

1 **SECTION 755 – PAVEMENT MARKING MATERIALS**
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4 **755.01 White and Yellow Traffic Paint**
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6 **(A) General.** White and yellow traffic paint color determinations and
 7 specifications shall conform to requirements of the FHWA Color Tolerance
 8 Charts or alternate requirements specified in appendix to 23 CFR Part 655,
 9 Subpart F.

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

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

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

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

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 28 Spreading rate for 4-inch-wide stripe shall conform to Table
 29 755.01-1 - Spreading Rate.
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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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Paints shall be dried to elastic adherent finish. Paints shall not show appreciable darkening or discoloration with age. Volatile material shall have minimum solvent action on asphalt, and gums and nonvolatile components of vehicle shall dissolve entirely in volatile material. Volatile material shall not precipitate from solution on standing..

(B) Tests. Tests shall conform to the following:

(1) Composition. Paint with composition, formulation, and milling identical to sample shall be furnished and manufacturer's certificate of formulation shall be submitted.

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
#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 milkiness 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.

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(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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(7) Date of manufacture.

(8) Batch number.

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

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

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

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

(A) Type of Markers.

(1) Type A - Nonretroreflective White Markers.

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

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

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

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

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

(7) Type J - Nonretroreflective Yellow Markers.

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

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

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(2) Properties of Markers.

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

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

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

(c) Glaze Thickness. Thickness of glazed marker surface shall be greater than 0.007 inch at points located more than 1/4 inch from edge of marker circumference. Glaze thickness shall be measured on fractured edge with microscope of at least 25 power with a calibrated reticule.

(d) Moh Hardness. Glazed marker surface shall have minimum Moh hardness of 6. Moh hardness of glazed marker surface shall be determined relative to the mineral orthoclase, which has Moh hardness of 6. Using moderate hand pressure, it shall not be possible to scratch glazed marker surface with orthoclase.

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

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

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

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

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(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:

1. 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.

2. 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.

(l) 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.

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2. At the Engineer’s discretion, resampling may be performed consisting of double the number of samples originally taken. Tolerances for new samples shall be in same ratio as specified in Subsection 755.02(B)(2)(l)1.

(m) Packaging. Shipments shall be in containers acceptable to common carriers. Shipments shall be packaged to ensure delivery in undamaged condition. Damaged shipments shall be replaced. Each package shall be marked clearly with name of manufacturer, type, color, quantity enclosed, lot or batch number, or both, and date of manufacture.

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

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

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

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

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

Unless otherwise specified, retroreflective markers shall conform to the following requirements when tested in accordance with California Test 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.

(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)(j) - 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.

(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.

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279 (7) **Packaging.** Packaging shall be as specified in Subsection
280 755.02)(B)(2)(m) - Packaging.

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

291
292 Unless otherwise specified in this subsection, temporary reflective
293 pavement markers shall conform to requirements for optical performance,
294 color, compressive strength, sampling, tolerance, and packaging specified in
295 Subsection 755.02(C) - Retroreflective Pavement Markers.

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

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301 **755.03 Adhesives for Pavement Markers.** Epoxy adhesive or bituminous
302 adhesive shall be used in accordance with Section 629 - Pavement Markings.

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

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

313
314 Adhesives shall not be used before sampling and testing unless
315 allowed by the Engineer or unless certificate of compliance is submitted and
316 accepted in accordance with Subsection 755.03(A)(3) - Sampling.

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

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322 Each component shall be packaged in containers of size proportional
323 to quantity of that component in mix. One container of each component shall
324 be used in mixing one batch of epoxy. Containers shall be of such design
325 that contents can be readily removed. Containers shall be sealed well to
326 prevent leakage and shall meet U.S. Department of Transportation's
327 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
- 332 (1) Authorized modifications.
 - 333
 - 334 (2) Designation (Component A or B).
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 - 336 (3) Type (Standard or Rapid).
 - 337
 - 338 (4) Manufacturer's name.
 - 339
 - 340 (5) Date of manufacture.
 - 341
 - 342 (6) Batch number (Batch shall consist of single charge of
 - 343 components in mixing chamber).
 - 344
 - 345 (7) Directions for use (as specified elsewhere).
 - 346
 - 347 (8) Such warnings or precautions concerning contents as may be
 - 348 required by State or Federal Laws and Regulations.
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350 Certificate of compliance from manufacturer of finished epoxy
351 components and copy of label for each material shall be submitted.
352 Certificate of compliance shall include list, by Title and Section, of the State
353 and Federal packaging and labeling laws and regulations that manufacturer
354 has complied with.

