# Special Specification 6148
# Inverted Profile Pavement Marking (Audible)

## 1. DESCRIPTION

Furnish and install an 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 heavy rain.

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

## 2. MATERIALS

2.1. **General.** This provision covers machine applied hot hydrocarbon thermoplastic or alkyd/maleic pavement marking material with both intermixed and drop-on glass beads for use in constructing the inverted profile marking (audible).

2.2. **Thermoplastic Pavement Marking Materials.** Furnish thermoplastic pavement marking material meeting the minimum requirements of DMS-8220, “Hot Applied Thermoplastic.”

2.3. **Traffic Beads.** Furnish a traffic bead system to meet the desired performance requirements of this Specification.

## 3. EQUIPMENT

3.1. **General.** Use pavement marking application equipment that:

- is maintained in satisfactory condition,
- meets or exceeds the requirements of the National Board of Fire Underwriters and the Texas Railroad Commission for this application,
- uses an automatic bead dispenser attached to the pavement marking equipment, and
- can provide continuous mixing and agitation of the pavement marking material.

3.2. **Material Placement Requirements.** Pavement marking equipment must also meet the following requirements:

- Equipment will be capable of providing uniform heating of striping materials to temperatures exceeding 390°F (199°C) .
- Equipment will be capable of maintaining the thermoplastic striping material in a plastic state in all mixing and conveying parts, including the line dispensing device until applied.
- Equipment will be capable of producing varying widths and thickness of thermoplastic traffic stripes.
- The equipment will be a mobile, truck mounted and self-contained pavement marking machine.
- The equipment will be capable of traveling at a uniform, predetermined speed over variable road grades to produce uniform application of striping material, following straight lines and making normal curves in a true arc. The equipment will be capable of air-blasting the pavement, applying the thermoplastic stripe and immediately applying the drop-on glass beads in a single.

- The equipment will be capable of application of drop-on glass beads to the surface of the pavement marking by double drop application.
- The applicator for the drop-on glass beads will be equipped with an automatic cut-off control that is synchronized with the cut-off of the thermoplastic material.
- The applicator for the drop-on glass beads will be capable of delivering a uniform drop rate at variable thermoplastic application speeds.
- The drop-on glass beads are applied such that they appear uniform on the entire traffic stripe and markings.
- 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 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 1 sec. of thermoplastic material application will not be allowed under this specification.
- The melt kettle must be equipped with an automatic temperature control device and thermometer to thermostatically control the temperature and prevent overheating of the thermoplastic material. It must also be equipped with sufficient agitation to prevent settling of the inter-mix beads.

3.3. **Retroreflectometers.**

3.3.1. **Mobile Retroreflectometer**. Use a mobile retroreflectometer approved by the Construction Division and certified by the Texas Transportation Institute Mobile Retroreflectometer Certification Program.

3.3.2. **Portable Retroreflectometer.** Use a portable retroreflectometer meeting the requirements of ASTM E1710 that has either an internal global positioning system (GPS) or the ability to be linked with an external GPS with a minimum accuracy rating of 16.4 ft in accordance with the circular error probability (CEP) method (CEP is the radius of the circle with its origin at a known position that encompasses 50% of the readings returned from the GPS instrument); and can record and print the GPS location and retroreflectivity reading for each location where readings are taken.

## 4. CONSTRUCTION

Place markings before opening to traffic unless short-term or work zone markings are allowed.

4.1. **General**. Obtain approval for the sequence of work and estimated daily production.

Place markings on roadways already open to traffic with minimum interference to the operations of that roadway. Use traffic control as shown on the plans or as approved. Protect all markings placed under open-traffic conditions from traffic damage and disfigurement.

Establish guides to mark the lateral location of pavement markings as shown on the plans or as directed and have guide locations verified. Use material for guides that will not leave a permanent mark on the roadway.

Provide markings with uniform and distinctive characteristics when observed in accordance with Tex-828-B. When minimum retroreflectivity requirements are specified, these values will be used to measure retroreflectivity performance.

Apply markings on pavement that is completely dry and passes the following test:

Place a sample of inverted profile marking material on a piece of tarpaper placed on the pavement. Allow the material to cool to ambient temperature and then observe the underside of the tarpaper in contact with the pavement. Pavement is dry if there is no condensation on the tarpaper.

Apply markings:

- using dimensions, colors and at locations shown in the plans,
- in proper alignment with the guides without deviating from the alignment more than 1 in. per 200 ft. of roadway or more than 2 in. maximum,
- free of blisters and with no more than 5%, by area, holes or voids,
- with uniform cross section and thickness,
- with clean and reasonably square ends, and
- using personnel skilled and experienced with installation of pavement markings.

Remove all applied markings that are not in alignment or sequence as stated in the plans or as stated in the specifications at the Contractor's expense in accordance with Item 677, "Eliminating Existing Pavement Marking and Markers."

4.2. **Surface Preparation**. Unless otherwise shown on the plans, prepare surfaces in accordance with this section.

4.2.1. **Cleaning for New Asphalt Surfaces and Retracing of All Surfaces**. For new asphalt surfaces (less than 3 yr. old) and retracing of all surfaces, air-blast or broom the pavement surface to remove loose material, unless otherwise shown on the plans. A sealer for inverted profile markings is not required unless otherwise shown on the plans.

4.2.2. **Cleaning for Old Asphalt and Concrete Surfaces (Excludes Retracing)**. For old asphalt surfaces (more than 3 yr. old) and all concrete surfaces, clean in accordance with Item 678, "Pavement Surface Preparation for Markings," to remove curing membrane, dirt, grease, loose and flaking existing construction markings, and other forms of contamination.

