

SPECIFICATION

Integrated Multi-polymer Pavement Marking Material

1. Scope

- 1.1. This specification covers a reflectorized engineered multi-polymer pavement marking material that can be applied to road surfaces, including Portland Cement Concrete (PCC) and aged asphalt without need of a primer/sealer. However, primer is recommended for use on concrete and aged asphalt surfaces when used in extended warranty projects. The material is 100% solids and can be applied by standard thermoplastic application equipment at thicknesses as low as 60 mil and up to 120 mil. The applied thickness will have a direct correlation to product durability as thicker markings will result in greater durability. Long-term retro reflectivity is obtained through the incorporation of both AASHTO Type 1 and Type 3 glass beads in the product. Upon cooling to normal pavement temperature, HPS 8 provides a very durable marking material for low and high volume traffic areas. In order to qualify as a pavement marking that can be applied to concrete surfaces without a sealer, the material must meet or exceed the requirements listed in Section 5.

2. Referenced Documents

- 2.1. Federal Standards:
- Federal Test Standard No. 5958
 - AASHTO Standard Test Method M 249
 - AASHTO Standard Test Method T 250
 - ASTM Standard Test Method D 4796 (Bond Strength)
 - ASTM Standard Test Method D 5420 (Impact Resistance)
 - ASTM Standard Test Method D 4960 (Color)
 - Others as referenced within specification

3. Definitions

- 3.1. Retroreflective Optics:
- 3.1.1. Glass Beads: Spherical glass manufactured for use with pavement marking materials to provide retroreflective properties to the marking, allowing them to be visible when viewed at night under automobile headlights.
- 3.1.1.1. Small Glass Beads: Also referred to as standard glass beads. This can refer to a number of products of various sizes, but as defined in this document it refers to a glass bead product meeting the requirements of AASHTO M247 Type 1 or Type 2.
- 3.1.1.2. Large Glass Beads: These glass beads meet the requirements of AASHTO M247 Type 3 or Type 4 as called for in the specification.
- 3.1.1.3. High Refractive Index Glass Beads: These glass beads typically meet the requirements of AASHTO M247 Type 1 or Type 2 except the refractive index of the glass bead is between 1.70 and 1.95.
- 3.1.2. Composite Optics: A multi-component retroreflective particle comprised of a pigmented core (typically white or yellow combined with very small glass or ceramic beads having a refractive index of between 1.90 and 2.4)

4. Materials

- 4.1. The pavement marking material shall be homogeneously composed of pigments, resins, polymers (adhesive constituent), glass reflectorizing spheres and other fillers.
- 4.2. The pavement marking material shall be available in white, yellow, and black from the same manufacturer. The manufacturer shall have the option of formulating the material according to manufacturer's own specifications. However, certain physical and chemical requirements specified in Section 4 must be met.
- 4.3. The material shall not exude fumes which are toxic, or injurious to persons or properties upon heating to application temperature.
- 4.4. Retroreflective Optics (Drop On): Initial retroreflectivity is achieved by the application of retroreflective optics at the time that the marking material is applied to the pavement. The choice of retroreflective optics used on the marking may be specified by the purchaser or shall be specified by the material manufacturer. The selection of the specific optics used will have a direct effect on the level of retroreflective performance of the installed marking. For some typical drop-on recommendations refer to the appendix.
- 4.5. Specific Gravity – The specific gravity of the white and yellow pavement marking material shall not exceed 2.15.

5. Requirements

- 5.1. Composition – The pigment, intermix reflectorizing spheres, and fillers shall be uniformly dispersed in the resin and polymer upon heating to application temperature. The material shall be free of dirt and foreign matter and must meet or exceed the compositional requirements given in Table 1.

TABLE 1. COMPOSITION (Percentage by Weight)

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Test Component	White	Yellow (Heavy Metal Free)	Black
Glass Beads	48% min	48 % min	N/A
Pigment – TiO ₂	10% min	N/A	N/A
Organic Yellow	N/A	Federal Color	N/A
Resin/Polymer Content	21% - 26%	21% - 26%	21%-26%
Inert Fillers	16% - 21%	26% - 31%	N/A

Note 1: Glass Beads (Intermix): The intermix glass beads shall be either uncoated or coated with an adhesion promoting coating. One half (50%) of the intermix beads shall meet the requirements of AASHTO M247 Type 1. The other half (50%) of the intermix beads shall meet the requirements of AASHTO M247 Type 3.