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

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

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

(1) **Rapid Set Epoxy Adhesive.** Rapid 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 755.03-1 - 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 Polysulfide 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	<table> <tr> <td>Specific Gravity</td> <td>2.68 to 2.86</td> </tr> <tr> <td>Oil Absorption, ASTM D 281</td> <td>26 to 33</td> </tr> <tr> <td>pH</td> <td>8.9 to 9.6</td> </tr> <tr> <td>Hegman Rating</td> <td>3 to 5</td> </tr> <tr> <td>Particle Shape</td> <td>Platey</td> </tr> <tr> <td>Maximum Particle Size, microns</td> <td>55</td> </tr> <tr> <td>Percent Passing U.S. No. 325 Screen, Minimum.....</td> <td>99</td> </tr> <tr> <td>Dry Brightness, minimum.....</td> <td>93</td> </tr> </table>	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
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 trichloropropane.																
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 preproduction batches shall be prepared to determine oleophilic silica level best suited for manufacturing equipment used.																

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

Components shall possess the following characteristics:

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	<p>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 \pm 2 degrees F, measurements at 77 degrees F using same spindle and apparatus as in Brookfield Viscosity Test.</p> <p>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.</p>	

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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
<p>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.</p> <p>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.</p> <p>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.</p>	

**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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Testing shall be performed in accordance with California Test 434 and shall comply with requirements of Table 755.03-5 - Standard Set Epoxy Component Characteristics. Components shall have the following characteristics:

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

(1) Properties and Test Methods.

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

439

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

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443 **755.04 Preformed Pavement Marking Tape.**

444

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

450

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

456

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

459

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

462

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

466

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

471

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

474

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

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

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(2) **Permanent Preformed Pavement Marking Tape.**

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(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.

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(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.

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(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.

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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	86.5	88.8
Observation Angle (degrees)	0.2	0.5	1.0	1.05	0.2	0.5	1.0	1.05
Type III	700	500	400	250	410	250	157	120

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(D) Temporary Preformed Pavement Marking Tape.

(1) Type I.

(a) Composition. Tape shall include glass beads embedded in white or yellow film with thin, flexible, conformable backing that is precoated with pressure-sensitive adhesive. Structured, interlaced medium shall be incorporated to facilitate tape removal.

(b) Thickness. Film, without adhesive, shall have minimum thickness of 0.06 inch.

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

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

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

(2) Type II.

(a) Composition. Tape shall include highly retroreflective, enclosed lens, white or yellow film with thin, flexible, conformable backing that is precoated with pressure-sensitive adhesive.

(b) Retroreflectance. Enclosed lens white and yellow films shall have initial minimum retroreflectance values under dry and wet conditions as specified in Table 755.04-1 - Initial Minimum Retroreflectance Values. Photometric quantity to be measured shall be RL. Dry condition values shall be measured in accordance with ASTM D 4061.

Wet condition values shall be measured in accordance with ASTM E 1720, using portable retroreflectometer capable of measuring at 30 meters geometry. Wet test condition shall be created using clean water poured from bucket of 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.

571
 572 Visually, retroreflective performance shall be similar
 573 under wet or dry conditions.

574
 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.

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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.

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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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611 (E) **Permanent Preformed Pavement Marking Tape.**

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(1) **Type I.**

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(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.

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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.

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(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.

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(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.

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(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.

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

Immediately after application, tape shall be able to withstand vehicle impacts without being picked up or distorted.

Type I permanent preformed marking tape may be installed by inlaying tape into newly laid HMA pavements and compacting into place, without loss of performance characteristics, in accordance with manufacturer's recommendations.

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

TABLE 755.04-2 - PERMANENT PREFORMED TYPE I MARKING WARRANTY	
Application	Warranty Period
Longitudinal Markings	4 years
Words and Symbols	2 years

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

1. Markings fail to retain minimum reflectance values.
2. Markings fail to adhere to roadway.
3. Markings fail due to complete wear-through.
4. Markings fail to conform to specified properties.

