

April 1, 2011

**PROFILE ROAD MARKING SYSTEM**  
**South Carolina Department of Transportation**

**GENERAL**

The object of this specification is to describe a profile, (raised shape) marking system that provides audible and vibratory warning when driven over. In addition to the requirements of Section 627 of the Standard Specifications for Thermoplastic Pavement Markings, the following requirements shall be met:

**APPEARANCE**

The finished product shall be a road marking system consisting of an extruded base line with raised shapes positioned at regular and predetermined intervals. The product shall be available in standard widths and standard colors of white and yellow.

**Base Line**

The base line shall consist of thermoplastic materials described below and extruded to a thickness of not less than 90 mils nor more than 125 mils above the pavement surface. The width of the line shall be in accordance with the plans. The base line shall meet the retro-reflectivity requirements of Sections 627.4.7 and 627.4.10 of the Standard Specifications for double drop bead systems regardless of what type of system is used. The edges of the lines shall be well defined and free from waviness.

**Raised Shapes**

The raised shapes shall either be formed integrally as part of the marking application or dropped on after application of the base line.

**Integrally formed ribs:** The raised ribs shall be positioned at regular 28 inch intervals when measured center to center. The length of a trapezoidal raised rib shall be a minimum of 1.75 inches to 2.25 inches measured at the widest portion of the crown of the rib, shall be the same width as the baseline and shall be approximately rectangular in shape. The raised rib shall be oriented squarely with the base line.

The raised rib shall stand .50 inches (+/- .1 inch) above the extruded base line. When lines of greater than 6 inches are specified multiple ribs shall be positioned across the width of the line. Lines eight inches and wider in width shall have two ribs separated by a drainage channel no greater than .50 inch at the base of the ribs. Lines of 12 inches shall have 3 ribs separated by a drainage channel of .50 inch at the base of the ribs.

**Drop on/Preformed Discs or Hot Extruded Shapes:** Preformed discs shall be a circular truncated dome shape and shall have the same color as the baseline material. Drop-on, hot applied thermoplastic shall be extruded in a manner to form a circular truncated dome shape upon cooling. Spacing between the shapes should be 28", and may vary as much as 10%, but the overall number of raised shapes in a 40 foot section shall not be less than 17, and no 10 foot skip shall contain less than 4 raised shapes. All drop-on shapes and materials shall be applied in a manner to melt sufficiently to form a permanent physical bond with the base line and to allow the drop-on beads to properly embed on the surface. For preformed discs, the bottom of the discs should be free of exposed beads in order to promote improved bonding of the thermoplastic material with the base line.

The minimum diameter of the circular shapes shall be 2.75 inches at the base and 1.75 inches at the top. The disc shall stand .50 inches (+/- .1 inch) above the baseline, and the center of the disk should be oriented within 0.50 inches of the center of the base line.

## SUPPLEMENTAL SPECIFICATION

In order achieve proper retro-reflectivity, all preformed discs or hot extruded shapes shall be uniformly coated AASHTO Type I glass beads which meet the requirements of Section 627.2.3 of the Standard Specifications with the following additional requirements:

- Drop-on glass beads shall not contain more that 200 ppm (total) arsenic, 200 ppm (total) antimony or 200 ppm (total) lead when tested to EPA methods 3052 and 6010B.
- 20% by volume of the Type I drop on glass beads shall have a refractive index of 1.9 or greater. The beads may be applied to the shapes in a uniform blend or with a double drop.

### **EQUIPMENT**

When the raised ribs are integrally formed with the base line, the marking system shall be applied to the pavement surface by automated screed extrusion equipment in a continuous process. If preformed drop-on discs or hot extruded shapes are applied, the base thermoplastic line may be applied using a ribbon gun device.

The marking system shall be applied to the pavement surface by equipment constructed to provide continuous uniform heating of the striping material to temperatures from 340 °F to 410 °F. The equipment shall be capable of mixing and agitating the material reservoir and dispensing devices to prevent accumulation and clogging. The equipment shall be capable of maintaining the striping material at a plastic temperature in all mixing and conveying parts including the line dispensing device. The equipment shall also meet the following requirements:

- a) capable of producing varying widths of traffic stripes.
- b) mobile and capable of traveling at a uniform, predetermined rate of speed, both uphill and downhill, in order to produce a uniform application of striping material and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc.
- c) capable of applying glass spheres to the surface of the completed traffic stripe by and automatic bead dispenser attached to the striping machine such that the glass beads are dispensed closely behind the installed traffic stripe. The equipment shall use a dispenser equipped with and automatic cut-off control that is synchronized with the cut-off of the striping material and applies the glass spheres uniformly over the entire traffic stripes surface with 50 to 60% embedment.
- d) equipped with a special kettle for uniformly melting and heating the striping material. The kettle must be equipped with and automatic temperature control device and material thermometer for positive temperature control and to prevent overheating or scorching of the striping material.
- e) Meets the requirements of the National Fire Protection Association, state and local authorities.

### **APPLICATION**

The Contractor shall apply the new material only to dry surfaces and when the ambient air and surface temperature is at least 55°F and rising.

