

# **SPECIFICATIONS FOR INVERTED PROFILE TRAFFIC STRIPE MATERIAL**

## **1. DESCRIPTION:**

This section shall cover the work of furnishing all materials, equipment, and the application of the materials to form an inverted profile thermoplastic traffic stripe that is hot applied to the pavement surface. This traffic stripe shall be formed during applications with an inverted profile that will rapidly drain water from the highway surface. This rapid draining shall allow the traffic stripe to be highly reflective in heavy rain. Unless specifically ordered in writing, no section of road shall be opened to traffic without a traffic stripe having been placed.

This type traffic stripe shall be designated as "Inverted Profile Traffic Stripe".

## **2. Materials:**

### **2.1 GENERAL.**

This provision covers machine applied hot Hydrocarbon thermoplastic pavement marking material with both intermixed and drop-on glass beads for use in Inlaid Inverted Profile Traffic Stripe.

### **2.2 THERMOPLASTIC MATERIAL.**

The thermoplastic material used for hot Hydrocarbon applications shall consist of homogeneously mixed pigments, fillers, resins, fibers, glass beads, and shall be available in both white and yellow colors.

The thermoplastic material shall be free of contaminants and shall be dry blended from 100% virgin stock using no reprocessed materials. The thermoplastic material, while on the roadway surface and at any natural ambient temperature shall exist in a hard solid state with cold ductility that permits normal movement with the road surface without chipping and or cracking.

The material manufacturer shall meet the minimum requirements specified herein including, but not limited to, composition, physical characteristics, etc. The physical and chemical properties contained in this specification shall apply regardless of the type of formulation used.

The thermoplastic material upon heating shall not exude fumes, which are toxic, or injurious to persons or property.

The thermoplastic material shall not deteriorate or discolor when held at the application temperature for periods of time up to 4 hours, or upon reheating to the application temperature for a period of time not to exceed 4 hours.

The thermoplastic material shall be readily applicable at temperatures between 400°F to 430° F (204°-221°C) from the approved equipment to produce lines of the required type and thickness above the pavement surface as described elsewhere in the specification.

**2.3 COMPOSITION:**

The pigment, beads, resin, and filler shall be a uniform blend. The material shall be free from all skins, dirt, and foreign objects and shall comply with requirements according to Table I.

TABLE I		
Components	Composition By Mass	
	White	Yellow
Binder	18% Minimum	18% Minimum
Glass Beads (Intermixed)	35%	35%
Titanium Dioxide (For White Material Only)	10% Minimum	N/A
Yellow Pigment (For Yellow Material Only)	N/A	4% Minimum
Calcium Carbonate & Inert Filler	See Note "A"	See Note "A"
Cross Link Fibers	0.005%	0.005%
NOTE "A": The amount of calcium carbonate and inert fillers shall be at the Option of the manufacturer, providing all other requirements of the Specifications are met.		
OTHER INGREDIENTS: Titanium Dioxide ASTM D 476, Type II		

**2.4 INTERMIX GLASS BEADS (CLASS A).**

The thermoplastic composition shall have a minimum total Intermix Glass Bead content of 35% by mass. The glass beads shall be AASHTO M 247 Type I with an AC 07 adhesion coating, or equivalent silane coating, and 70% round or true spheres.

**2.5 DROP ON GLASS BEADS.**

Drop on glass beads used in both coats shall conform to State Standard Specifications and shall have a moisture proof coating. Sampling shall be done according to the applicable State Specification.

**2.6 PHYSICAL CHARACTERISTICS.**

**(a) COLOR.**

The thermoplastic pavement marking material shall meet the following requirements for daylight reflectance and color when tested using a standard color difference meter (0°-45°) CIE, Illuminant C, and a magnesium oxide standard or an approved secondary standard. (ASTM reference number 1925)

**White:** Daylight reflectance at 45°-0° of 80% minimum and match federal test standard number 595a, Color 17886)

**Yellow:** Daylight reflectance at 45°-0° of 45% minimum and match federal test standard number 595a, (Color 13538), which shall fall within the limits of FHWA highway color tolerance chart, PR color #1.

**Chromaticity:** Coordinates X and Y shall fall in an area bordered by these coordinates:

X	0.470	0.510	0.490	4.537
Y	0.455	0.489	0.432	0.462

**(b) REFLECTIVITY.**

The initial reflectance for the in-place marking shall have the minimum reflectance values shown as follows, as obtained with a Mirolux 12 Retroreflectometer.

