

**California Department of Transportation
Specification for
Thermoplastic Traffic Striping Material,
Hydrocarbon Resin Binder, White and Lead-Free Yellow**

1.0 SCOPE

This specification covers a hot-melt, retroreflective, thermoplastic traffic marking material that is suitable for producing durable traffic stripes and pavement markings on Portland cement concrete or asphalt concrete pavements. This material is heated and applied to road surfaces in a molten state using a mechanical applicator. While still hot, reflectorizing glass beads are applied to the surface of the applied thermoplastic striping material. Upon cooling to normal pavement temperatures this material shall produce durable, adherent, retroreflective traffic stripes and pavement markings that are capable of resisting deformation by traffic.

2.0 APPLICABLE SPECIFICATIONS

The following specifications, test methods and standards in effect on the opening date of the Invitation for Bid form a part of this specification where referenced.

- California Test Methods CT 423 and CT 660 (latest revision).
- California Department of Transportation (Caltrans), Standard Specifications.
- AMS-STD-595A, color 33538.
- U.S. Environmental Protection Agency (EPA), SW-846, Methods 3052 and 6010B.
- American Association of State Highway and Transportation Officials, (AASHTO) Designation: M 247 and AASHTO Designation: T 250.
- American Society for Testing and Materials, (ASTM) Designations; D 476, D 2794, D 3335, D 3718, D 4563, D 4764, D 5380, D 5381, D 6359, D 6628, E 11, E 28, E 313, E 1710, and G 154.
- Commission International de l'Eclairage (C.I.E.) 1931 Chromaticity Diagram.
- California Code of Regulations: Title 22.

3.0 REQUIREMENTS

3.1 Composition:

The thermoplastic material shall be composed of 100% solids. The binder shall consist of synthetic hydrocarbon thermoplastic resins which are homogeneously blended together with all necessary prime pigments, fillers, glass beads and additives to produce a traffic striping material that meets the requirements as specified herein. All thermoplastic material shall be free from; lead, chromium, cadmium, barium and other toxic metals.

3.1.1 White Material:

White thermoplastic shall contain a minimum of 10% (by weight) of titanium dioxide pigment meeting ASTM D476 Type II (Rutile). The titanium dioxide content will be determined using ASTM Designations; D 4563, D 4764, D 5380 or other x-ray diffraction analysis method. White thermoplastic must meet the Retroreflectivity requirement when applied with drop-on glass beads.

3.1.2 Lead-Free Yellow Material:

Lead-Free (L/F) yellow thermoplastic shall contain proper amounts of C.I. Pigment Yellow 83 (opaque version) and titanium dioxide (Rutile) to produce a yellow material that has a weather-fast and heat stable yellow color which meets the; Yellow Color, Reflectance, Color Stability (Accelerated Weathering) and Retroreflectivity requirements as stated herein. Other pigments may be added to achieve these color requirements. The L/F yellow thermoplastic material shall appear yellow during both daytime and nighttime conditions when applied with drop-on beads.

3.1.3 Other Ingredients:

The remainder of the thermoplastic composition shall be determined by the manufacturer - within the constraints of the requirements below. It shall be the manufacturer's responsibility to produce a thermoplastic material containing the necessary plasticizers, antioxidants, and other additives so that the thermoplastic will retain its color, viscosity and all other properties as specified herein. In addition to being

essentially lead and chromium free, the thermoplastic shall not contain any hazardous materials at levels that would cause the thermoplastic to be classified as a hazardous waste under Title 22, Division 4, section 66261.20 of the California Code of Regulations.

3.2 Form:

The thermoplastic material shall be supplied in either block or granular form as requested in the purchase order.

3.3 Application Type/Viscosity:

Two viscosity grades of thermoplastic material shall be available for purchase; Extruded-Viscosity and Low-Viscosity. Extruded-Viscosity grade is more suitable for screed type applicators and thicker applications (98 mils), including recessed applications. Low-Viscosity grade material is commonly used with ribbon or spray type applicators. The thermoplastic material shall be formulated to meet the viscosity grade specified in the purchase order.