Note 2: Heavy metal free yellow and black pigment content shall be formulated at the manufactures discretion provided all other requirements are met.

5.2 Physical Characteristics:

5.2.1 Color – The multi-polymer pavement marking material after heating for four hours \pm 5 min. at $218 \pm 2^\circ\text{C}$ ($425 \pm 3^\circ\text{F}$) and cooled to $25 \pm 2^\circ\text{C}$ ($77 \pm 3^\circ\text{F}$) shall meet the following when tested according to ASTM D4960:

White: Daylight reflectance – 80% min.

The white marking shall be a visual match to FED 595B 17886

Yellowness Index: 0.12 max.

Yellow: Daylight reflectance – 45% min.

The yellow marking shall be a visual match to FED 595B 13538 and lie within the following ranges:

$$x = 0.485 - 0.510$$

$$y = 0.445 - 0.470$$

5.3.1.1 The chromaticity and luminance factors shall be determined under the following standard conditions:

- a. Geometry: 45/0 degrees
- b. Direction of view: perpendicular to surface
- c. Illuminate/Observer conditions: CIE D65/2°

5.2.2 Bond Strength – After heating the multi-polymer pavement marking material for four (4) hours \pm 5 minutes at $218 \pm 2^\circ\text{C}$ ($425 \pm 3^\circ\text{F}$), the bond strength to Portland Cement Concrete (PCC) shall equal or exceed 300 psi when tested according to ASTM Standard Test Method for Bond Strength of Traffic Marking Materials – D 4796 or ASTM C321.

5.2.2.1 Failures of type described in Section 6.1 of ASTM D 4796, must be repeated to obtain a quantifiable number. Failure of types 6.2, 6.3, and 6.4 of ASTM D 4796-88 bond test, must exceed the specified bond strength given in Section 5.3.2. herein.

5.2.3 Low Temperatures Cracking (Stress) Resistance for Extended Period – The material shall be tested according to AASHTO T 250 modified for an extended cold temperature ($-9.4 \pm 2^\circ\text{C}$ ($15 \pm 3^\circ\text{F}$)) exposure period of 72 hours. Any cracking shall constitute failure of the material to qualify as a non-sealer aggressive bonding material for PCC road surfaces.

5.2.4 Impact Resistance (Gardner Falling Weight) – The test specimens should be formed according to the following procedure:

5.2.4.1 Heat approximately 1500 grams of material in an open quart can for 4 hours at $218 \pm 2^\circ\text{C}$ ($425 \pm 3^\circ\text{F}$).

5.2.4.2 Preheat specimen draw down blade, (2" X 4", with a 1/8" die opening) for approximately one hour at $218 \pm 2^\circ\text{C}$ ($425 \pm 3^\circ\text{F}$). The blade is usually placed in the oven containing the sample material during the last hour of sample heating.