Dry Night	White - 450 mcd/lux/m <sup>2</sup>	Yellow - 300 mcd/lux/m <sup>2</sup>
Wet Night	White - 200 mcd/lux/m <sup>2</sup>	Yellow - 175 mcd/lux/m <sup>2</sup>

**(c) WET NIGHT TEST PROCEDURE.**

Mark or delineate a 1 m long section of pavement marking to be tested. Utilizing a pump type garden sprayer, wet the test section for 5 seconds with water so that the pavement marking is thoroughly

wet. Wait 30 seconds after wetting the stripe and place the Mirolux 12 Retroreflectometer on the previously wet test section.

**(d) YELLOWNESS INDEX.**

The white thermoplastic material shall not exceed a yellowness index of 0.15. (AASHTO T 250)

**(e) BOND STRENGTH.**

The bond strength of the thermoplastic material to Portland Cement Concrete shall exceed 180 Psi (1.24 Mpa). (ASTM D 4796-88)

**(f) CRACKING RESISTANCE AT LOW TEMPERATURE:**

The thermoplastic pavement marking material shall pass. (AASHTO T 250)

**(g) IMPACT RESISTANCE.**

The impact resistance of the thermoplastic pavement marking material shall be a minimum of 10 inch pounds (1.1 Joules). (AASHTO T 250)

**(h) SOFTENING POINT.**

The thermoplastic material shall have a softening point of not less than  $248^{\circ} \pm 17.1^{\circ}\text{F}$  ( $120^{\circ} \pm 9.5^{\circ}\text{C}$ ). (ASTM D 36)

**(i) DRYING TIME.**

When applied at a temperature of between  $400^{\circ}\text{F}$  to  $430^{\circ}\text{F}$  ( $204^{\circ}$ - $221^{\circ}\text{C}$ ), and at a thickness of .160" (4 mm), the thermoplastic material shall set to bear traffic in not more than two minutes when the air temperature is  $50^{\circ}\text{F}$  ( $11^{\circ}\text{C}$ ) and not more than 10 minutes when the air temperature is  $90^{\circ}\text{F}$  ( $32^{\circ}\text{C}$ ).

**(j) PROFILABILITY.**

The thermoplastic pavement marking material shall be formulated so that when applied at a temperature of between  $400^{\circ}\text{F}$  to  $430^{\circ}\text{F}$  ( $204^{\circ}$ - $221^{\circ}\text{C}$ ), the individual profiles shall be a minimum of .160" (4 mm) when measured at the highest point of the profile and shall not excessively run back together. Individual profiles shall not compress more than 0.02" (0.50 mm) under traffic. (See Figure 1.) It is normal

for some areas of the stripe to be a different line thickness. Horizontal slump shall be not less than 0.22" (5.56 mm) when tested by RLC-1PS.

**(k) FLASHPOINT.**

The thermoplastic material shall have a flashpoint not less than 475°F (246°C). (ASTM D 92, "Flash and Fire Points made by Cleveland Open Cup.")

**(l) INDENTATION RESISTANCE.**

After 15 seconds with the sample panels and Shore Durometer (TY-A2) reading 90°F (32°C), and applying a 2 kg load, the reading shall not be less than 45. (ASTM D 2240)

**(m) PLATE TEST.**

Place a test cube of thermoplastic material measuring 40 mm x 100 mm x 15 mm under a static mass of 2500 g in an oven at a temperature of 225°F for 4 hours. Remove and allow it to cool to room temperature. Determine the surface area of the cube. The maximum allowable increase in the surface area of the cube shall be no more than 10%. (RLC-1PT)

**(n) SKID RESISTANCE.**

Minimum vehicle skid resistance of the in place markings shall not be less than 55.

**(o) STORAGE LIFE.**

The thermoplastic material shall meet the requirements of this specification for a period of one year. The thermoplastic shall also melt uniformly with no evidence of skins or unmelted particles for the one-year period. The manufacturer shall replace any material not meeting the above requirements.

