

SPECIAL PROVISION

NOTE: This special provision is generally written in the imperative mood. The subject, "the Contractor" is implied. Also implied in this language are "shall", "shall be", or similar words and phrases. The word "will" generally pertains to decisions or actions of Sedgwick County Public Works.

THERMOPLASTIC PAVEMENT MARKING

1. DESCRIPTION

This special provision covers a retroreflective thermoplastic pavement marking material of a type that is applied to the road surface in a molten state by ribbon extrusion or screed extrusion with a surface application of glass beads. Upon cooling to a normal pavement temperature it produces a retroreflective marking of specified thickness and width capable of resisting deformation by traffic and maintenance vehicles.

BID ITEMS

Thermoplastic Pavement Marking (*)+(#)

* White or Yellow

+ Width (When bid per lineal foot) or
Symbol Type

Thickness

Pavement Pre-heating

2. CLASSIFICATION

The thermoplastic material shall be homogeneously composed of pigment, filler, resins, and glass beads. The thermoplastic shall be available in white and yellow.

3. MATERIALS

a. The vendor shall have the option of formulating the material according to its own specifications. However, the solid resin shall be a "maleic-modified glycerol ester resin" (alkyd binder). The alkyd binder shall consist of a mixture of synthetic resins; at least one of which is solid at room temperature, and high boiling point plasticizers. At least one-third of the binder composition shall be solid maleic-modified glycerol ester resin and shall be no less than eight (8) percent by weight of the entire material formulation. The alkyd binder shall not contain petroleum based hydrocarbon resins. The physical and chemical properties contained in this special provision shall apply regardless of the vendor's specifications. The material upon heating to application temperature shall not exude fumes that are toxic, or injurious to persons or property. The pigment, beads, and filler shall be well dispersed in the resin.

b. Glass Beads.

- i. **Pre-mix:** The pre-mix beads shall be uncoated and conform to AASHTO M247-81 (1986) Type I.

SPECIAL PROVISION – THERMOPLASTIC PAVEMENT MARKING

- ii. **Drop-on:** The drop-on beads shall be moisture resistant coated, and they shall conform to AASHTO M247-81 (1986) Type I. The beads shall have a minimum of 80 percent true spheres.

4. REQUIREMENTS OF THE THERMOPLASTIC MIXTURE

- a. **Specific Gravity.** The specific gravity of the thermoplastic material shall not exceed 2.3.
- b. **Composition.** The pigment, beads, and filler shall be uniformly dispersed in the resin. The material shall be free from skins, dirt, and foreign objects and shall comply with the requirements in Table 1.

Table 1. Composition (Percentages by Weight)

Component	White	Yellow
Binder	18.0 min.	18.0 min.
Glass Beads	30.0 min.	30.0 min.
Titanium Dioxide	10.0 min.	N/A
Yellow Pigment	N/A	2.0 min.
Calcium Carbonate & Inert Fillers	42.0 max.	50.0 max.

- c. **Physical Characteristics.** The thermoplastic material after heating for 4 hours ± 5 minutes at $425^{\circ} \pm 3^{\circ}$ Fahrenheit (F)($218^{\circ} \pm 2^{\circ}$ Celsius) under agitation shall meet the following luminosity and color requirements:
 - i. **Luminosity**
White: Daylight reflectance at 45 degrees, 0 degrees – 75% minimum
Yellow: Daylight reflectance at 45 degrees, 0 degrees – 45% minimum
 - ii. **Color**
The colors shall match Federal Highway Administration yellow and white color specifications.
 - iii. **Set Time**
When applied at a temperature of $412.5^{\circ}\text{F} \pm 12.5^{\circ}\text{F}$ ($211^{\circ}\text{C} \pm 7^{\circ}\text{C}$) and thickness of 60 mils to 185 mils (1.5mm to 4.7mm) the material shall set to bear traffic in not more than 2 minutes when the air and road surface temperature is approximately $50^{\circ}\text{F} \pm 3^{\circ}\text{F}$ ($10^{\circ}\text{C} \pm 2^{\circ}\text{C}$) and not more than ten minutes when the air and road surface temperature is approximately $90^{\circ}\text{F} \pm 3^{\circ}\text{F}$ ($32^{\circ}\text{C} \pm 2^{\circ}\text{C}$).