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- 5.2.4.3 After heating the sample for four hours, remove the sample and the draw down blade from the oven. Place the 125 mil blade onto a PCC block.
- 5.2.4.4 Quickly pour the sample $218 \pm 2^{\circ}\text{C}$ ($425 \pm 3^{\circ}\text{F}$) into the opening of the draw down screed and draw down the sample for the entire length of the concrete block. Prepare two test specimens in this manner.
- 5.2.4.5 Allow the drawn down test samples to condition in the open in the standard laboratory atmosphere, $23 \pm 2^{\circ}\text{C}$ ($73.4 \pm 3^{\circ}\text{F}$) and $50 \pm 5\%$ relative humidity for 24 hours.
- 5.2.4.6 Perform the testing procedure according to ASTM test method D 5420 Section 11. Test one sample at room temperature $23 \pm 2^{\circ}\text{C}$ ($73.4 \pm 3^{\circ}\text{F}$). Condition the other sample by placing it in a cold box maintained at $0 \pm 2^{\circ}\text{C}$ ($32 \pm 3^{\circ}\text{F}$) for a period of 24 hours. Remove the sample from the cold box and test immediately upon removal. Record and report the type of failure as (a) radial cracking or surface cracking within or just outside the impact area of the striker, (b) cracks that penetrate the entire thickness, (c) brittle shatter (the test specimen shatters in several pieces after impact), or (d) ductile failure (the specimen is penetrated by a blunt tear).
- 5.2.4.7 Both the yellow and white materials shall have minimum impact resistance of 60 inch pounds (no visible surface cracks) when tested at $23 \pm 2^{\circ}\text{C}$ ($73.4 \pm 3^{\circ}\text{F}$) and a minimum of 10 inch pounds when tested at $0 \pm 2^{\circ}\text{C}$ ($32 \pm 3^{\circ}\text{F}$).
- 5.2.5 *Tabor Abrasion* – The multi-polymer pavement marking material after heating for four hours ± 5 min. at $218 \pm 2^{\circ}\text{C}$ ($425 \pm 3^{\circ}\text{F}$) and cooled to $25 \pm 2^{\circ}\text{C}$ ($77 \pm 3^{\circ}\text{F}$) shall have a maximum tabor abrasion loss of 350 mg when tested according to ASTM D4060. The test shall consist of 1000 cycles using CS17 wheels with a 1000 gram load. Test specimens shall be conditioned at room temperature for 72 hours before testing.
- 5.2.6 *Oil and Grease Resistance* – The multi-polymer pavement marking material shall show no signs of deterioration or solubility after motor oil is rubbed vigorously into a sample for 2 minutes and allowed to penetrate for 5 minutes.
- 5.2.7 *Set Time* – When applied at a temperature range of $211 \pm 7^{\circ}\text{C}$ ($412.5 \pm 12.5^{\circ}\text{F}$) and thickness of .090 to .125 inch the material shall set to bear traffic in not more than 2 minutes when the pavement surface temperature is $50 \pm 3^{\circ}\text{F}$ and not more than ten minutes when the pavement surface temperature is $130 \pm 3^{\circ}\text{F}$.
- 5.2.8 *Flash Point* – The multi-polymer pavement marking material shall have a flash point of not less than 260°C (500°F) when tested in accordance with ASTM D 92 “Flash and Fire Points by Cleveland Open Cup.”
- 5.2.9 *Retroreflectivity*:
- 5.2.9.1 Initial Retroreflectivity: The initial retroreflectivity of the pavement marking is dependent on the type of retroreflective optics applied at the time of the application of the pavement marking. Please refer to the Appendix for additional information.
- 5.2.9.2 Retained Retroreflectivity: Long-term retroreflectivity of the multi-polymer pavement marking material is provided by the intermix glass beads present in the material. The following minimum retroreflectivity values shall be maintained on non-wheel path areas throughout the service life of the marking:
- White: 150
Yellow: 150

6. Application Properties

- 6.1. The multi-polymer pavement marking material shall readily spray and extrude at temperatures of 204 to 218°C (400 to 425°F), from approved equipment and produce lines of 60 – 125 mil thicknesses. Application temperatures shall not exceed 232°C (450°F).
- 6.2. The material shall not exude fumes which are toxic, obnoxious or injurious to persons or property when it is heated during application.

7. Application, Sampling and Testing

7.1. Material Application Surfaces:

7.1.1. Asphalt Road Surfaces:

- 7.1.1.1. Existing thermoplastic markings may be overlaid with multi-polymer pavement marking providing that the existing markings are less than 30 mils thick, and are securely bonded to the substrate. If the markings are

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greater than 30 mils and securely bonded to the substrate, then it shall be ground to 30 mils, or removed completely if not securely bonded to the road.

- 7.1.1.2. Existing solvent based paint may be over laid with multi-polymer pavement marking provided that more than 75% of the road surface is exposed, and there is no more than a single coat of paint on the remaining unexposed area. If more than one layer of paint exists, the paint is not securely anchored to the substrate, or there is less than 75% of the road surface exposed, then the paint must be thoroughly removed.
- 7.1.1.3. Existing waterborne paint may be over laid with multi-polymer pavement marking provided that it is a single layer of paint not more than 10 mils in thickness with minimal drop on glass bead coverage. Waterborne paint markings that do not meet these criteria must be removed prior to the application of the multi-polymer pavement marking material.
- 7.1.1.4. Existing polyester, epoxy, or other type pavement marking paints must be completely removed from all road surfaces prior to the installation of multi-polymer pavement marking material.