**(p) PACKAGING AND MARKING.**

The thermoplastic material shall be packaged in suitable containers to which it will not adhere during shipment and storage. The bags of thermoplastic material shall be approximately 22" x 14" x 4" (559 mm x 356 mm x 100 mm) and shall have a mass of approximately 50 lb (23 kg). Each container label shall designate the

color, manufacturer's name, batch number, and date of manufacture. Each batch manufactured shall have its own separate number. The label shall warn the user that the material shall be heated to 400°F to 430° F (204°-221°C) during application

The Contractor shall assume all costs resulting from the use of patented materials, equipment, devices or processes used on or incorporated in the work, agrees to indemnify and save harmless the purchaser and his duly authorized representatives from all suits at law, or action of every nature for or on account of the use of any patented materials, equipment, devices, or processes.

## **CONSTRUCTION SPECIFICATIONS FOR INVERTED PROFILE THERMOPLASTIC TRAFFIC STRIPES (CLASS A)**

“IP CLASS I” type thermoplastic material meeting State Specification for inverted profile type thermoplastic material shall be used for this delineation. The application equipment shall utilize a screed shoe which will lay down a base line stripe of hot 400°F to 430°F (204°-221°C) thermoplastic material at the specified width of 4” to 8” (100mm to 200mm) wide and a minimum of .110” (2.8 mm) thick, as measured above the pavement surface. A moveable gate or door, which controls the flow of thermoplastic onto the pavement, shall be incorporated into the die/shoe for starting/stopping and skip-line application. All thermoplastic tanks, lines, manifolds and the extrusion shoe itself, should be surrounded by a heated jacket in order to maintain proper application temperature.

Two low-pressure glass bead applicator guns shall apply a minimum of 70 kg of drop-on glass beads per kilometer of 100 mm wide stripe or 106 kg of drop-on beads per kilometer of 150 mm wide stripe. The first behind the point where the thermoplastic material flows onto the pavement (See Figure 2) and shall use Standard State Specification coated drop on beads at the rate of 28 kg/km of 100 mm stripe or 42 kg/km of 150 mm stripe. The second glass bead gun shall be located just ahead of the Profiling Wheel and shall utilize Standard State Specification waterproof coated drop on beads at the rate of 42 kg/km of 100 mm stripe or 63 kg/km of 150 mm stripe.

A profiling wheel approximately 7” (178 mm) in diameter shall be located approximately 15-21” (381-533 mm) behind the thermoplastic applicator. This profiling wheel shall emboss a pattern of transverse corrugations onto the hot thermoplastic ribbon, leaving it profiled as shown in Figure 1. This profiling wheel shall be mounted on the same carriage as the extrusion shoe and glass bead guns, and shall be free to move up and down over pavement undulations. The profiling wheel shall also be wider than the specified 100 mm or 150 mm wide ribbon of thermoplastic so as to emboss a pattern across the entire width of the stripe. Specifically, this Inverted Profile Thermoplastic line shall be a minimum of .160” (4 mm) thick at the raised areas of the profile, and .010-.051” (0.25 – 1.3 mm) thick at the low or groove areas. These grooves shall be .090-.311” (2.4 – 7.9 mm) wide and shall occur regularly at approximately .945” (24 mm) intervals (See Figure 1 ). The Contractor shall provide a Micrometer type thickness gauge (for cold thickness) to the Engineer for use during the duration of the project.

A fine mist of water shall be applied from an air-atomized spray gun at an exact rate onto the top of the profiling wheel to cool the wheel and keep the

thermoplastic from sticking to it. This water spray shall be kept to a minimum so that no pools of water greater than .252" (6.4 mm) in diameter accumulate along the striping. Application speed shall be such that no more than one second elapses between the extrusion of the thermoplastic onto the pavement and the passage of the profiling wheel over the hot material.

The thermoplastic material shall have sufficient viscosity at application temperatures so that it will not flow or lose its profile while cooling. After cooling, the hardness of the thermoplastic material shall be such that the profile is not deformed white bearing traffic.

Application of Inverted Profile Thermoplastic Striping shall not be done unless the ambient and pavement temperatures exceed 61°F (16°C). The pavement shall be completely dry.

All existing paints and pavement markings, other than a single thin coat of temporary paint, shall be removed before applying Inverted Profile Thermoplastic Striping. Removal of existing stripe will be paid for as a separate item of work.

When striping over existing painted stripe, old bleached asphalt, on all Portland Cement Concrete, or on all surfaces when ambient temperatures are below 72°F (22°C), a primer sealer shall be used and installed as recommended in writing by the thermoplastic material supplier.

