:
1. **Glass Bead Retention.** Sample 2 inches by 6 inches shall be bent around 1/2-inch diameter mandrel with 2-inch dimension perpendicular to mandrel axis. Examination of sample with 5x magnifier shall show that less than 10 percent of beads in sample have 40 percent or less embedment in binder.
 2. **Taber Abraser Simulation Test.** Sample shall be tested using Taber Abraser with H-18 wheel and 125-gram load for 200 cycles. Examination of sample with 5x magnifier or greater shall show that not more than 15 percent of beads in sample are lost due to popout and that bead erosion is major mode of failure.
- (h) **Effective Performance.** Tape shall not flow or distort due to temperature or vehicle impacts. Pliant polymer shall provide cushioned, resilient substrate that shall reduce bead crushing and loss of marking service life. Film shall be weather-resistant and shall show no appreciable fading, lifting,

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707 or shrinkage throughout its usage. Tape shall show no
708 significant tearing, rollback, or other signs of poor adhesion
709 during its useful life, which shall be minimum one year from
710 date of installation.

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712 Immediately after application, tape shall be able to
713 withstand vehicle impacts without being picked up or distorted.
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715 Type I permanent preformed marking tape may be
716 installed by inlaying tape into newly laid HMA pavements and
717 compacting into place, without loss of performance
718 characteristics, in accordance with manufacturer's
719 recommendations.
720

721 **(i) Warranty.** The Contractor shall warrant that pavement
722 marking material shall remain effective for its intended use and
723 shall meet minimum retained coefficient of retroreflection value
724 of 100 millicandelas per square foot per foot-candle (measured
725 at 1.0-degree observation and 86.5-degree entrance angles),
726 subject to requirements of this subsection and Subsection
727 108.17 - Guarantee of Work.
728

**TABLE 755.04-2 - PERMANENT PREFORMED TYPE I
MARKING WARRANTY**

Application	Warranty Period
Longitudinal Markings	4 years
Words and Symbols	2 years

729 The Contractor shall provide replacement materials to
730 restore markings to their original effectiveness if during
731 specified warranty period, any of the following failures occur:
732
733

- 734 1. Markings fail to retain minimum reflectance
735 values.
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- 737 2. Markings fail to adhere to roadway.
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- 739 3. Markings fail due to complete wear-through.
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- 741 4. Markings fail to conform to specified properties.
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743 (2) **Type III.**

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(a) Composition. Type III permanent preformed marking tape shall include mixture of high-quality polymeric materials, pigments, and glass beads distributed throughout its base cross-sectional area. Tape shall have retroreflective layer of glass beads and layer of skid-resistant ceramic particles bonded to top urethane wear surface. Urethane wear surface shall have nominal thickness of 0.005 inch. Film shall have precoated, shear-resistant, pressure-sensitive adhesive.

Preformed markings shall include white or yellow film with pigments selected to conform to standard highway colors. Film shall be manufactured without use of lead-chromate pigments or other lead-containing chemicals.

Surface preparation adhesive may be used to precondition pavement surface. Preformed marking film shall mold itself to pavement contours by action of traffic and shall be capable of overlay application on new, dense or open-graded HMA wear courses in accordance with manufacturer's instructions. Following application and tamping, markings shall be immediately ready for traffic.

(b) Skid Resistance. Surface of retroreflective film shall provide initial minimum skid resistance value of 55 BPN when tested in accordance with ASTM E 303.

(c) Retained Skid Resistance. Surface of retroreflective film shall retain average skid resistance value of 45 BPN when tested in accordance with ASTM E 303, for a period as specified in Table 755.04-3 - Permanent Preformed Type III Marking Warranty. The 45 BPN minimum value shall be average of several readings taken in both wheel track and non-wheel track areas.

(d) Patchability. Tape shall be capable of being used to repair worn or missing areas of same marking type in accordance with manufacturer's instructions.

(e) Tensile Strength and Elongation. Tape shall have minimum tensile strength of 150 pounds per square inch of cross section. Tensile strength shall be measured in direction of roll length and tested in accordance with ASTM D 638, except that sample 6 inches by 1 inch shall be tested at temperature between 70 degrees F and 80 degrees F using

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jaw speed of 10 to 12 inches per minute. Sample shall have maximum elongation of 50 percent at break when tested in accordance with specified method.

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(f) Retroreflectivity Retention. Tape shall comply with requirements of Subsection 755.04(E)(1)(g) - Retroreflectivity Retention.

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(g) Glass Beads. Size, quality, and refractive index of glass beads shall be such that performance requirements for markings shall be met. Bead adhesion shall be such that beads are not easily removed when material surface is scratched.

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(h) Thickness. Film without adhesive shall have minimum thickness of 0.060 inch.

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(i) Effective Performance. Requirements of Subsection 755.04(E)(1)(h) - Effective Performance shall be met.

