

Special Specification 6085

Inverted Profile Pavement Marking (Audible)



1. DESCRIPTION

This work must consist of furnishing all material and placing the Inverted Profile Pavement Marking (Audible) that is hot applied to the pavement surface. This pavement marking must be formed during application with a profile that will create an audible effect when driven over. The inverted profile allows for the rapid draining of the pavement marking which results in a highly reflective marking in a heavy rain.

The Inverted Profile Pavement Marking (Audible) System must be composed of three items: a thermoplastic marking compound, a double drop glass bead system and special equipment capable of producing an Audible Inverted Profile Pavement Marking.

2. SAMPLING AND TESTING

Sampling and testing must be in accordance with the Department's Manual of Testing Procedures.

3. MATERIALS

3.1. **General.** This provision cover machine applied hot hydrocarbon thermoplastic or alkyd/maleic pavement marking material with both intermixed and drop-on glass beads for use in construction the Inverted Profile Marking (Audible).

3.2. **Thermoplastic Material.** The thermoplastic material used for hot hydrocarbon or alkyd/maleic applications must consist of homogeneously mixed pigments, fillers, resins and glass beads and must be available in both white and yellow.

The thermoplastic material must be free of contaminates and must 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, must 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 must meet the minimum requirements specified herein including, but not limited to: composition, physical characteristics, etc. The physical and chemical properties contained in this specification must apply regardless of the type of formulation used. The pigment, beads and fillers must be free from all skins, dirt and foreign objects.

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

The thermoplastic material must 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 must be readily applicable at temperatures between 400°F and 430°F, from the approved equipment, to produce lines of the required type and thickness above the pavement surface as described elsewhere in this Specification.

3.3. **Composition.** The pigment, beads, resin and fillers must be a uniform blend. The material must be free from all skins, dirt, and foreign objects and must comply with requirements according to Table 1.

Table 1
Composition

Component	Composition by Weight	
	White	Yellow
Binder	19% Min	19% Min
Glass Beads (Intermixed)	40% Min	40% Min
Titanium Dioxide (For White Material)	12% Min	N/A
Yellow Pigment (For Yellow Material)	N/A	5% Min
Calcium Carbonate & Inert Filler (-200 Mesh)	31%	41%

Other Ingredients: Titanium Dioxide must meet ASTM D 476- Type II, (Rutile grade – 93 percent minimum titanium content)

3.3.1. **Glass Beads – Intermixed and Drop-On.** The glass beads used in formulating the thermoplastic compound or dropped on the thermoplastic must be smooth, clear and free from any air inclusions and scratches that might affect their function as a retroreflective media, and must have the characteristics listed as follows:

3.4 **Intermix Glass Beads.** The thermoplastic composition must have a minimum total intermix glass bead content of 40% by weight.

Intermix glass beads must make up a minimum of 40% of the thermoplastic compound. These beads must meet all requirements of ASTM D 1155, with 70% true spheres; the +20 sieve must be tested visually.

All Intermix glass beads must be coated with an adhesion promoting coating.

Size Distribution: The gradation of Intermix glass beads must have the following size distribution.

US Standard Sieve Size	Percent Passing
12	100
14	90-100
16	80-100
18	30-100
20	15-100

30	10-100
50	0-50
100	0-5

3.5. **Drop-On Glass Beads.** Drop-on glass beads must be separated into the 2 following classes:

Class A drop-on glass beads must be used in the first bead coat and must exhibit the following characteristics:

3.5.1. **Color and Clarity.** The glass beads must be free of carbon residues.

3.5.2. **Index of Refraction.** The index of refraction must be 1.90 or higher.

3.5.3. **Roundness.** The 1.90 glass beads must have a 70% round visual for +20 mesh material and an 80% overall minimum round via Roundometer.

3.5.4. **Density.** The density of the 1.90 glass beads must be in the range of 4.00 – 4.50 g/cm³

3.5.5. **Gradation.** The gradation of Class A glass beads must be as follows:

US Standard Sieve Size	Retained
18	0-5
20	5-15
30	10-30
40	20-40
50	20-40
Pan	0-5

Class B drop-on beads must be used in the second bead coat and must comply with ASTM d1155; the +20 portion must be tested visually and must have an adhesion. Promoting coating applied, which must also provide moisture resistance as tested by AASHTO M247-81 (1990), Section 4.4.2. Not more than 30% of the glass spheres must be irregular or fused spheroids. At least 70% of the beads must be true spheres. (ASTM D-1155, Procedure B).