(2) **Type III.**

(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.

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

(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.

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

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

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

1. Markings fail to retain minimum skid resistance value.
2. Markings fail to adhere to roadway.
3. Markings fail due to complete wear-through.
4. Markings fail to conform to specified properties.

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755.05 Retroreflective Thermoplastic Compound Pavement Markings.

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

(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
<p>* 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.</p>		

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(C) Material Properties.

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

- (a)** Have minimum refractive index of 1.50 when tested by liquid immersion method at 77 ± 9 degrees F.
- (b)** Have minimum 70 percent true spheres.

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- (c) Be free from air inclusions.
- (d) Have standardized Type I gradation as specified in Table 755.05-2 - Glass Bead Gradation.

TABLE 755.05-2 - GLASS BEAD GRADATION	
U.S. Sieve Number	Percent Passing
20	100
30	75 - 95
50	15 - 35
100	0 - 5

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- (e) At least 70 percent of spheres shall conform to the following requirements:

1. Surfaces of spheres shall be smooth, lustrous, and free from film scratches and pits.
2. Spheres shall be clear, transparent, and not ovate in shape or fused.
3. Spheres shall show high autocollimating efficiency, with less than 1 percent of spheres black, amber, or milky.

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

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

889
890 (f) Material shall not discolor as result of up to three
891 reheatings, or vary in color from batch to batch.

892
893 (g) Material shall not change color and brightness
894 characteristics after prolonged exposure to sunlight.

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

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

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

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

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

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

922
923 (5) Material shall allow stripe to maintain original dimensions and
924 placement. Exposed surface shall be free from tack. Applied marking
925 shall not chip or debond under normal movement of pavement
926 surface.

927
928 (6) Pigment shall be dispersed evenly throughout material.
929 Material shall be of uniform density and character, throughout its
930 thickness.

931
932 (7) Material shall not smear or spread at pavement temperatures
933 of 140 degrees F or less.

934 (E) **Specifications and Tests.**
935

936 (1) **Color.** Material color after heating for 240 ± 5 minutes at $425 \pm$
937 3 degrees F and cooled to 77 ± 3 degrees F shall meet the following
938 requirements:

939
940 (a) **White.** Daylight reflectance at 45 degrees to 0 degrees
941 shall be minimum of 75 percent. Chemical analysis of white
942 titanium pigment shall be performed in accordance with
943 ASTM D 1394. Material shall have maximum yellowness index
944 of 15.

945
946 (b) **Yellow.** Daylight reflectance at 45 degrees to 0 degrees
947 shall be minimum of 45 percent. Yellow color shall match
948 Federal Standard Number 595B, Color 13538.

949
950 (2) **Water Absorption.** Material shall have less than 0.5 percent
951 by weight of retained water when tested in accordance with
952 ASTM D 570, Procedure (a).
953

954
955 (3) **Softening Point.** After heating for 240 ± 5 minutes at 425 ± 3
956 degrees F, material shall have softening point of 215 ± 15 degrees F
957 when tested in accordance with ASTM D 36.
958

959 (4) **Specific Gravity.** Material shall have specific gravity of 1.9 to
960 2.5 when determined in accordance with ASTM D 153, Method A.
961 Kerosene shall be used as immersion liquid. Test sample shall be
962 ground to pass No. 30 sieve.
963

964 (5) **Impact Resistance.** Material shall have impact resistance of
965 not less than 10 inch-pounds at 77 degrees F when tested as follows:
966

967 (a) Heat material for 240 ± 5 minutes at 425 ± 3 degrees F.
968

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

971
972 (c) Place material with 1 inch extending above vise in
973 cantilever beam (Izod Type) tester, using 25 inch-pound scale
974 in accordance with ASTM D 256.
975

976 (6) **Bond Strength.** Material shall have bond strength of not less
977 than 150 pounds per square inch. Two concrete blocks, 2 inches by 3
978 inches by 7 inches, shall be cemented together on 3-inch by 7-inch
979 faces with 1/16- to 1/8-inch layer of thermoplastic traffic line material
980 and tested in accordance with ASTM D 4796.
981

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(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

988

(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.

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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.

999

(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.

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Acceptable performance shall be as indicated in Figure 1.

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1007

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.

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1012

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

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