3.4 Characteristics of the Finished Thermoplastic:

Use CT 423 unless otherwise specified.

Section Number	Material	White	L/F Yellow
3.4.1	Glass Bead Content, intermixed, Percent by weight. Glass beads shall meet AASHTO Designation: M 247 Type I, except the glass beads shall not contain more than 200 ppm (total) arsenic, 200 ppm (total) antimony, nor more than 200 ppm (total) lead, when tested according to EPA Methods 3052 and 6010B. Other suitable x-ray fluorescence spectrometry analysis methods may be used to screen samples of glass beads for arsenic, antimony and lead content.	30-35	30-35
3.4.2	Binder Content, percent by weight, minimum	18	18
3.4.3	Inert Fillers, insoluble in hydrochloric acid, percent passing a sieve with openings of 150µm, percent by weight,	100	100

Section Number	Material	White	L/F Yellow
	minimum, ATSM Designation: E-11.		
3.4.4	Titanium Dioxide (Rutile) Pigment meeting ATSM Designation D476 Type II, analyze titanium dioxide content using ASTM Designation: D 4563, D 4764, D 5380, or other x-ray diffraction method, percent by weight, minimum.	10	---
3.4.5	Specific Gravity, maximum.	2.15	2.15
3.4.6	Ring and Ball Softening Point, ATSM Designation: E 28.	93-121°C	93-121°C
3.4.7	Perform the remaining tests on the material after 4 hours heating with stirring at 425 F. This 4-hour period includes time required (~1 hour) for melting and temperature stabilization of the 6 kg sample.		
3.4.7.1	Tensile Bond Strength to an unprimed abrasive blasted Portland cement concrete brick, 125 mils thick film drawn down at 425°F, tested at 25±3°F, MPa, minimum	1.24 MPa	1.24 MPa
3.4.7.2	Brookfield Thermosel Viscosity, Low-Viscosity Grade Extrude-Viscosity Grade Spindle SC4-27, 20 rpm at 425 F, Poise	≤45 45-100 100	≤45 45-100
3.4.7.3	Daylight Luminous Reflectance, Use a BYK-Gardner "Color-Guide" spectrophotometer. Follow the manufacturer's instructions to obtain the reflectance or "Y value".	80 min	42-59
3.4.7.4	Yellow Color, shall match AMS-STD-595, color 33538 and shall lie within the following chromaticity limits "colorbox" defined by plotting the following four (x,y) pairs on a C.I.E 1931 Chromaticity diagram;	---	Pass

Section Number	Material	White	L/F Yellow
	<p>(x1, y1)=(0.5125, 0.4866) (x2, y2)=(0.4450, 0.4300) (x3, y3) = (0.4600, 0.4150) (x4, y4) = (0.5348, 0.4646) Reflectance(Y) shall be between 42 and 59. Use a BYK-Gardner "Color-Guide" Spectrophotometer to measure the color. Follow the manufacturers instructions to obtain the (x, y) chromaticity coordinates.</p>		
3.4.7.5	<p>Yellowness Index, maximum Use a BYK-Gardner "Color-Guide" Spectrophotometer to measure the Yellowness Index of the white thermoplastic using the ASTM Designation: E313 mode.</p>	10	----
3.4.7.6	<p>Color Stability after Accelerated Weathering, ASTM Designation: G 154, Table X2.1, Cycle 1; UVA-340 lamp, 0.89 W/(m²*nm) typical irradiance, 340 nm approximate wavelength, four hours condensation at 40°C, four hours UV exposure at 60°C. 500 hours total exposure time. Prepare sample by dipping a sheet aluminum panel into the molten thermoplastic and removing it to obtain a 60 to 120 mils coating thickness of thermoplastic on the panel. Place the panel in the weathering apparatus for 500 hrs. After accelerated weathering, measure the Yellow Color or Yellowness Index as in section 3.4.7.4 or 3.4.7.5 above. Material must meet the color stability requirements below after this exposure.</p> <p>White - Yellowness Index, maximum 20 --- Yellow - Measured chromaticity --- Pass</p> <p>must fall within a "colorbox" defined by plotting the following four (x, y) pairs on a C.I.E. 1931 Chromaticity diagram. See attached Yellow Color graph.</p> <p>(x1, y1) = (0.5125, 0.4866) (x2, y2) = (0.4450, 0.4300) (x3, y3) = (0.4600, 0.4150) (x4, y4) = (0.5348, 0.4646)</p>		