The Contractor shall remove surface dirt, grease, concrete curing compounds and all loose existing striping material by methods approved by the engineer.

In addition, if existing thermoplastic or profile thermoplastic markings are in place on the roadway to be marked, the existing markings must be removed prior to the application of the new profile markings. Removal should be in accordance with Section 631 of the Standard Specifications and should not damage the existing pavement surface. Separate payment for removal will be made on a linear foot basis in accordance with this Section 631 of the Standard Specifications.

SUPPLEMENTAL SPECIFICATION

A primer sealer of the type recommended by the manufacturer shall be applied on all Portland cement surfaces prior to the installation of the marking material.

The markings shall be offset a minimum of 2 inches from any longitudinal joint.

Profile thermoplastic markings shall not be installed on new asphalt surfaces for a period of 7 days.

**DROP-ON GLASS BEADS/ELEMENTS**

Glass beads shall be applied to all baselines and integrally formed shapes. Drop on glass beads shall meet the material requirements of Section 627.2.3 of the Standard Specifications for AASHTO Type I beads with the following additional requirements:

- Drop-on glass beads shall not contain more than 200 ppm (total) arsenic, 200 ppm (total) antimony or 200 ppm (total) lead when tested to EPA methods 3052 and 6010B.
- 20% by volume of the Type I drop on glass beads shall have a refractive index of 1.9 or greater. The beads may be applied to the shapes in a uniform blend or with a double drop.

When drop-on, preformed discs or hot extruded shapes are used, a combination of highly reflective elements and Standard AASHTO Type I beads may be applied to the baseline in lieu of high index beads. The elements, 3M Wet Reflective Elements, Potter's/Epoplex Visimax Elements, or approved equal shall be applied at the rate recommended by the manufacturer and shall be supplemented with a second drop of standard AASHTO Type I bead at a rate recommended by the manufacturer.

The drop on glass beads shall also meet the requirements of and be applied in accordance with Section 627.4.6.1 of the Standard Specifications. In addition, In accordance with Section 627.4.6.1, all glass beads should have an adhesion promoting coating, which shall also provide moisture resistance when tested in accordance with AASHTO M247-05, latest edition, Section 5.4.1.

**MATERIALS**

When preformed drop-on discs are used, the base line thermoplastic material shall meet the requirements of Section 627 of the Standard Specifications. The discs shall meet the following requirements with the exception that color will be measured on the ribs as supplied, not after a 4 hour heating. For all other applications the following requirements shall be met:

The material shall be a thermoplastic compound, available in white and yellow, with the following composition:

<u>Component</u>	<u>White</u>	<u>Yellow</u>
Binder	19% Minimum	19% Minimum
Glass Beads	36% Minimum	36% Minimum
Titanium dioxide	10% Minimum	N/A
Yellow pigment	N/A	* See Note Below
Fillers	35% Maximum	41% Maximum

\* The type and amount of yellow pigment used shall be at the discretion of the manufacturer, provided that all other requirements of this specification are met.

**SUPPLEMENTAL SPECIFICATION**

- Binder:** Alkyd.
- Intermix Beads:** Shall conform to AASHTO M247 – Type I. The glass beads shall consist of a minimum of 80% true spheres when tested in accordance with ASTM D-1155. Intermix glass beads shall not contain more than 200 ppm (total) arsenic, 200 ppm (total) antimony or 200 ppm (total) lead when tested to EPA methods 3052 and 6010B.
- Pigments:** White - Titanium Dioxide - ASTM D 476 Type II rutile – 93% minimum Titanium content.  
  
Yellow – Organic pigment as necessary to meet the color coordinates of these specifications. The yellow thermoplastic shall be lead-free (L/F). The material shall not contain more than 3 ppm of lead by weight in a cured state and not more than 100ppm of total Heavy Metals as defined by Resource Conservation and Recovery Act (RCRA) including lead and hexavalent chromium when tested in accordance with Environmental Protection Agency (EPA) Methods 3050 and 6010.
- Fillers:** Calcium carbonate and other light colored inert materials.

**COLOR**

**White**

The white thermoplastic binder shall be pure white and free from any tint. Using a standard color difference meter (0°-45°) CIE, Illuminant C, the materials shall not show deviations from the magnesium oxide color standard greater than the following when tested in accordance with ASTM D 4960:

<b>Scale Definition</b>	<b>Magnesium Oxide Standard</b>	<b>Sample</b>
RD	100	75% Minimum
Reflectance		
a. Red – Green	0	-5 to +5
b. Yellow- Blue	0	-10 to +10

The color of the white thermoplastic material shall visually match that of Federal Test Number 595a, Color 47886.

**Yellow**

The thermoplastic material shall contain proper amounts of yellow pigment to produce a material that is weather-fast, heat stable, and meets the Yellow Color, Reflectance, Color Stability (Accelerated Weathering), and Retroreflectivity requirements specified herein. The thermoplastic material shall appear yellow during both daytime and nighttime conditions after the application of drop-on beads. The material shall not contain any hazardous materials at levels that would cause the thermoplastic to be classified as a hazardous waste as defined by RCRA Subarticle C rules and Table 1 of 40 CFR 261.24 Toxicity Characteristic.

