Single Component Hybridized Polymer Pavement Markings

628.1 Description

1 Furnish and place single component hybridized polymer pavement markings according to the Contract documents and the *Manual on Uniform Traffic Control Devices* (MUTCD).

2 The work also includes the determination of passing/no passing zones on two lane facilities according to the MUTCD where existing passing/no passing zones have not been established. Provide the Department with data used in establishing passing/no passing zones.

628.2 Materials

628.2.1 Single Component Hybridized Polymer Pavement Marking Material

1 Provide single component hybridized polymer pavement markings that are durable retro-reflective (white or yellow) and non-retroreflective (black) pavement marking materials of the colors and patterns indicated on the Plans or Special Provisions. Supply all necessary equipment and materials for proper surface preparation and correct application of the pavement marking material.

2 Provide markings consisting of a single component hybridized polymer coating material that can be applied by truck-mounted spray equipment. Ensure that the material can be applied at a minimum ambient air temperature of 38°F. Ensure that the material is capable of retaining glass bead systems to provide specified values of retroreflectivity. Provide material that is suitable for application on all types of concrete and asphalt pavement surfaces.

3 Provide a material that will not separate or settle in original packaged form for a period of not less than 6 months from date of manufacture.

4 Provide a single component hybridized polymer that may be reapplied over the original single component hybridized polymer material without requiring the removal of the original residual material, provided that the original material shows no signs of failure due to poor adhesion to the pavement surface.

628.2.2 Single Component Hybridized Polymer Coating Material

628.2.2.1 Formulation

1 Provide a durable single component material that can produce a rapid no-track condition. Ensure that the material is free of heavy metals. Provide a flexible, UV stable material that may be applied at a typical wet film thickness of 25 mils.

628.2.2.2 Composition

1 Ensure that the pigments for single component hybridized polymer material fall within the following limits:

Pigments	White	Non-Lead Yellow	Black
Titanium dioxide*	18% – 25%	14% – 17%	—
Organic yellow	—	7% – 8%	—
Black	—	—	18% – 25%
Single component hybridized polymer resin	75% – 82%	75% – 79%	75% – 82%

** ASTM D476, Types II & III*

628.2.2.3 Color

1 Ensure that the single component hybridized polymer marking materials, without drop-on beads, visually match the color chips that correspond to the Federal Standard Number 595B for the following colors:

White: 17925
Yellow: 13538
Black: 37038

1 Apply the single component hybridized polymer compound, white, yellow and black, to 2 sets of 3-in. × 6-in. steel plates at 20 mils (±1 mil) in thickness, without glass beads as specified. Expose the prepared samples according to ASTM G154 Cycle 1. Ensure that the color of the single component hybridized polymer materials is within 5 units of the Federal Standards shown above.

628.2.2.4 Yellowness Index (ASTM G154 Cycle 1)

1 Check for compliance as follows:

- Cure 72 hours after sample preparation.
- Take yellow index reading, Lab C/2 degrees, following the 72-hour cure and the preceding QUV (ASTM G154 Cycle 1).
- Maximum before QUV, 6.0.
- Place sample in QUV for 72 hours.
- Maximum after QUV, 9.0.

628.2.2.5 Directional Reflectance (ASTM E1347)

1 The Directional Reflectance after QUV using C/2 degrees is as follows:

White: 85 Minimum
Yellow: 50 Minimum

628.2.2.6 Elongation

1 Ensure that the single component hybridized polymer provides an elongation of greater than 40% when tested according to ASTM D638, Type IV, average of 3 at 7 days.

628.2.2.7 Toxicity

1 Provide material that does not exude fumes that are toxic or injurious to persons or property when heating to the application temperature.

628.2.2.8 Viscosity

1 Ensure that the formulation is such that the viscosity, when tested to ASTM D562, provides Krebs Unit (KU) measurement of 90 – 105.

628.2.2.9 Drying Time

1 Ensure that the single component hybridized polymer marking material, when applied at 20 mils (±0.5 mil) wet film thickness at 75°F (±2°F) and with the proper saturation of glass spheres, exhibits no-track time of less than 5 minutes when tested according to ASTM D711.