Section Number	Material	White	L/F Yellow
3.4.7.7	Hardness, Type A Needle-type Durometer Note: Thermoplastic for recessed application shall have a Hardness between 30 and 50.	45-75	45-75
3.4.7.8	Lead, mg/kg in thermoplastic, maximum, ASTM D3335	20	20
3.4.7.9	Chromium, mg/kg in thermoplastic, maximum, ASTM D3718	5	5
3.4.7.10	Initial retroreflectivity of applied thermoplastic striping (with beads), $\text{mcd}\cdot\text{m}^{-2}\cdot\text{lx}^{-1}$, minimum The thermoplastic shall produce delineation and pavement markings that have the required minimum level of retroreflectivity when applied with drop-on beads. Drop-on glass beads shall be uniformly applied at a minimum rate of 4-kg of beads per 10 square meters of thermoplastic. The retroreflectivity shall be measured as specified in ASTM D6359-99 using a retroreflectometer meeting ASTM E1710-97.	250	125
3.4.7.11	Color after Application The daytime color of the applied white and yellow thermoplastic traffic stripes and pavement markings (with drop-on beads) shall meet the color requirements in section 3.4.7.6 (Color Stability after Accelerated Weathering). The color shall be measured within 60 days of application using a portable BYK-Gardner "Color-Guide" Spectrophotometer (see sections 3.4.7.4 and 3.4.7.5).		

3.5 Other Requirements:

3.5.1 Melting and Applicability:

Bags of thermoplastic shall not harden during shipment and storage to the point where the material must be broken-up with tools before loading into the melter. When heated, the

thermoplastic material shall completely melt to a homogeneous fluid with satisfactory application qualities and shall be free of debris. The molten thermoplastic material shall be readily applied at temperatures between 400 F and 450 F. Upon application to the pavement, the thermoplastic material shall be sufficiently tack-free to carry traffic; in not more than 2 minutes when the pavement surface temperature is 60 F, and in not more than 10 minutes when the pavement surface temperature is 130 F.

3.5.2 Workmanship:

The materials' ingredients (resins, pigments, glass beads, fillers and additives) shall be homogeneously blended. The finished product shall be uniform from bag to bag. The melted thermoplastic material shall have no indications of resin separation or incompatibility of resins when melted or after cooling. The material shall be free from all; dirt, water, foreign matter, and other deleterious substances capable of clogging; screens, valves, pumps and other striping apparatus. The thermoplastic material shall be of such composition that it will not bleed, stain, or discolor when applied to pavements.

3.5.3 Shelf Life:

The material shall maintain the requirements of this specification for a minimum period of one (1) year from the date of manufacture. Any materials failing to do so shall be replaced at the expense of the manufacturer. Ordered thermoplastic shall be no more than 120 days old (based on date of manufacture) upon delivery to a Department of Transportation Maintenance facility. The date of manufacture shall be clearly marked on each bag of thermoplastic.

3.5.4 Air Pollution Compliance:

This material shall comply with all applicable air pollution control rules and regulations. The thermoplastic material shall not emit fumes that are toxic or injurious to persons or property when it is heated to application temperature. The material shall not emit excessive smoke during heating or application.

For questions, please contact Caltrans, Division of Engineering Services, Materials and Engineering Testing Services, Chemical Laboratory branch by e-mail sent to <Chemistry.Branch@dot.ca.gov>.