The yellow color of unbeaded material shall match Federal Standard Designation No. 595b, color No. 13538 and is within the following chromaticity limits (color box) defined by plotting the following four (x, y) pairs on a C.I.E. 1931 Chromaticity diagram:

- (x1, y1)            (.5300, .4560)
- (x2, y2)            (.5100, .4850)
- (x3, y3)            (.4550, .4440)
- (x4, y4)            (.4720, .4000)

The Reflectance (Y) shall be between 45 and 55.

- Measurement conditions = 2 degrees observer/illuminant D65
- Instrument: BYK – Gardner “Color-Guide” Spectrophotometer

**Accelerated Color Stability**

The accelerated weathering of white and yellow (L/F) thermoplastic shall meet the requirements of ASTM G 155, Table X3.1, Cycle I for 1500 hours total exposure time.

Prepare sample by dipping a sheet aluminum panel into the molten thermoplastic and removing it to obtain a 1.5 to 3.0 mm coating thickness of thermoplastic on the panel. Place the panel in the weathering apparatus for 1500 hrs.

After accelerated weathering, measure the Yellow Color or Yellowness Index of the unbeaded material as stated in AASHTO M 249, Section 4.3.1 or 4.3.7. The material must meet the color stability requirements below after this exposure:

White - The thermoplastic material shall not exceed a yellowness index of 0.12 when tested in accordance with AASHTO T-250.

Yellow – Measured chromaticity coordinates shall fall within a “color box” defined by the following four (x, y) pairs on a C.I.E. 1931 Chromaticity diagram:

(x1, y1)	(.5300, .4560)
(x2, y2)	(.5100, .4850)
(x3, y3)	(.4350, .4290)
(x4, y4)	(.4490, .3770)

**PHYSICAL CHARACTERISTICS**

**Cracking Resistance At Low Temperature**

The thermoplastic pavement marking material shall be 100% passing when tested in accordance with AASHTO T-250.

**Softening Point**

The thermoplastic material shall have a minimum softening point of 200° F when tested in accordance with AASHTO T-250.

**Impact Resistance**

The impact resistance of the thermoplastic pavement marking material shall be a minimum of 10 inch pounds when tested in accordance with AASHTO T-250.

**Indentation Resistance**

After 15 seconds with the sample panels and Shore Durometer (Type-A2) reading 115° F, and applying a 4.4 lb. load, the reading shall not be less than 45 when tested in accordance with ASTM D-2240.

**Flashpoint**

The thermoplastic material shall have a flashpoint not less than 475° F when tested in accordance with ASTM D-92 - "Flash and Fire Points by Cleveland Open Cup".

**Set Time**

Applied markings shall be "track free" within 15 minutes after applications at ambient temperatures to 85°F.

**Audible Effect**

The noise that is produced by driving a vehicle on the markings at the posted speed limit shall be a minimum of 80 dBA as measured by any approved noise meter such as the Radio Shack Digital Sound Level Meter, Model Number 33-2055. The sound level shall be measured in the front seat of the vehicle between the driver and passenger seat with the instrument resting on the center console or seat of the vehicle. The vehicle used for evaluation shall be a typical mid-sized four door sedan such as the Chevrolet Impala or equivalent.

**COLOR STABILITY OF IN-SERVICE WHITE AND YELLOW THERMOPLASTIC**

The daytime color of the applied white and yellow thermoplastic pavement marking material (with drop-on beads) must meet the color requirements shown in the Subsection entitled Accelerated Color Stability. The color may be measured within 60 days of application using a portable BYK-Gardner "Color-Guide" Spectrophotometer and must remain within the "color-box".

**MATERIAL STORAGE LIFE**

The thermoplastic material shall meet the requirements of this specification for a period of one (1) year. The thermoplastic must 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.

**MATERIAL PACKAGING AND MARKING**

The thermoplastic material shall be packaged in granular form in meltable plastic bags. The bags of thermoplastic material shall be approximately 22 by 14 by 4 inches and shall weigh approximately 50 pounds.

Prefomed drop-on discs shall be packaged so that each package weighs no more than 50 pounds. The raised ribs should be packaged in a manner to minimize damage to the glass beads on the surface of the ribs.

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.

**INSPECTION AND ACCEPTANCE OF WORK**

All materials, including highly reflective elements, will be accepted base on manufacturer's certifications for each batch or lot. The Contractor shall provide all certifications prior to the installation of the profile thermoplastic markings.

The profiled thermoplastic pavement markings shall be inspected for proper thickness, width, profile, audible effect, adhesion and retro-reflectivity. The markings shall be observed both day and night to determine whether all of the requirements of the Contract have been met. Any markings failing to have a satisfactory appearance, either day or night, shall be reapplied by the Contractor at his expense.

The final acceptance of the pavement markings will be delayed for a period of 180 days after the last date of application to permit observation of performance. The pavement markings shall show no sign of failure due to excessive cracking, chipping, discoloration or poor adhesion. The Contractor shall be required to replace any markings that, in the opinion of the Engineer, have not performed satisfactorily during this 180 day period due to failure to meet the performance requirements included in this specification.