2 Ensure that the single component hybridized polymer marking material, when applied in the field at 25 mils (±0.5 mil) wet film thickness between 38° – 110°F and with proper saturation of glass spheres, exhibits no-track time of less than 10 minutes.

628.2.2.10 Curing

1 Ensure that the single component hybridized polymer materials can fully cure under a constant pavement surface temperature of 32ºF or above.

628.2.2.11 Adhesion to Concrete

1 Ensure that the single component hybridized polymer pavement marking materials, when tested according to ACI Method 503, have such a higher degree of adhesion to the specified concrete (4000 psi minimum) surface that it results in a 100% concrete failure in the performance of this test. Condition the

prepared specimens at room temperature for a minimum of 24 hours and a maximum of 72 hours before the performance of the tests indicated.

628.2.2.12 Hardness

1 Ensure that the single component hybridized polymer pavement marking materials, when tested according to ASTM D2240, have a Shore D Hardness greater than 30. Cure samples at room temperature for a minimum of 24 hours and a maximum of 72 hours before performing the tests indicated.

628.2.2.13 Abrasion Resistance

1 Evaluate the abrasion resistance on a Taber Abrader with a 1000-gram load and CS-10 wheels at a duration of 1000 cycles. Calculate the wear index based on ASTM C501. Ensure that the wear index for the catalyzed material is not more than 50. Run the tests on cured samples of material that have been applied at a film thickness of 15 mils (±0.5 mil) to code S-16 stainless steel plates (to be run without glass spheres). Cure the samples at room temperature for a minimum of 24 hours and a maximum of 72 hours before performing the tests indicated.

628.2.3 Glass Beads

628.2.3.1 Composition

1 Ensure that the silica content of the beams is not less than 60%.

628.2.3.2 Physical Characteristics

1 Ensure that the glass spheres are colorless, clean, transparent, and free from milkiness or excessive air bubbles. Ensure that the glass beads have a minimum refractive index of 1.5 when tested by the liquid immersion method at 77°F. Use beads that are essentially free of sharp angular particles and particles showing surface scarring or scratching.

628.2.3.3 Gradation

1 Ensure that Type 1 and Type 4 glass beads meet the requirements of AASHTO M 247 with the following exceptions.

2 Glass beads are a minimum of 80% true spheres when tested according to ASTM D1155 and meet the gradation requirements when tested according to ASTM D1214 shown in the following table.

Percent by Mass Passing Designated Sieve (ASTM D1214)

Grading Designation Sieve Size (AASHTO)	Type 1	Type 4
No. 8	—	—
No. 10	—	100
No. 12	—	95 – 100
No. 14	—	80 – 95
No. 16	100	10 – 40
No. 18	—	0 – 5
No. 20	95 – 100	0 – 2
No. 25	—	—
No. 30	75 – 95	—
No. 40	—	—
No. 50	15 – 35	—
No. 80	—	—
No. 100	0 – 5	—

628.2.3.4 Bead Coating

1 Ensure that all beads are embedded and moisture proof coated with Potters Industries AC-100 series or an equivalent performance ensuring coating. Test the embedment coating by the Dansyl Chloride Method. Test the moisture proof coating by the following method:

A. Equipment:

1. Teaspoon
2. 500-ml beaker

B. Procedure:

1. Place approximately 400 ml of cold water in the beaker.
2. Fill a spoon with the coated beads and gently immerse them into the water.
3. Tap the spoon to force the mass of beads to fall to the bottom of the beaker. The material should maintain its initial shape for at least

1 hour. Some beads may fall from the agglomerated mass; however, there should not be a considerable dropping of beads before 1 hour.

628.2.4 Certification

1 Obtain from the manufacturer of the single component hybridized polymer material final certification that each batch of material furnished meets the requirements of these specifications. Also, obtain from the manufacturer of the glass beads certifications that each batch of material furnished meets the requirements of these specifications. Ensure that the certifications provided for the marking material or glass beads indicate the batch numbers used and include the manufacturer's production control tests for each batch. Ensure that certifications also include the manufacturer's safety data sheets. Furnish copies of the certifications to the RCE before the work commences.