The gradation of Class B glass beads must be as follows:

Us Standard Sieve Size	Percent Passing
16	99-100
20	75-100

30	55-95
50	10-35
100	0-5

4. **Physical Characteristics.**

4.1 **Color.** The thermoplastic pavement marking material must 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 and ITE Specification Section 4.3.1)

4.1.1. **White.** Daylight reflectance at 45-0 of 75% minimum and match Federal Test Standard Number 595A (Color 17886).

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

4.2. **Chromaticity.** Coordinates X and Y must fall in an area bordered by these coordinates:

X 0.470 0.510 0.490 0.537

Y 0.455 0.489 0.432 0.462

4.3. **Reflectivity.** The initial reflectance for the in-place marking must have the minimum reflectance values shown as follows, as obtained with a 30 meter LTLX, LTL 2000 or ASTM approved Retroreflectometer capable of reading ASTM E1710, ASTM 2176 and ASTM 2177.

4.3.1. **Dry Night.** White – 450 mcd/lux/m²

Yellow – 350 mcd/lux/m²

4.3.2. **Wet Night.** Wet Night Test Procedure – Mark or delineate a 3 foot long section of stripe to be tested. Utilizing a pump type garden sprayer, wet the test section for 5 seconds with water so that the stripe is thoroughly wet. Wait 30 seconds after wetting the stripe and place the ASTM approved 30 Meter Geometry Retroreflectometer on the previous wet line.

The minimum wet Retroreflectivity reading must be 200 mcd/lux/m² for white and 175 mcd/lux/m² for yellow. Do not attempt to spray water under the meter as severe damage to the meter can result.

4.4. **Retained Reflectivity.** The thermoplastic pavement marking material must retain the minimum dry reflectance value of 150 mcd/lux/m² and 75 mcd/lux/m² wet minimum reflectance value for at least 4 years after placement. Failure to meet this requirement must require the manufacturer to replace the portion of the material shown to be below these minimums. The manufacturer must supply a written warranty to the Engineer indicating the terms of this requirement in accordance with Item 6, "Control of Materials."

4.5. **Yellowness Index.** The white thermoplastic material must not exceed a yellowness index of 0.15 (I.T.E. Spec 4.3.8).

4.6. **Cracking Resistance at Low Temperature.** The thermoplastic pavement marking material must be 100% (AASHTO T-250 and I.T.E. Spec Section 4.3.4).

- 4.7. **Impact Resistance.** The impact resistance of the thermoplastic pavement marking material must be a minimum of 10 inch pounds (I.T.E. Spec Section 4.3.5).
- 4.8. **Softening Point.** The thermoplastic material must have a softening point of 215°F +/- 15°F, (ASTM D-36).
- 4.9. **Drying time.** When applied at a temperature of 412°F +/- 12.5°F and at a thickness of 0.140 inches, the thermoplastic material must set to bear traffic in not more than 2 minutes when the air temperature is 50°F and not more than 10 minutes when the air temperature is 90°F.
- 4.10. **Profitability.** The thermoplastic pavement marking material must be formulated so that when applied at a temperature of between 400°F and 430°F, the individual profiles must be a minimum of 0.140 inches when measured at the highest point of the profile and must not excessively run back together. In addition for audibility, a longitudinal spacing of approximately 12 inches center to center must be profiled in a vertical manner such that the profile is transverse to the longitudinal marking dimension. The profile must not be less than 0.30 inches (300 mil) nor greater than 0.50 inches (500 mil) in height when measured above the normal top surface plane of the roadway. The transverse width of the profile must be equal to the width of stripe and the longitudinal width not less than 1 inch when measured at the top surface plane of the marking.
- 4.11. **Flashpoint.** The thermoplastic material must have a flashpoint not less the 475°F, (ASTM D-92 "Flash and Fire Points by Cleveland Open Cup").
- 4.12. **Indentation Resistance.** After 15 seconds with the sample panels and Shore Durometer (TY-A2) reading 900°F, and applying a 1 pound load, the reading must not be less than 45 (ASTM D-2240).
- 4.13. **Flowability.** After heating the thermoplastic material for 4 hours 5 minutes at 425°F +/- 30°F and testing for flowability, the white thermoplastic must have a maximum percent residue of 22% and the yellow thermoplastic must have a maximum residue of 24% (I.T.E. Spec Section 4.3.7).
- 4.14. **Extended Heating.** After heating and stirring the thermoplastic material for 8.5 hours at 425°F +/- 30°F and testing for flowability, the thermoplastic must have a maximum residue of 28%.
- 4.15. **Storage Life.** The thermoplastic material must meet the requirements of this specification for a period of 1 year. The thermoplastic must also melt uniformly with no evidence of skins or unmelted particles for the one-year period. Any material not meeting the above requirements must be replaced by the manufacturer.
- 4.16. **Packaging and Marking.** The thermoplastic material must be packaged in suitable containers to which it will not adhere during shipment and storage. The bags of thermoplastic material must be approximately 22 by 14 x 4 inches and must weigh approximately 50 pounds. Each container label must designate the color, manufacturer's name, batch number and date of manufacture. Each batch manufactured must have its own separate number. The label must warn the user that the material must be heated to 400°F to 430°F during application. The Contractor must 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.