SPECIAL PROVISION – THERMOPLASTIC PAVEMENT MARKING

iv. Bond Strength

After heating the thermoplastic material for 4 hours ± 5 minutes at 425°F ± 3 °F (218°C ± 2 °C), the bond strength to Portland cement concrete shall exceed 180 psi (1.24Mpa), (Method – ASTM D4796-88).

v. Cracking Resistance at Low Temperature

After heating the thermoplastic material for 4 hours ± 5 minutes at 425°F ± 3 °F (218°C ± 2 °C), applying to concrete blocks for cooling 15°F ± 3 °F (9.4°C ± 1.7 °C), the material shall show no cracks when observed from a distance exceeding 12 inches (30cm).

vi. Impact Resistance

After heating the thermoplastic material for 4 hours ± 5 minutes at 425°F ± 3 °F (218°C ± 2 °C) and forming test specimens, the impact resistance shall be a minimum of 10 inch pounds (1.13J).

vii. Softening Point

After heating the thermoplastic material for 4 hours ± 5 minutes at 425°F ± 3 °F (218°C ± 2 °C) and testing in accordance with ASTM D36, the materials shall have a softening point of 215°F ± 15 °F (102.5°C ± 9.5 °C).

viii. Flowability

After heating the thermoplastic material for 4 hours ± 5 minutes at 425°F ± 3 °F (218°C ± 2 °C) and testing for flowability, the white thermoplastic shall have a minimum percent residue of 18 and the yellow thermoplastic shall have a maximum residue of 21 percent.

ix. Yellowness Index

The white thermoplastic material shall not exceed a yellowness index of 0.15.

x. Flowability – Extended

After heating the thermoplastic material for 8.5 hours ± 5 minutes at 425°F ± 3 °F (218°C ± 2 °C) and testing for flowability, the thermoplastic shall have a maximum percent residue of 28 percent.

xi. Flash Point

The thermoplastic material shall have a flash point not less than 475°F (246°C) when tested in accordance with ASTM D92 “Flash and Fire Points by Cleveland Open Cup.”

- d. **Storage Life.** The material shall meet the requirements of this special provision for a period of at least 1 year. The thermoplastic must also melt uniformly with no evidence of skins or unmelted particles for this minimum 1-year period. The manufacturer shall replace any material not meeting the above requirements.
- e. **Primer Sealer.** Primer sealers for use on Portland cement concrete or hot mix asphaltic Concrete surfaces prior to application of the thermoplastic material shall be either

SPECIAL PROVISION – THERMOPLASTIC PAVEMENT MARKING

recommended by the thermoplastic material manufacturer or especially compounded for use with the specified thermoplastic material.

5. APPLICATION PROPERTIES

- a. The thermoplastic material shall readily apply to the pavement at temperatures of 400°F – 440°F (204°C – 226°C) from approved equipment to produce “an extruded line which shall be continuous and uniform to shape having clear and sharp dimensions” at a thickness of 0.090 – 0.125 in. (2.286 – 3.175mm). Low wear longitudinal and special markings, i.e., lane lines, center lines, edge lines, gore, island, diagonal strip markings, and bike lane symbols/legends, shall have a minimum thickness of 0.090 inch (2.286mm) at the edges and a maximum of 0.120 inch (3.048mm) at the center with a minimum of 0.090 inch (2.286mm) maintained throughout. High wear and transverse markings, i.e., stop lines, symbols and legends, shall have a minimum thickness of 0.125 inch (3.175mm) at the edges and a maximum of 0.188 inch (4.775 mm) at the center with a minimum of 0.125 inch (3.175mm) maintained throughout.
- b. The material shall not exude fumes which are toxic, obnoxious or injurious to persons, animals or property when it is heated during applications. The manufacturer shall provide material safety data sheets for the product.
- c. The application of additional glass beads by drop-on method shall be at a uniform rate not to exceed 10 pounds (4.53kg) of glass spheres every 100 ft² (9,29m²) of marking.
- d. The material, when formed into traffic markings, must be readily renewable by placing an overlay of new material directly over old markings of the same material. Such new material shall bond itself to the old markings in such a manner that no splitting or separation takes place.

6. PACKAGING AND MARKINGS

- a. The thermoplastic material shall be packaged in suitable containers that will not adhere to the product during shipment and storage. The container of thermoplastic material shall weigh approximately 50 pounds (23kg). Each container shall designate the color, binder (alkyd), extrusion, user information, manufacturer’s name and address, 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 in the range of 400°F – 440°F (204°C – 226°C). No mislabeled containers shall be allowed for any reason.
- b. The Contractor shall assume all costs arising from the use of the patented materials, equipment, devices or processes used on or incorporated in the work. The Contractor agrees to indemnify and save harmless the Engineer from all legal suits or action of every nature for, or on account of, the use of any patented materials, equipment, devices or processes.