4.2.3. **Sealer**. For asphalt surfaces more than 3 yr. old or for concrete, apply a pavement sealer before placing inverted profile markings on locations that do not have existing markings, unless otherwise approved. The pavement sealer must be an epoxy sealer unless otherwise shown on the plans. Follow the manufacturer's directions for application of epoxy sealers. When the sealer becomes dirty after placement, clean by washing or in accordance with Section 4.2.1, "Cleaning for New Asphalt Surfaces and Retracing of All Surfaces." Place the sealer in the same configuration and color (unless clear) as the Inverted profile markings unless otherwise shown on the plans.

4.3. **Application**. Apply markings on surfaces with a minimum surface temperature of 60ºF, when measured in accordance with Tex-829-B.

Apply markings during good weather unless otherwise directed. If markings are placed at Contractor option when inclement weather is impending and the markings are damaged by subsequent precipitation, the Contractor is responsible for all costs associated with replacing the markings if required.

Apply within the temperature limits recommended by the material manufacturer. Apply on clean, dry pavements (meeting moisture test described above). 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 (19 kmph). 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.

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 in., (4 mm), for inverted profile markings. The thickness of the thermoplastic in the bottom of the profiles must range from 0.025 - 0.050 in., (0.6 - 2.0 mm). The individual profiles must be located transversely across the pavement markings at intervals of approximately 1 in. (25 mm). The bottoms of these intervals must be between 3/32 in. and 5/16 in. (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 will be verified and any thickness more than 5% under the designated thickness must be reworked. A consistent, un-corrected underrun will not be allowed and the Contractor will be required to install the specified minimum thickness of 0.140 in. (4 mm). Provide a wet film thickness and a cold film thickness gauge to the Engineer for thickness verification.

4.4. **Retroreflectivity Measurements.** Use a mobile retroreflectometer unless otherwise shown on the plans.

4.4.1. **Mobile Reflectometer Measurements.** Provide mobile measurements averages for every 0.1 mi. unless otherwise specified or approved by the Engineer. Take measurements on each section of roadway for each series of markings (e.g., edge-line, center skip line, each line of a double line) and for each direction of travel. Take all measurements in the direction of traffic flow, except on centerline on two-way roadways, take measurements in both directions. Furnish measurements in compliance with Special Specification 6040, "Mobile Retroreflectivity Data Collection for Pavement Markings," unless otherwise approved by the Engineer. The Engineer may require an occasional field comparison check with a portable retroreflectometer meeting the requirements listed above to ensure accuracy. Use all equipment in accordance with the manufacturer's recommendations and directions. Inform the Engineer at least 24 hr. in advance of taking any measurements.

4.4.2. **Portable Reflectometer Measurements.** When using a portable reflectometer to measure retroreflection take a minimum of 20 measurements for each 1-mi. section of roadway for each series of markings (i.e., edgeline, center skip line, each line of a double line, etc.) and direction of traffic flow. Measure each line in both directions for centerlines on 2-way roadways (i.e., measure both double solid lines in both directions and measure all center skip lines in both directions). The spacing between each measurement must be at least 100 ft. The Engineer may decrease the mileage frequency for measurements if the previous measurements provide satisfactory results. The Engineer may require the original number of measurements if concerns arise.

4.4.3. **Traffic Control.** Provide traffic control, as required, when taking retroreflectivity measurements after marking application. On low volume roadways (as defined on the plans), refer to the figure entitled "Temporary Road Closure" in Part VI of the Texas Manual on Uniform Traffic Control Devices for the minimum traffic control requirements. For all other roadways, the minimum traffic control requirements will be as shown on the standard plans TCP (3-1) and TCP (3-2). The lead vehicle will not be required on divided highways. The traffic control plan and traffic control devices must meet the requirements listed in Item 502, "Barricades, Signs, and Traffic Handling." Time restrictions that apply during striping application will also apply during the retroreflectivity inspections except when using the mobile retroreflectometer unless otherwise shown on the plans or approved.

4.5. **Retroeflectivity Requirements.** The initial retroreflectivity for the in-place marking must meet the following minimum values when measured any time after 3 days, but not later than 10 days after application:

4.5.1. **Dry Night.** White – 450 mcd/lux/$m^2$
Yellow – 350 mcd/lux/$m^2$

4.5.2. **Wet Night**. The minimum initial wet retroreflectivity values, when measured any time after 3 days, but not later than 10 days after application must be:

- White - 200 mcd/lux/$m^2$
- Yellow - 175 mcd/lux/$m^2$

when measured in accordance with ASTM E2177 in the standard condition of wetness test.

4.6. **Retained Retroreflectivity.** The thermoplastic pavement marking material must retain a minimum dry retroreflectivity value of 150 mcd/lux/$m^2$ and a minimum wet retroreflectivity value of 75 mcd/lux/$m^2$ for both yellow and white markings and for a minimum of 4 yr. after placement. Failure to meet this requirement will 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 indication the terms of this requirement in accordance with Item 6, “Control of Materials.”

4.7. **Profilability.** 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 in. when measured at the highest point of the profile and must not excessively run back together. Additionally, a longitudinal spacing of at least 12 in. 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 in. (300 mil) nor greater than 0.50 in. (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 in. when measured at the top surface plane of the marking.

## 5. MEASUREMENT

This Item must be measured by the linear foot. Where double stripes are place, 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.

Epoxy sealer when used as a sealer must be measured as Pavement Sealer.

## 6. 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 eliminating existing pavement markings or markers, when shown on the plans, must be paid for under a separate pay item.