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(j) Warranty. The Contractor shall warrant that pavement marking material shall remain effective for its intended use and shall meet specified minimum value for skid resistance, subject to requirements of this subsection and Subsection 108.17 - Guarantee of Work.

**TABLE 755.04-3 - PERMANENT PREFORMED TYPE III
MARKING WARRANTY**

Application	Warranty Period
Legends, Symbols, and Channelizing Markings: New Asphalt Inlay Asphalt Overlay New Concrete Overlay	2 years 2 years 2 years
Stop Bars, Crosswalks, and Gore Markings with ADT/Lane of 6,000 or Less: New Asphalt Inlay Asphalt Overlay New Concrete Overlay	2 years 1 year 1 year

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816 The Contractor shall provide replacement materials to
817 restore markings to their original effectiveness if during
818 specified warranty period, any of the following failures occur:

- 819 1. Markings fail to retain minimum skid resistance
820 value.
- 821 2. Markings fail to adhere to roadway.
- 822 3. Markings fail due to complete wear-through.
- 823 4. Markings fail to conform to specified properties.
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830 **755.05 Retroreflective Thermoplastic Compound Pavement Markings.**

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(A) **General.** Retroreflective thermoplastic compound pavement markings shall conform to AASHTO M 247 and AASHTO M 249.

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(B) **Composition.** Pigment, beads, and filler shall be uniformly dispersed in the resin. Material shall be free from skins, dirt, foreign objects, and ingredients that cause bleeding, staining, or discoloration, or combination thereof, and shall conform to Table 755.05-1 - Composition Requirements.

TABLE 755.05-1 - COMPOSITION REQUIREMENTS

Component	White	Yellow
Binder (percent minimum)	18	18
Titanium Dioxide (TiO_2) Pigment (percent minimum)	10	N/A
Glass Beads (percent by weight)	30 - 40	30 - 40
Yellow Pigment	N/A	See Note *
Calcium Carbonate Filler (percent maximum)	42	48

* **Note:** Amount of yellow pigment, calcium carbonate, and inert fillers shall be at manufacturer's option, provided that all other requirements of these specifications are met. Yellow pigment used shall not contain materials listed under the Resource Recovery and Conservation Act (RRCA), including lead, cadmium, mercury, and hexavalent chromium. Total content of these materials in striping compound shall not exceed 100 parts per million.

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(C) Material Properties.

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(1) **Glass Beads.** Glass beads shall conform to the following requirements:

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(a) Have minimum refractive index of 1.50 when tested by liquid immersion method at 77 ± 9 degrees F.

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(b) Have minimum 70 percent true spheres.

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- 851 (c) Be free from air inclusions.
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 853 (d) Have standardized Type I gradation as specified in
 854 Table 755.05-2 - Glass Bead Gradation.
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TABLE 755.05-2 - GLASS BEAD GRADATION	
U.S. Sieve Number	Percent Passing
20	100
30	75 - 95
50	15 - 35
100	0 - 5

- 856
 857 (e) At least 70 percent of spheres shall conform to the
 858 following requirements:
 859
 860 1. Surfaces of spheres shall be smooth, lustrous,
 861 and free from film scratches and pits.
 862
 863 2. Spheres shall be clear, transparent, and not
 864 ovate in shape or fused.
 865
 866 3. Spheres shall show high autocollimating
 867 efficiency, with less than 1 percent of spheres black,
 868 amber, or milky.

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 870 (2) **Thermoplastic Material.** Thermoplastic material shall conform
 871 to the following requirements:

- 872
 873 (a) Material shall be a maleic-modified glycerol ester resin
 874 (Alkyd-based) compound designed for traffic markings.
 875
 876 (b) Material shall not be slippery, once installed.
 877
 878 (c) Material shall not deteriorate by contact with sodium
 879 chloride, calcium chloride, oil content of pavement materials, or
 880 oil droppings from traffic, before warranty period has expired.
 881
 882 (d) Material shall not be volatile, shall not give off fumes in
 883 application state, and shall not be toxic, noxious, or injurious to
 884 persons or property.

886 (e) Material shall not break down or deteriorate if held at
887 application temperature for 4 hours, or if reheated to
888 application temperature three times.

890 (f) Material shall not discolor as result of up to three
891 reheatings, or vary in color from batch to batch.

893 (g) Material shall not change color and brightness
894 characteristics after prolonged exposure to sunlight.

895 **(D) Application Properties.** Thermoplastic compound shall conform to
896 the following requirements:

897 (1) Compound shall be machine-applied to pavement surface in
898 molten state at temperature range of 412.5 ± 12.5 degrees F.
900 Material shall not scorch or discolor if kept at molten state
901 temperatures for up to 4 hours.

902 (2) After cooling to ambient temperature and without
903 polymerization or other chemical change, compound shall form traffic
904 marking stripe of quality and appearance as specified herein.

905 (3) Material shall show no appreciable deformation or discoloration
906 under local traffic conditions and in ambient or pavement
907 temperatures ranging from 0 degrees F to 120 degrees F.