# **INSPECTION PROCEDURE FOR IN-PLACE INVERTED PROFILE THERMOPLASTIC PAVEMENT MARKINGS**

## **1. PURPOSE.**

To provide supervising department of transportation personnel with procedure for insuring compliance with various items in the performance specification, for in-place Inverted Profile Thermoplastic traffic stripe pavement markings, as listed below.

## **2. APPARATUS.**

- Measuring tape or ruler
- Mirolux 12 Retroreflectometer (optional)
- Magnifying glass
- Micrometer type thickness gauge (for cold thickness)
- Infrared heat gun or bimetal thermometer

## **3. LINE SELECTION PROCEDURE.**

The engineer throughout the project shall select periodic random inspection stations. Measurements of line thickness, width, apparent bond strength and retroreflectivity shall be taken. In a given 3' section, several reflectance readings will be taken and averaged to yield a net reading.

## **4. PROCEDURE – COLD THICKNESS.**

Once the in-place line has had time to cure (approximately 5 minutes) and been swept free of excess beads, line thickness can be checked with a micrometer type thickness gauge. Place the gauge over the stripe so that the two base points rest on flat road surface on either side of the stripe. The measuring foot of the micrometer should rest on the highest point of the stripe. The line thickness can then be read on the dial indicator. Two to three readings should be taken to ensure accuracy.

**NOTE:** Minimum required in place thickness of Inverted Profile Traffic Stripe shall be .160 inches (160 mils) as measured at the highest point of the stripe. The thickness of the stripe shall be verified periodically (at least every 1/2 mile) and thickness more than 5% under the designated thickness shall be removed and replaced at the Contractor's expense. This tolerance is for providing leeway in

equipment adjustment only; a consistent and uncorrected underrun, even within the 5% percent tolerance will not be acceptable.

**5. PROCEDURE - WIDTH.**

Measure the line width across the stripe at the bottom of the Inverted Profile.

Specified Line Width	Width Should Be Between
4"	3 7/8" to 4 3/8"
6"	5 7/8" to 6 3/8"
8"	7 7/8" to 8 3/8"

**6. TEMPERATURE.**

The temperature of the hot molten thermoplastic, as measured with the infrared heat gun or bimetal thermometer, shall be in the range of 400°F to 430°F (204°-221°C).

**7. APPEARANCE.**

The overall appearance of the in-place stripe should have a uniform profile, except in the case of seams or joints in the road surface. All road surfaces should be cleaned immediately prior to laying the stripe to help prevent any smooth sections in the line.

**8. REFLECTIVITY.**

The initial reflectance for the in-place marking shall have the minimum reflectance values shown as follows, as obtained with a Mirolux 12 Retroreflectometer.

Dry Night	White - 450 mcd/lux/m <sup>2</sup>	Yellow - 300 mcd/lux/m <sup>2</sup>
Wet Night	White - 200 mcd/lux/m <sup>2</sup>	Yellow - 175 mcd/lux/m <sup>2</sup>

**Wet Night Test Procedure** - Mark or delineate a three (3) foot long section of pavement marking to be tested. Utilizing a pump type garden sprayer, wet the test section for 5 seconds with water so that the pavement marking is thoroughly wet. Wait 30 seconds after wetting the stripe and place the Mirolux 12 Retroreflectometer on the previously wet test section.

## **9. RETAINED REFLECTIVITY.**

The thermoplastic pavement marking material shall retain the minimum reflectance value of 150 mcd/lux/m<sup>2</sup> for at least 36 months after placement. Failure to meet this requirement shall require the manufacturer to replace the portion of the material shown to be below these minimums. The manufacturer shall supply a written warranty indicating the terms of this requirement.

## **10. PROCEDURE - GENERAL.**

Beads - 50% of glass beads should be embedded to approximately 60% of their diameter to insure proper adherence to the thermoplastic marking material and provide maximum initial retroreflectivity. Shallow embedment allows the beads to debond and deep embedment reduces retroreflectivity. Use a magnifying glass to view bead embedment.

Bonding - The thermoplastic Inverted Profile Traffic Stripe shall be properly bonded to the pavement surface. This can be checked with a knife or screwdriver while the material is still pliable. If the material is properly bonded it should bring up some asphalt with it. When completely cured, it should be almost impossible to get a knife or screwdriver blade between the marking and the roadway.