

**California Department of Transportation
Specification for
Sprayable Thermoplastic Traffic Striping Material,
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, 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.
- American Society for Testing and Materials, (ASTM) Designations; D 476, D 2794, D 3335, D 3718, D 5380, D 5381, D 6628, E 11, E 28, E 313, E 1621, 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 hydrocarbon or alkyd 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. The type of resin binder (alkyd or hydrocarbon) may be specified in the purchase order. 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) titanium dioxide pigment meeting ASTM D476 Type II (Rutile). The titanium dioxide content will be determined using ASTM Designations; D 5380 and E 1621. 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 granular or pelletized form as requested in the purchase order.

3.3 Application Type/Viscosity:

The thermoplastic material shall be suitable for air-atomized spray application at temperatures between 350 F and 400 F. The viscosity of the molten material at these temperatures shall be suitable for applying thermoplastic traffic stripes that are 40 mils thick.

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	25	25
3.4.3	Inert Fillers, insoluble in hydrochloric acid, percent passing a sieve with openings of 150µm, percent by weight, minimum, ATSM Designation: E-11.	100	100
3.4.4	Titanium Dioxide (Rutile) Pigment meeting ASTM Designation D476 Type II. Analyze titanium dioxide content using ASTM Designation: D 5380 and E 1621 percent by weight, minimum.	10	---

Section Number	Material	L/F	
		White	Yellow
3.4.5	Specific Gravity, maximum.	2.10	2.10
3.4.6	Ring and Ball Softening Point, ATSM Designation: E 28.	90-121°C	90-121°C
3.4.7	Perform the remaining tests on the material after 4 hours heating with stirring at 375°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, 60 mils thick film drawn down at 375°F, tested at 25±2°C, MPa, minimum	1.24 MPa	1.24 MPa
3.4.7.2	Brookfield Thermosel Viscosity, Spindle SC4-27, 20 rpm at 191°C, Poise	≤20	≤20
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	47-60
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; (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 47 and 60. Use a BYK-Gardner "Color-Guide" Spectrophotometer to measure the color. Follow the manufacturer's instructions to obtain the (x, y) chromaticity coordinates.	---	Pass

Section Number	Material	L/F	
		White	Yellow
3.4.7.5	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.	8	----
3.4.7.6	Color Stability after Accelerated Weathering, ASTM Designation: G 154, Table X2.1, Cycle 1; UVA-340 lamp, 0.89 W/(m ² *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 40 to 80 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. White - Yellowness Index, maximum 20 --- Yellow - Measured chromaticity --- Pass coordinates 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. (x1, y1) = (0.5125, 0.4866) (x2, y2) = (0.4450, 0.4300) (x3, y3) = (0.4600, 0.4150) (x4, y4) = (0.5348, 0.4646)	20	---
3.4.7.7	Hardness, Type A Needle-type Durometer	20-65	20-60
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), mcd•m ⁻² •lx ⁻¹ , minimum	250	125

Section Number	Material	White	L/F Yellow
	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 E 1710.		
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 Manufacturer Quality Assurance Program:

3.5.1 CTB Certificate of Compliance Program:

Follow the Chemical Testing Branch Certificate of Compliance (COC) Program (See attachments 1 and 2).

3.6 Other Requirements:

3.6.1 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 350°F and 400°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.

3.6.2 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 stripping apparatus. The thermoplastic material shall be of such composition that it will not bleed, stain, or discolor when applied to pavements.

3.6.3 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.

3.6.4 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>.

Certificate of Compliance

State Specification Type: **PTH-02SPRAY, (January 2022)**

Manufacturer's Product #: _____

ID #s of batches comprising the lot and lot number: _____

Lot Quantity: _____ Date COC Issued: _____

Date of Manufacture: _____ Color: _____ Viscosity Type _____

Issued To:
{Contractor Name here}
{State Project Number here}
{Dist-County-Route}

CC:
California Department of Transportation
OCL, Chemical Testing Branch
5900 Folsom Boulevard
Sacramento, CA 95819

The {Manufacturer} representatives whose signatures are below certify that this lot of thermoplastic meets or exceeds the requirements in Section 84-2 of the 2018 and 2022 Standard Specifications, and all the specification requirements in the current State Specification listed above.

Attach a certificate of compliance and test results from an independent laboratory for each lot of intermixed glass beads used in the thermoplastic formulations.

Batch Test Results

Quality Characteristic	Test Method	Date Tested	Test Result	Tested By	Requirement
Brookfield Thermosel Viscosity, 20 rpm, 375°F, Poise	CT 423				≤ 2
Hardness, Shore A-2 Durometer 115°F	CT 423				20-65
Yellowness Index, white only, max	CT 423				8
Daytime Luminance Factor	CT 423				White ≥ 80 Yellow – 47-60
Yellow Color, yellow only	CT 423				Within color box
Glass Bead Content, %	CT 423				30-35
Binder Content, %, min	CT 423				25

Intermix Glass Bead Test Results

Quality Characteristic	Test Method	Test Results	Requirement
Lead content, mg/kg	EPA Test Method 3052 and 6010B or 6020C		<200
Arsenic content, mg/kg	EPA Test Method 3052 and 6010B or 6020C		<200

Certified by (person in charge of testing):

Executed by (authorized representative of manufacturer):

Name

Name

Title

Title

Attachment 2: Thermoplastic Certificate of Compliance Program Diagram

**Chemical Testing Branch
Certification of Compliance Program**

Revision date: 1/19/2022