628.2.5 Department Samples

1 The Department reserves the right to perform in-plant sampling of the finished single component hybridized polymer material or glass beads during packaging operations and/or sampling of the packaged single component hybridized polymer material or glass beads after they are received. The Department, as deemed necessary, may test the samples. Department inspectors or its designated agents will observe performance of all sampling. The inspectors will designate at random two containers from each batch to be sampled for testing and enclose a copy of the sampling inspection with the samples.

628.2.6 Marking and Packaging

1 Provide all materials used in the performance of the work in the manufacturer's original, undamaged packaging. Ensure that this packaging clearly shows the following information:

- Name of the manufacturer,
- Type of material packaged,
- Weight or volume of the material enclosed,
- Batch or lot numbers,
- Date of manufacture, and
- Color (if applicable).

628.3 Construction

1 Inventory and document the existing marking configurations before beginning any resurfacing project. Collect information sufficient to replace the markings in the existing configuration. Unless otherwise directed by the RCE, place the new markings in the documented configuration.

628.3.1 Equipment for Single Component Hybridized Polymer Pavement Markings

1 Use equipment for applying the single component hybridized polymer material that is truck-mounted and can apply the material at the manufacturer's recommended application temperature. Ensure that the equipment can automatically dispense beads immediately following application of the single component hybridized polymer material using a double drop system.

2 Use marking equipment that applies the single component hybridized polymer material at a uniform thickness of up to 25 mils and, in addition, can dispense beads at a constant rate of 25 lb/gal of marking material.

3 Ensure that the application equipment can distribute glass beads as required in **Subsection 628.3.4.1**.

4 Ensure that the application equipment is mobile and maneuverable, can follow straight lines, and can make normal curves in a true arc. Use equipment that is constructed to ensure continuous uniformity in the dimensions of the applied markings.

5 Ensure that the equipment can cleanly cut off square stripe ends and can provide a method of automatically applying "skip" or longitudinal lines, including right and left edge-lines, or any combination of single or double line configurations (color and pattern) as illustrated in the MUTCD. In addition, ensure that the controls are such that the operator can override set automatic cycles to extend a line or to begin a new cycle at any selected point.

6 Use equipment that can produce markings of varying widths as indicated in the Pavement Marking Plans, the MUTCD, the *Standard Drawings*, or the Contract.

7 Ensure that the equipment travels only in the direction of normal traffic flow during marking operations.

8 Ensure that the equipment is configured to allow the operator to see the pressure gauges for each type of proportioning pump at all times so that any fluctuation or pressure difference can be detected immediately.

9 Ensure that 6-digit electrical foot counters with a reset feature are installed on the marking equipment to individually tabulate the amount of footage applied by each striping gun.

10 Equip the marking equipment with a pressure regulated air jet that sprays all debris from the pavement in advance of the applicator guns that operate when marking material is applied. Synchronize the jets with marking material application, or remain "on" at all times.

628.3.2 Surface Preparation

1 Ensure that the pavement is dry and free of glaze, oil, dirt, grease, or other foreign contaminants. When directed by the RCE, remove any existing markings that conflict with the Pavement Marking before the application of single component hybridized polymer material. Use approved removal methods, which are shot blasting, sand blasting, water blasting, or grinding.

2 Where the existing symbol markings (e.g., arrows, words) differ from or conflict with the Plans, the MUTCD, or the *Standard Drawings*, the RCE will determine which governs. For symbol marking relocation or replacement, remove 95% of the conflicting markings by buffing, water blasting, sand blasting, or otherwise ensuring that the pavement surface is in proper condition for adequate bonding of the new single component hybridized polymer markings.

3 On Portland cement concrete surfaces including bridge decks, remove at least 95% of any existing markings by an approved method to provide for adequate bonding of the single component hybridized polymer material. Make the width of the removal 2 in. wider than the line to be applied.

4 When removing existing markings from the pavement surface, provide a positive means to control dust and accumulation of debris resulting from the removal operation. Capture the removed material using a separate vacuum equipped vehicle or other approved system to prevent its dispersal and to properly dispose of the material. Do not allow visible marking material debris to remain on the pavement shoulders. Ensure that the clean-up operations include removal and disposal of excess or waste materials away from the project site.