908 (4) Drying time is defined as minimum elapsed time from marking
909 application to time after which normal local traffic leaves no
910 impression or imprint on applied marking, and after which stripe
911 attains and retains required characteristics, including thickness.

912 When applied at temperature range of 412.5 ± 12.5 degrees F
913 and thickness of 1/8 inch to 3/16 inch, material drying time shall not
914 exceed two minutes when the air temperature is 50 ± 3 degrees F.
915 When air temperature is 90 ± 3 degrees F, drying time shall not
916 exceed 10 minutes.

917 (5) Material shall allow stripe to maintain original dimensions and
918 placement. Exposed surface shall be free from tack. Applied marking
919 shall not chip or debond under normal movement of pavement
920 surface.

921 (6) Pigment shall be dispersed evenly throughout material.
922 Material shall be of uniform density and character, throughout its
923 thickness.

924 (7) Material shall not smear or spread at pavement temperatures
925 of 140 degrees F or less.

(E) Specifications and Tests.

(1) **Color.** Material color after heating for 240 ± 5 minutes at 425 ± 3 degrees F and cooled to 77 ± 3 degrees F shall meet the following requirements:

(a) **White.** Daylight reflectance at 45 degrees to 0 degrees shall be minimum of 75 percent. Chemical analysis of white titanium pigment shall be performed in accordance with ASTM D 1394. Material shall have maximum yellowness index of 15.

(b) **Yellow.** Daylight reflectance at 45 degrees to 0 degrees shall be minimum of 45 percent. Yellow color shall match Federal Standard Number 595B, Color 13538.

(2) **Water Absorption.** Material shall have less than 0.5 percent by weight of retained water when tested in accordance with ASTM D 570, Procedure (a).

(3) **Softening Point.** After heating for 240 ± 5 minutes at 425 ± 3 degrees F, material shall have softening point of 215 ± 15 degrees F when tested in accordance with ASTM D 36.

(4) **Specific Gravity.** Material shall have specific gravity of 1.9 to 2.5 when determined in accordance with ASTM D 153, Method A. Kerosene shall be used as immersion liquid. Test sample shall be ground to pass No. 30 sieve.

(5) **Impact Resistance.** Material shall have impact resistance of not less than 10 inch-pounds at 77 degrees F when tested as follows:

(a) Heat material for 240 ± 5 minutes at 425 ± 3 degrees F.

(b) Cast material into bars of 1 square inch cross-sectional area, 3 inches long.

(c) Place material with 1 inch extending above vise in cantilever beam (Izod Type) tester, using 25 inch-pound scale in accordance with ASTM D 256.

(6) **Bond Strength.** Material shall have bond strength of not less than 150 pounds per square inch. Two concrete blocks, 2 inches by 3 inches by 7 inches, shall be cemented together on 3-inch by 7-inch faces with 1/16- to 1/8-inch layer of thermoplastic traffic line material and tested in accordance with ASTM D 4796.

(7) Indentation Resistance. After heating material for 240 ± 5 minutes at 425 ± 3 degrees F, testing in accordance with ASTM D 2240, and taking Shore Durometer readings after 15 seconds, material shall exhibit minimum hardness values, at designated testing temperature, as specified in Table 755.05-3 - Indentation Resistance.

TABLE 755.05-3 - INDENTATION RESISTANCE

Temperature	Reading
115 degrees F	65
77 degrees F	95
40 degrees F	95

(F) Packaging. Each unit container shall be marked clearly to show color of material, process batch number or similar manufacturer's identification, manufacturer's name, plant address, and manufacture date. Each batch manufactured shall have its own, unique number. Label shall warn user that material shall be heated to 412.5 ± 12.5 degrees F during application.

Material shall be delivered to designated area in unit containers, such as sacks or bags, as processed by manufacturer; and shall weigh more than 24 pounds but less than 52 pounds, or as ordered by the Engineer.

(G) Warranty. Thermoplastic compound pavement marking material furnished and installed shall be guaranteed against failure resulting from defective materials or methods of application, or both.

Acceptable performance shall be as indicated in Figure 1.

Should Average Annual Daily Traffic (AADT) be above 10,500 vehicles per lane, thermoplastic pavement markings shall be covered by one-year guarantee against failure.

Thermoplastic pavement markings that are installed on roadways with AADT below 10,500 vehicles per lane and fall within unacceptable range in Figure 1 shall be subject to the following warranty requirements:

TABLE 755.05-4 - WARRANTY REQUIREMENTS

Duration After	Minimum Retention
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Acceptance	Longitudinal Lines (Percent)	Transverse Lines, Words and Symbols (Percent)
90 Percent Average Life	90	90
75 Percent Average Life	80	75
50 Percent Average Life	60	50

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Minimum retention shall be calculated in accordance with publication FHWA-SA-93-001, *Roadway Delineation Practices Handbook*.

Guarantee of replacement material installed shall match guarantee of original material, from date of original installation.

END OF SECTION 755