5. CONSTRUCTION

- 5.1 **General.** The application equipment must be specially designed for placing for thermoplastic material in a hot molten state on the pavement surface utilizing a pressure type application method. A thermoplastic die that is allowed to travel along in proximity with the road surface must form the hot Inverted Profile thermoplastic pavement markings. The die is pulled forward by a special linkage that will allow it to automatically level itself as to float and remain parallel with the road surface. The top of the die must be enclosed and provide entry means for the hot molten thermoplastic to enter the die cavity. The bottom of the die must contain a movable door that is remotely controlled so as to start or stop the flow of thermoplastic on to the pavement surface. When the movable door is open, thermoplastic can flow through the die and will apply a thermoplastic line that will be formed rearward of the advancing die. The road surface must be at the bottom

of the die enclosure. Thermoplastic must be fed to the die under pressure through flexible oil-jacketed stainless steel hoses. The thermoplastic die must be formed from a single solid block of steel that is oil-jacketed on four (4) sides in order to keep the die hot at all times.

The thermoplastic Inverted Profiling system consists of a low-pressure drop-on type glass bead gun, (Bead Coat 1). The thermoplastic die must be oil jacketed on four (4) sides and is formed from a single bloc of steel. The glass bead gun must dispense glass beads onto the hot thermoplastic line from a height of approximately 1 inch, (25 mm), above the road surface. The point at which the glass beads strike the surface of the pavement marking must be approximately 3 inches, (75 mm), behind the strike point of the thermoplastic itself. The reflective bead coat 1 must utilize Class A glass beads as specified in the "Drop-ON Blass Bead" Section €, and must provide a surface coating of 50% of the thermoplastic pavement marking surface. Of this 50% surface coverage, at least 50% of the beads must be embedded to a depth of 60% of their diameter.

A second low-pressure drop-on type glass bead gun capable of applying a continuous coating of glass beads must follow at an interval of approximately 10 inches, (250 mm), behind the first bead gun. This second glass bead gun must apply bead coat 3 which will form a continuous drop-on coat of Class B glass beads immediately in from of the pavement marking profiling device. This second coat of glass beads must be applied with low impact so that they are not forced into the pavement marking under pressure.

A special rotatable wheel pavement marking profiling device must be located approximately 8 inches, (200mm), behind bead gun 2. This rotatable wheel device must be approximately 7 inches, (175 mm), in diameter and must have a plurality of spaced projections located around it circumference. The pavement marking profiling device must be wider than the pavement marking being applied in order that the pavement marking must be adequately covered. The projections on the rotatable pavement marking profiling device must have an angular pavement marking profiling surface set at an angle to the pavement surface. The rotatable pavement marking profile device must be mounted with an automatic leveling device to the same carriage assembly as the thermoplastic gun. Using rollers to place grooves in the traffic marking utilizing a separate vehicle or grooves that are not pressed within one (1) second of thermoplastic material application will not be allowed under this specification. To insure that not hot thermoplastic adheres to the wheel as it rotates and profiles the marking, a small air atomized water jet must apply a thin mist of water to the rotatable profile wheel. No water puddles greater than ¼ inch (6 mm), in diameter must be allowed to accumulate on the pavement surface in proximity to the freshly placed pavement marking.

All parts of the thermoplastic holding tank including manifolds, hoses, pipes, dies, etc., must be oil-jacketed to insure accurate temperature control. The thermoplastic material must be preheated in kettles designed specifically for that purpose. Each kettle of preheated thermoplastic material must be properly mixed and heated to the correct application temperature. The preheated material must then be fed to the thermoplastic gun for application.

The striper unit must be truck mounted with kettle capacity to hold approximately 2000 pounds, (908 kg), of thermoplastic and must have the capacity to contain enough glass beads and water to apply one full kettle of thermoplastic.

All new asphalt surfaces must have a minimum cure period of 14 days prior to installing the Inverted Profile pavement markings, unless otherwise approved by the Engineer,

All Pavement areas to be marked must be thoroughly cleaned using equipment capable of cleaning without damaging the surface. This will include, but not limited to, all vegetation, loose soil, oils, and other debris. Installation of the Inverted Profiled pavement markings must follow as closely as practical after the surface has been cleaned.