5 Ensure that the removal of dust and debris collection operations do not damage the existing pavement surfaces (concrete or asphalt) or damage the pavement joint materials. Repair any significant damage occurring from the removal operations to the satisfaction of the RCE at no additional cost to the Department.

6 Immediately before the application of the new marking material, clean all surfaces to be marked with a jet of compressed air. At the time of marking application, ensure that the pavement surface is free of dust, dirt, oil, grease, and any remaining loose or flaking marking material.

628.3.3 Application of Markings

628.3.3.1 General

1 Place all longitudinal markings with a truck-mounted applicator except where approved by the RCE. Such an exception may occur where the length of a particular marking is too short or the curvature too great to permit efficient use of a truck-mounted applicator. Such markings, including transverse markings, may be applied with a portable unit.

2 Ensure that markings are sharp, well defined, uniformly retroreflective (except black markings), and free of uneven edges, overspray, or other readily visible defects that, as determined by the RCE, detract from the appearance or function of the pavement markings. Non-retroreflective lines are unacceptable with the exception of black pavement markings. Remove and reapply pavement markings that are improperly applied or are not of uniform retroreflectivity at no additional cost to the Department, including furnishing of materials. Remove and reapply improperly located markings in the correct location at no additional cost to the Department, including furnishing of materials.

3 Ensure that the markings are straight or uniform in curvature and conform uniformly to tangents, curves, and transitions. Apply symbols of dimensions shown in the *Standard Drawings*. Ensure that line markings are of the dimensions shown on the Pavement Marking Plans or as directed by the RCE. Provide sufficient control points to serve as guides for the application of markings.

4 Ensure that the finished line markings are free from waviness and that lateral deviations do not exceed 2 in. in 100 ft. Remove and correct line markings with a deviation greater than 2 in. in 100 ft at no additional cost to the Department. Remove and correct any symbol markings not meeting the dimensional requirements of the Pavement Marking Plans and the *Standard Drawings* at no additional cost to the Department.

5 Protect the markings until dry by placing protective or warning devices as necessary. If a vehicle crosses the wet marking, re-apply the marking and remove any tracking lines made by the moving vehicle to the satisfaction of the RCE.

6 If the Contract includes sections of roadway where raised pavement markers are installed on the surface, do not apply marking material onto the reflective surface of the raised markers. If marking material is applied to the reflective marker surface, the RCE will suspend the work. Remove all marking material from the reflector unit, or remove and replace the damaged marker.

628.3.3.2 Rate of Application

1 Provide an adequate number of personnel experienced in the handling and application of this type of material to ensure that the work is performed properly.

2 Apply the single component hybridized polymer marking materials at the rate specified in the following table to produce a uniform 25 mil wet film thickness, calculated without drop-on beads.

Gallons of Material per Mile of Line

Line Width (inches)	Material for Solid Line (gallons)	Material for Broken Line (gallons)
4	27.5	6.875
6	41.25	10.375
8	55	—
12	82.5	—
24	165	—

3 Ensure that the application rates for solid lines in gore areas are not less than 1 gal per 64 sq ft of marking surface (25 mil thickness). The following table gives the application rate on a linear foot basis for shorter lengths of markings (gore markings and stop bars).

Linear Foot of Line per Gallon of Material	
Line Width (inches)	**Solid Line Length (feet)**
8	96
12	64
24	32

Heat the single component hybridized polymer to the manufacturer's recommended temperature before application to the pavement surface.

628.3.4 Glass Beads

628.3.4.1 Application of Glass Beads

1 Apply two sizes of glass beads by the double drop method. This method requires that the large and small glass spheres be injected into or dropped onto the liquid single component hybridized polymer marking immediately after the material is applied to the pavement surface while the pavement marking material is still wet to ensure that the beads are held by and mechanically embedded into the surface of the single component hybridized polymer material. Ensure that the beads are uniformly distributed over the entire surface of the marking material according to **Subsection 628.3.4.2**.

2 Apply the large beads first and immediately follow with the application of the small beads. Ensure that the beads adhere to the cured single component hybridized polymer, or cease all marking operations until corrections are made.