7. MATERIAL ACCEPTANCE

SPECIAL PROVISION – THERMOPLASTIC PAVEMENT MARKING

Final acceptance of the particular lot of thermoplastic material or drop-on glass spheres shall be based on receipt of written certification of the following:

1. Compliance with the specification for material composition requirements.
2. Compliance with the physical properties of the thermoplastic material or glass spheres with the specification.
3. Manufacturer's test results for each lot of thermoplastic material or glass spheres.
4. Identification requirements are satisfactory.

Written certification shall be delivered to the Engineer via the General Contractor no less than 48 hours prior to the placement of the thermoplastic.

8. METHODS OF SAMPLING AND TESTING

- a. The minimum batch size of thermoplastic material when tested shall not be less than 2000 pounds (907kg) unless the total order is less than that amount. A small trial batch should be made prior to making the thermoplastic marking material in large quantities to make certain the finished product will comply with all requirements of this special provision.
- b. The thermoplastic material shall conform to AASHTO M249-79 (1986) and T250 with the appropriate method in Federal Test Method Standard No. 141 or ASTM designation. At the Engineer's discretion, the material may be tested by State or independent laboratories following ASTM test methods D-4960-89, D-4797-88, and D-4796-88.

9. THERMOPLASTIC PERFORMANCE AND APPLICATION CHARACTERISTICS

- a. The thermoplastic material shall not deteriorate by contact with sodium chloride, calcium chloride or other chemicals used to prevent roadway ice. Additionally, the thermoplastic shall not deteriorate because of the oil content of pavement materials or from contact with oil droppings other effects of traffic.
- b. All application equipment shall be approved by The Engineer prior to use on the project. Application equipment shall provide for varying traffic marking application widths.

The material shall be applied to the pavement by ribbon extrusion or by screed extrusion. The equipment shall have a heated path for material flow between melting kettles and the die, inclusive.

Motorized units shall have a totally closed material delivery system between the melting kettles and application die(s) to prevent loss of temperature. All melting of the thermoplastic material shall be performed on the application equipment.

Non-motorized hand applicators shall have a protective hood over the die area with a source of heat mounted on the hood to provide heat to the die area. The die shall be attached to the non-motorized applicator at the factory. Walk behind carts with open-air systems for

SPECIAL PROVISION – THERMOPLASTIC PAVEMENT MARKING

use on symbols and transverse lines shall be approved by the Engineer prior to use on the project. Approval may include sample application of thermoplastic material, at Contractor expense, for comparison against unacceptable work as described in section 12.0 of this special provision.

Motorized units shall have an electronic skip-timing system to target specified material thickness(es) (in mils). This system shall also adjust bead tank pressure to provide specified bead application rate(s) (in lbs/100ft²).

An auxiliary low-speed propulsion system initiated and regulated by the electronic skip-timing system is preferred, but not mandatory.

- c. The equipment used to install hot applied thermoplastic material by contract under this special provision shall be constructed to provide continuous uniform heating to temperatures of 400°F – 440°F (204°C – 226°C), mixing and agitation of the material. Conveying parts of the equipment between the main material reservoir and the line-dispensing device shall prevent accumulation and clogging. All parts of the equipment that come in contact with the material shall be constructed for easy accessibility and exposure for cleaning and maintenance. The equipment shall operate so that all mixing and conveying parts including the line dispensing device maintains the material at the plastic temperature. The use of pans, aprons or similar appliances that the dispenser overruns will not be permitted under this special provision. The equipment shall provide for varying traffic marking application widths.
- d. The application equipment shall be mobile and maneuverable to the extent that straight markings can be followed and normal curves can be made in a true arc.
- e. Glass spheres applied to the surface of the completed marking shall be applied by an automatic bead dispenser attached to the marking machine so that the beads are dispensed closely behind the installed marking. The glass sphere dispenser shall be equipped with an automatic cut-off control synchronized with the cut-off of the thermoplastic material.
- f. A special kettle shall be provided for uniformly melting and heating the thermoplastic material. (The kettle shall be mounted on motorized equipment.) It shall be equipped with an automatic thermostat control device and material thermometer for positive temperature control and to prevent overheating or underheating of the material. The heating kettle and all related application equipment shall meet the requirements of the national Fire Underwriters and the National Fire Protection Association of the state and local authorities.