7.1.2. Concrete (PCC) Road Surfaces:

- 7.1.2.1. All existing thermoplastic, polyester, epoxy, or other type pavement marking paints must be removed completely.
- 7.1.2.2. Surface Preparation and Curing Compound Removal- Clean, and remove curing compound as necessary to insure that the markings adhere to the pavement. Obtain approval for all surface preparation methods prior to implementing.
- 7.1.2.3. Pavements shall be free of grease, oil, mud, dust, dirt, grass, loose gravel and other deleterious material, prior to applying pavement markings.
- 7.1.2.4. Prepare the pavement surface, including removal of curing compound, a minimum of 2 " inch wider than the pavement markings to be placed, such that, an additional 1 inch of prepared area is on all sides of the pavement markings after they are applied.
- 7.1.2.5. Remove all curing compound and surface laitance from application area of Portland cement concrete pavements. Remove where pavement markings will be placed. Perform curing compound removal by shot blasting, sand blasting, or water blasting. Ensure that the surface is free of all residue, laitance and debris prior to applying the pavement marking.
- 7.1.2.6. When surface preparation and curing compound removal operations are completed, blow the pavement surface clean by compressed air to remove residue or debris.
- 7.1.2.7. Conduct all pavement surface preparation including curing compound removal in such a manner that the pavement or joint material is not damaged or left in a condition that will mislead or misdirect the motorist. Repair any damage caused to the pavement, or joint materials caused by surface preparation or the removal of curing compound by acceptable methods. Where pavement surface preparation results in obscuring existing pavement markings of a lane occupied by traffic, immediately remove the residue, including dust, by approved methods.

- 7.1.3. Primer Application—Although a primer is not required for this product on concrete pavements, it is recommended for use on concrete and aged, oxidized asphalt pavements when used in extended warranty projects. The primer shall be a two part epoxy primer recommended by the pavement marking manufacturer and shall be applied at the rate and in the manner specified. For concrete pavements the requirements spelled out in 7.1.2 shall be followed prior to the application of the primer and the pavement marking.

- 7.2. Material Application: Durability of road markings is directly related to the applied mil thickness of the multi-polymer pavement marking material. Therefore, in order to achieve the performance described herein, the subsequent requirements listed below must be followed:

- 7.2.1. Pavement Surface: The pavement surfaces where the multi-polymer pavement marking is to be applied must be clean and dry and at a minimum temperature of 50°F to 65°F and rising depending upon the application method being used (Screed extrude @ 50°F, Spray @ 55°F and Ribbon extrude @ 65°F). Even though the surface may appear dry, it is best to check for sub-surface moisture to improve bond and minimize moisture pops. Check by taping a one foot square piece of clear plastic down on the roadway and observe for 30 minutes to see if moisture forms. One can also check by pouring some hot thermoplastic onto a piece of tar paper which is on top of the surface to be striped, wait 5 minutes, and see if moisture was drawn up onto the road surface under the tar paper. If moisture appears by either of these methods, we recommend you do not apply thermoplastic. When in doubt, always check adhesion.

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7.2.2. Air Temperature: The minimum ambient air and wind chill temperature should be no less than 50°F and rising at the time of actual marking. The temperature should be verified at the start of each day's work and monitored accordingly throughout the day. Failure to comply with temperature specifications can lead to premature bond failure.

7.2.3. Application Thickness: All minimum application thicknesses shall be measured above the plane of the road surface and include the multi-polymer pavement marking material only. Drop-on retroreflective optics shall not be included in the measurement, or if so, then appropriate allowances shall be made for the added mil thickness. Recommended application thicknesses are as follows for inlaid or non-snowplowable installations:

New construction with anticipated service life of 8 - 12 years

Longitudinal Edge Lines	100 mils
Longitudinal Skip Lines	100 mils

Refurbishment / maintenance with anticipated service life of less than 3 - 5 years

Longitudinal Edge Lines	60 - 90 mils
Longitudinal Skip Lines	60 - 90 mils

For non-inlaid snowplow areas the service life of the markings will be reduced based on the level of snow removal activities.