628.3.4.2 Double Drop Method

1 Use small glass beads meeting the gradation for Type 1 required in **Subsection 628.2.3.3**.

2 Use large glass beads meeting the gradation for Type 4 required in **Subsection 628.2.3.3**.

3 Apply large beads uniformly to the surface of the single component hybridized polymer material so that the beads are embedded at 60% of their diameter at a rate of 12 lb per gal of material. Immediately follow the application of the large beads with application of the smaller spheres at a rate of 12 lb per gal of material.

4 Ensure that the beads are properly imbedded and adhere to the cured single component hybridized polymer line; if not, cease all marking operations until corrections are made.

5 Ensure that the marking is uniformly retroreflectorized upon cooling.

628.3.5 Weather, Seasonal, and Other Limitations

1 Place single component hybridized polymer pavement markings only when the pavement is dry, as determined by visual inspection or other approved method, the pavement temperature is a 45°F or greater, and the air temperature is 40°F or greater. No work is allowed when any moisture is visible on the pavement surface or if the pavement is wet.

2 Provide each work crew with a hand-held infrared non-contact thermometer with a temperature range of 0°F to 1000°F to verify the minimum surface temperature and a pocket thermometer that can accurately measure air temperature. Measure air temperature away from heat generating equipment.

3 Application of markings may be disallowed on any day when, as determined by the RCE, moisture or temperature conditions are not satisfactory for obtaining quality pavement markings.

4 Do not apply single component hybridized polymer pavement markings between December 15 and March 15, inclusive.

5 Ensure that new asphalt concrete surfaces are in place a minimum of 14 days before marking application. Remove the curing compound on new Portland cement concrete surfaces before application.

628.3.6 Inspection and Acceptance

1 All single component hybridized polymer markings will be inspected for proper line thickness and width, proper adhesion, and proper cycle length. The markings will also be observed during both daytime and nighttime conditions to determine whether all the requirements of these specifications have been met.

Remove and replace markings that fail to have satisfactory appearance in either daytime or nighttime conditions at no additional cost to the Department.

2 The final acceptance of the single component hybridized polymer pavement markings will be delayed for a period of 180 days after the last date of marking on the project to permit observation of performance.

3 Traffic must be operating on the facility during the entire 180-day observation period unless otherwise directed.

4 Replace markings that, as determined by the RCE, have not performed satisfactorily during this 180-day period due to defective materials and/or workmanship.

5 Ensure that the pavement marking material shows no signs of failure due to blistering, excessive cracking, chipping, bleeding, staining, discoloration, oil content of the pavement materials, smearing or spreading under heat, deterioration due to contact with grease deposits, oil, or gasoline drippings, spilling, poor adhesion to the pavement materials, loss of retroreflectivity, and normal wear.

628.3.7 Retroreflectivity Requirements

1 Measure marking retroreflectivity using either a hand held or mobile retroreflectometer that uses 30-m CEN geometry. If a hand held unit is used, take measurements for all long lines in the direction of travel at intervals determined by the RCE. Ensure that mobile measurements comply with **Section 629**.

2 Ensure that the markings achieve the initial minimum retroreflectance values shown in the following table. Ensure that the values are obtained within 20 days of marking placement. Ensure that the finished markings are uniformly retroreflective as determined by visual inspection.

Retroreflectivity (mcd/lux/m^2)		
Drop-on Glass Beads	**White**	**Yellow**
Double Drop	375	250

3 Ensure that the markings maintain the minimum retroreflectance values shown in the following table for a period of 180 days. Take measurements within 20 days of the end of the observation period.

Retroreflectivity (mcd/lux/m^2)		
Drop-on Glass Beads	**White**	**Yellow**

Double Drop	325	200

4 Immediately replace any markings failing to meet the initial minimum retroreflectivity requirements by more than 50 mcd/lux/m² at no additional cost to the Department. Any markings failing to meet the initial requirements by less than 50 mcd/lux/m² may be reevaluated at the time of the 180-day evaluation unless the defect causing the lower readings is obvious to the RCE.