10. INSTALLATION TECHNIQUES

a. Surface Preparation

i. Moisture

All surfaces shall be inspected for moisture content prior to application of the thermoplastic material. Approximately two square feet (0.372m²) of a clear plastic or tar paper shall be laid on the road surface and held in place for 15-

SPECIAL PROVISION – THERMOPLASTIC PAVEMENT MARKING

20 minutes. The underside of the plastic or tar paper shall then be inspected for a build up of condensation from the road surface. If the amount of condensed moisture is of a sufficient amount to result in water dripping from the plastic or tar paper when held in a vertical position, thermoplastic material shall not be applied. This test shall be repeated until the moisture in the road surface has been allowed to evaporate to a level whereby there is not excessive build up of condensation on the underside of the plastic or tar paper.

ii. **Cleaning**

All surfaces shall be clean of all non-asphaltic materials and dry before thermoplastic can be applied. Cleaning methods shall include, but not be limited to, compressed air, power broom and water. All cleaning shall be performed to the satisfaction of the Engineer prior to the installation of the marking material. If the thermoplastic is to be applied over existing paint lines, the paint line shall be swept with a mechanical sweeper or wire brush to remove poorly adhered paint and dirt that would interfere with the proper bonding of the thermoplastic material. Latence and curing compound shall be removed from all new Portland cement concrete surfaces by loose grain abrasive pressure blasting. The Contractor shall take full responsibility for pavement/shoulder damage due to surface cleaning.

iii. **Layout**

The pavement marking shall be placed in proper alignment with guidelines established on the roadway. All guidelines greater than one-half inch (12.7mm) in width shall be completely covered by thermoplastic material or removed by a method approved by the Engineer after thermoplastic application. Deviation from alignment established shall not exceed two inches (50.8mm), and, in addition, the deviation in alignment of the marking being placed shall not exceed one inch (25.4mm) per 200 feet (70m) of roadway nor shall any deviation be abrupt. Longitudinal markings shall be offset at least two inches (50.8mm) from construction joints and pavement seams/edges. All temporary/construction pavement marking shall be removed prior to the application of the thermoplastic material.

iv. **Sealer**

A primer sealer of the type recommended by the manufacturer of the thermoplastic material shall be applied on all Portland cement concrete pavement surfaces, all asphaltic surfaces greater than 2 years in age, and, if recommended by the manufacturer, on other types of pavement surfaces, prior to the installation of the thermoplastic material. The primer shall be applied as recommended by the thermoplastic manufacturer, and it shall be void of solvent and water prior to the application of thermoplastic material.

SPECIAL PROVISION – THERMOPLASTIC PAVEMENT MARKING

11. TEMPERATURE REQUIREMENTS

The ambient air and road surface shall be 55°F (12.8°C) for screed extrusion and 65°F (18.3°C) for ribbon extrusion and rising before application of thermoplastic material can begin. Wind chill shall be considered in conjunction with the air temperature. If the wind chill factor creates an apparent air temperature of 45°F (7.2°C) or less for screed extrusion and 55°F (12.8°C) for ribbon extrusion or less, thermoplastic material application will not be allowed.

12. CONTRACTOR RESPONSIBILITY

The Contractor shall notify the Engineer a minimum of 48 hours prior to the application of the thermoplastic material to enable an inspector to be present during the application process. At the time of notification, the Contractor shall indicate the manufacturer and the lot numbers of the thermoplastic that he intends to use. A check should be made by the Contractor to insure that the approved lot numbers appear on the material packaging. Failure to do so is cause for rejection of the thermoplastic material.

13. MARGINAL WEATHER INSTALLATION

The Contractor shall bid, per lineal foot, a pay item that will allow for pre-heating the pavement in marginal weather situations, i.e., moisture visible or present (as indicated by bubbles or holes in the finished line; pavement temperature less than 50°F (10°C); cool/windy conditions; etc. Pre-heating shall only be allowed as directed by the Engineer to improve the probability for proper bond between material and pavement. Pre-heating shall be allowed to temperatures not exceeding 150°F (65.5°C). The Contractor shall take full responsibility for pavement damage due to pre-heating the pavement.

14. TIME OF YEAR

Installation of thermoplastic pavement marking material shall be performed between April 1st and October 15th of any calendar year. Any material installed outside of these dates shall be done so only after the marking contractor submits written certification that all liability for proper installation rests with the contractor. The Engineer shall make final determination for acceptability of conditions for installation. Any remedial action shall be the contractor's responsibility.