7.2.4. Drop on Retroreflective Optics Application:

The choice of retroreflective optics applied to the multi polymer pavement marking material will have a direct correlation on the initial retroreflective performance of the applied markings. Regardless of the choice of optics used, the application shall result in the embedment of the optic in the pavement marking at 50 – 65% below the surface of the pavement marking. All drop on retroreflective optics shall have a coating with both adhesion and moisture resistant properties and shall be approved for use by the manufacturer of the pavement marking. For additional information refer to the Appendix.

7.3. Inspection:

Success of the project depends upon the proper continuous inspection of the installation process by authorized DOT personnel. Failure to properly monitor and record compliance with the manufacturer's recommended procedures, or specification application requirements can lead to a substandard installation.

The multi-polymer pavement marking material supplied by the manufacturer shall be manufactured in accordance with the specifications described herein. A verifiable material certification report showing detailed analysis and compliance shall be provided by the material manufacturer, and submitted to the State Inspecting Engineer by the contractor performing the installation work, and made part of the Inspecting Engineer's project file.

8. Limitations:

- 8.1. Apply a test strip to determine if surface is dry enough if there has been rain in the last 24 hours.
 - 8.1.1. Do not apply if hot material shows moisture bubbles.
- 8.2. Do not heat the integrated multipolymer above 450°F.
- 8.3. Do not apply when road and ambient temperatures are below 50°F.
- 8.4. Do not apply when dew point is within 5 degrees of the ambient temperatures.
- 8.5. Material at application is hot – wear personal protective equipment as described in SDS

9. Storage Life

The material shall maintain the requirements of this specification for a minimum period of one year. When properly stored the multi-polymer pavement marking material must melt uniformly with no evidence of skins or unmelted particles for this one year time period. Any material failing to do so shall be replaced by the manufacturer at their expense. Proper storage includes inside or covered storage to protect from moisture, and temperatures below 120oF. Outside storage for short intervals is acceptable as long as the material is kept dry.

10. Packaging and Markings

The multi-polymer pavement marking material shall be sold in one ton increments (2000 pounds). The material shall be packaged in suitable containers to which it will not adhere during shipment and storage. The container of the multi-polymer pavement marking material shall weigh approximately 50 lb. (23kg). Each container shall designate user

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information, manufacturer's name and address, batch number and date of manufacture. Each batch manufactured shall have its own separate number. The label shall carry appropriate user warnings and instructions.

Appendix (Non-mandatory Information)

Drop On Retroreflective Optics: The choice of retroreflective optics applied to the multi polymer pavement marking material at time of application will have a direct correlation on the initial retroreflective performance of the applied markings. The table below provides an example of typical initial retroreflectivity performance levels expected with various types or combination of types of drop on optics.

Dry Retroreflectivity (ASTM E1710)*	Class 1	Class 2	Class 3
White (mcd/m ² /lux)	300	450	700
Yellow (mcd/m ² /lux)	200	350	500

Typical retroreflective optics applications: The following are typical retroreflective optics applications that can be used to achieve the retroreflectivity performance outlined in the table in Section 1 above. The type of retroreflective optics and drop rates shall be at the option of either the purchaser or the manufacturer, providing all other requirements of this specification are met. NOTE: This is not intended to be all inclusive.

1. **Class 1:** Class 1 markings may be applied with a single drop on application of either AASHTO M247 Type 1 or Type 2 glass beads applied at a rate of 8 – 10 lbs. per 100 ft².
2. **Class 2:** Class 2 markings may be applied with a double drop optic application with the first drop consisting of approximately 8 – 10 lbs. / 100 ft² of AASHTO Type 3 or Type 4 glass beads and the second drop consisting of approximately 6 – 8 lbs. / 100 ft² of AASHTO Type 1 or Type 2 glass beads.
3. **Class 3:** Class 3 markings may be applied with either a single drop application of high index beads or a multi-drop application of a combination of retroreflective optics of which one component is a high refractive index bead or a retroreflective composite optic.