628.4 Measurement

1 The quantities for single component hybridized polymer pavement markings for lines are measured by the linear foot (LF) along the center of the pavement marking lines for each width and color of single component hybridized polymer pavement marking in-place, complete and accepted. The measurement is the length of the single component hybridized polymer pavement marking only and excludes spaces between broken lines.

2 The quantities for single component hybridized polymer pavement marking symbols (arrows, word, railroad crossing symbol) are measured by each (EA) symbol in-place, complete and accepted. A railroad-crossing symbol consists of "X RR."

3 Traffic control used during the performance of single component hybridized polymer pavement marking work is not measured under items covered by this Section but is included in the item Traffic Control according to **Subsection 601.4**.

4 Unless included in other bid items in the Contract, the work required to remove existing pavement markings is considered incidental work for single component hybridized polymer pavement marking work and is not measured separately.

5 Unless included in other bid items in the Contract, the work required to determine the no passing zones for two-lane facilities and to provide the Department with the data used in establishing the zones is considered incidental to the work under this Section and is not measured for payment.

628.5 Payment

1 Payment for the accepted quantity for each type of single component hybridized polymer pavement marking at the Unit Price is full compensation for furnishing all materials, labor, equipment, supplies, and incidentals necessary to complete the work as specified.

2 Removal of existing pavement markings is considered incidental to the other items of work, and no separate payment is made for this work unless separate pay items are included in the Contract.

3 Unless otherwise included in the Contract, traffic control for application and/or removal of pavement markings is included in the pay item Traffic Control according to **Subsection 601.5**.

4 Determination of the no passing zones for two-lane facilities and providing the Department with the data is considered incidental to the other various items of work, and no separate payment is made for this work.

5 Pay items under this Section include the following:

Item No.	Pay Item	Unit
6282005	4″ White Broken Lines - (Gaps Excluded) - Single Component Hybridized Polymer – 25 mils	LF
6282007	6″ White Broken Lines - (Gaps Excluded) - Single Component Hybridized Polymer – 25 mils	LF
6282008	6″ Black Broken Lines - (Gaps Excluded) - Single Component Hybridized Polymer – 25 mils	LF
6282010	4″ White Solid Lines - (Pavement Edge Lines) - Single Component Hybridized Polymer – 25 mils	LF
6282012	6″ White Solid Lines - (Pavement Edge Lines) - Single Component Hybridized Polymer – 25 mils	LF
6282015	8″ White Solid Lines - (Crosswalk & Channelization) - Single Component Hybridized Polymer – 25 mils	LF
6282020	12″ White Solid Lines (Gore Markings) Single Component Hybridized Polymer – 25 mils	LF
6282021	12″ White Solid Lines (Diagonal Lines) - Single Component Hybridized Polymer – 25 mils	LF
6282025	24″ White Solid Lines (Stop Lines/Diagonal Lines) - Single Component Hybridized Polymer – 25 mils	LF
6282030	White Single Arrows (Left, Straight, Right) - Single Component Hybridized Polymer – 25 mils	EA
6282035	White Word Message “Only” - Single Component Hybridized Polymer – 25 mils	EA

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Item No.	Pay Item	Unit
6282040	White Combination Arrow (Straight & Right or Straight & Left) - Single Component Hybridized Polymer – 25 mils	EA
6282043	White Lane Drop Arrow (Left or Right) - Single Component Hybridized Polymer – 25 mils	EA
6282045	Railroad Crossing Symbols - Single Component Hybridized Polymer – 25 mils	EA
6282105	4″ Yellow Broken Lines (Gaps Excluded) - Single Component Hybridized Polymer – 25 mils	LF
6282110	4″ Yellow Solid Lines (Pavement Edge & No Passing Zone) - Single Component Hybridized Polymer – 25 mils	LF
6282112	6″ Yellow Solid Lines (Pavement Edge & No Passing Zone) - Single Component Hybridized Polymer – 25 mils	LF
6282114	12″ Yellow Solid Lines (Diagonal Line) - Single Component Hybridized Polymer – 25 mils	LF
6282115	24″ Yellow Diagonal Line - Single Component Hybridized Polymer – 25 mils	LF