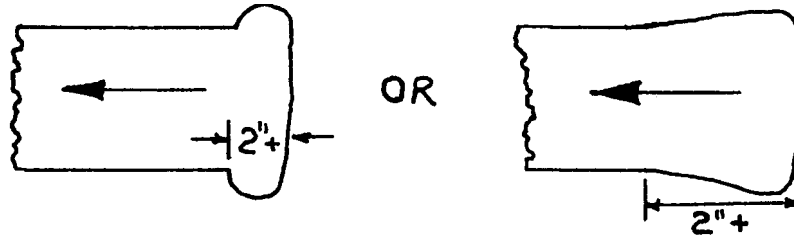
15. PENALTIES

It is agreed to by the Contractor and any sub-contractors that the esthetics, as well as the durability, of the thermoplastic pavement marking is of paramount importance. Under this agreement, penalties shall be levied for substandard work. Substandard work described herein shall carry the prescribed penalties when the Engineer determines the substandard work to be correctable by the Contractor. Illustrations, when used, are for example only.

- a. **Lack of specified thickness.** The full unit price bid per foot shall be penalized if lack of thickness is found more than three (3) times per mile, or project if less than one mile in length. Each line shall be checked a minimum of six (6) times per mile, or project if less than one mile in length, using the random number tables and method of sampling as set forth in section 5.17.06 of Part V of the KDOT Construction Manual.

SPECIAL PROVISION – THERMOPLASTIC PAVEMENT MARKING

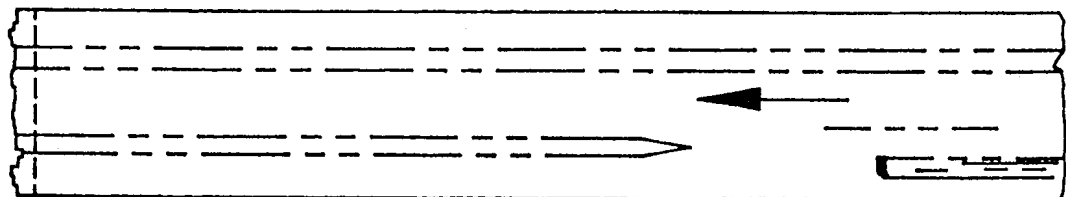
- b. **Lack of specified width.** Payment shall be made with penalty being equal to 25% of the unit price bid per foot for each $\frac{1}{4}$ " of width lacking not to exceed 100% of the unit price bid per foot for the length of the line less than specified width. Penalty shall be imposed upon the first occurrence and every occurrence thereafter.
- c. **Bell ends.** The full unit price bid per foot shall be withheld for wide "bell" ends greater in length than two (2) inches. This penalty shall be for the full ten (10) feet of a lane line or broken center line or for no more than ten (10) feet of a long line.



- d. **Lack of adhesion.** The full unit price bid per foot shall be withheld for one (1) foot for each occurrence if found more than three (3) times per mile, or project if less than one mile in length.

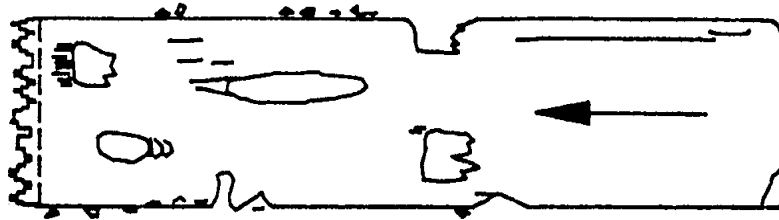


- e. **Line Deviation.** A line that in the judgment of the Engineer deviates from the specified layout by an unreasonable amount shall be replaced. The Contractor shall be responsible for removal of the deviated marking material/repair of the pavement as designated by, and to the satisfaction of, the Engineer at no additional compensation.
- f. **Pitted Line.** The full unit price bid per foot shall be withheld for each pit greater than ten (10) feet in length.