Where so shown on the plans or as directed, the existing pavement marking must be removed by grinding or water blasting.

When placing Inverted Profile pavement markings on asphalt or concrete pavement that has more than one coat of striping material, the existing marking must be removed to the point that 80% of the pavement surface is visible.

When placing Inverted Profile pavement markings on Portland Cement Concrete, no curing compound must be marked over.

Removal of existing pavement markings must be paid for as a separate item of work.

Unsatisfactory Inverted profile pavement markings performed by the Contractor must be removed and replaced in compliance with these specifications. No payment must be made for removal or replacement of the Contractor's unsatisfactory markings.

When placing Inverted Profile pavement markings, no striping must be permitted when the surface temperature is less than 60°F, (16°C), (A non-contact infrared pyrometer must be supplied by the Contractor for use by the Engineer for temperature verification. To prevent the rapid cooling of the freshly placed markings, no striping must be performed when there is moisture on the pavement surface or when winds exceed 12 mph (19kmph). After hard rains even though no moisture is visible, Portland Cement Concrete and asphalt surfaces can hold water. When unseen moisture is suspected to be present, a moisture test must be performed. The test must be as follows:

- A. Place a piece of paper on the pavement surface.
- B. Pour ½ gallon, (2 liter), of thermoplastic onto the paper
- C. After two (2) minutes, lift the paper and inspect to see if moisture has been drawn from the pavement.
- D. If moisture is present, do not proceed with Inverted Profile pavement marking until the surface is moisture free.

Documentation of weather and pavement conditions must be maintained by the Contractor and supplied to the Engineer on the approved form.

The thermoplastic material must be preheated and thoroughly mixed at an application temperature of between 400°F, (200°C), minimum and 430°F, (225°C), maximum. A digital thermometer, complete with a 24 inch probe, must be supplied to the Engineer by the Contractor for temperature verification.

When measured at the highest point of the profile, except for the audible transverse bar, the cold thickness of the in place thermoplastic pavement markings must be a minimum of 0.140 inches, (4 mm), for Inverted Profile markings. The thickness of the thermoplastic in the bottom of the profiles must range from 0.025 – 0.050 inches, (0.6 – 2.0 mm). The individual profiles must be located transversely across the pavement markings at intervals of approximately 1 inch, (25 mm). The bottoms of these intervals must be between 3/32 inches and 5/16 inches (2 mm and 8 mm) wide. In order to drain water and to reflect light, it is normal for the top surface of the Inverted Profiles to be irregular.

The thickness of the pavement marking materials must be verified periodically (at least every ¼ mile), (40 km), and any thickness more than 5% under the designated thickness must be reworked. A consistent, uncorrected underrun will not be allowed and the Contractor must be required to install the specified minimum thickness of 0.140 inches, (4 mm). A wet film thickness gauge, such as a Gulf Line Model 180w and GL model 400 W, must be provided to the Engineer. Also, the Contractor must provide a cold thickness gauge, such as a GulfLine Model 180C, to the Engineer for film thickness verification

When installing Audible Inverted Profile thermoplastic markings over old bleached asphalt, or all Portland Cement Concrete pavements, a two component epoxy primer sealer must be used per thermoplastic manufacturer's recommendations. The epoxy primer sealer must be EXX255/EX256 as manufactured by Crown Paint Company of Oklahoma City, OK, or approved equal.

If an alternate epoxy primer sealer to the Crown Paint EX255/EX256 is used, the contractor must supply a mill analysis and proof of adequate performance of the alternate when used with Inverted Profile thermoplastic pavement markings.

6. MEASUREMENT

This Item must be measured by the linear foot. Where double stripes are placed, each pavement marking must be measured separately.

This is a plans quantity measurement item. The quantity to be paid is the quantity shown in the proposal unless modified by Article 9.2, "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

Acrylic sealer, epoxy sealer, or Type II markings, when used as a sealer must be measured as Pavement Sealer.

7. PAYMENT

The work performed and materials furnished in accordance with this item and measured as provided under "Measurement" will be paid for at the unit price bid for "Audible Inverted Profile Pavement Markings" of the color, width and thickness specified. This price is full compensation for furnishing all materials, for application of pavement markings and for all labor, tools, equipment and incidentals necessary to complete the work, except as shown below. No compensation must be paid for additional work performed and materials furnished resulting from failure to comply with manufacturer's written warranty. This will include materials, application of markings, labor, tools, equipment, traffic control and incidentals necessary to complete the work.

Surface preparation, and/or eliminating existing pavement markings and/or markers, when shown on the plans, must be paid for under a separate pay item.