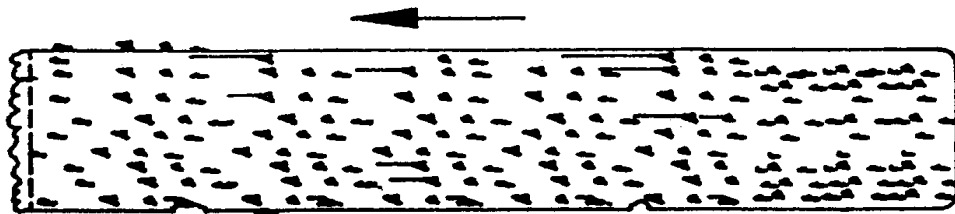


SPECIAL PROVISION – THERMOPLASTIC PAVEMENT MARKING

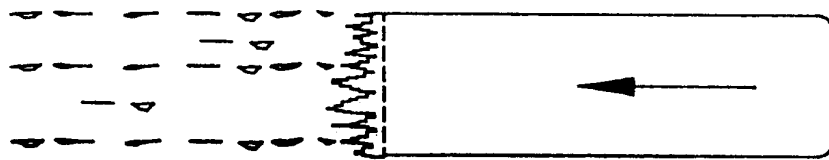
- g. **Gaps in Line or Crumbly Edges.** The full unit price bid per foot shall be withheld for the entire length of the portion of any line receiving less than the required amount of thermoplastic material. Penalty shall be imposed when the Contractor fails to correct line thickness after the second warning within a mile, or project if less than one mile in length.



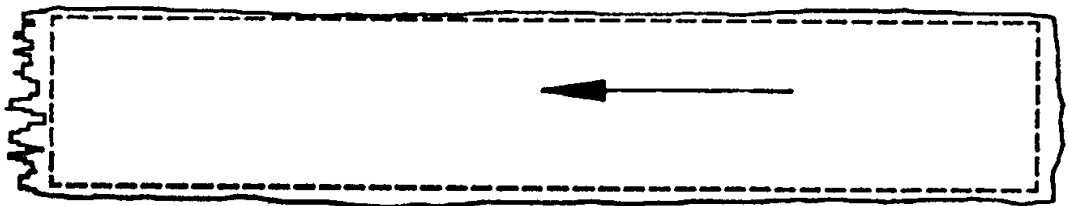
- h. **Rough Line Surface.** The full unit price bid per foot shall be withheld for the entire length of the portion of any line with a rough or “burlap” surface. Penalty shall be imposed upon the first occurrence and every occurrence thereafter.



- i. **Excessive Dripping between Lines.** The full unit price bid per foot shall be penalized for the length of any dribbled open space between broken lines that is not removed to the satisfaction of the Engineer before leaving the project site that work day. Penalty shall be imposed upon the first occurrence and every occurrence thereafter.

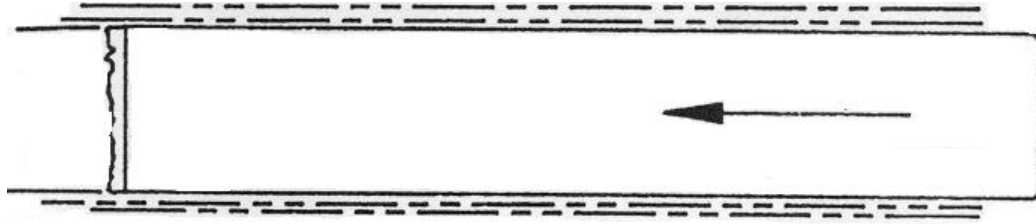


- j. **Swollen Line of Excessive Width:** The full unit price bid per foot shall be penalized for swollen lines in excess of the specified width.

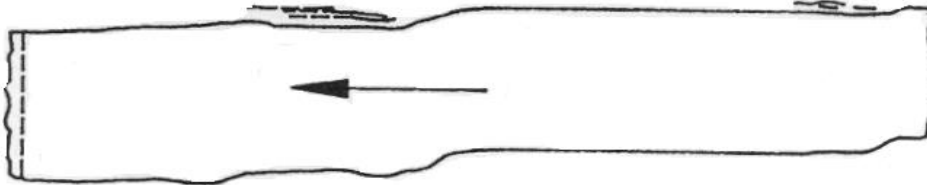


SPECIAL PROVISION – THERMOPLASTIC PAVEMENT MARKING

- k. **Smearred Line Edges.** Fifty (50) percent of the unit price bid per foot shall be penalized for each occurrence of a length greater than fifteen (15) feet.



- l. **Wavy Line.** The full unit price bid per foot shall be withheld for the entire length of waviness in a line caused by poor operation by the driver/operator of the application equipment. Penalty shall be imposed from the first occurrence.



- m. **Lack/Excess of Surface Beads or Improper Application.** The full unit price bid per foot shall be withheld for each lineal foot of material with inappropriate application rate of the surface glass beads. The same penalty shall apply if the beads are not evenly disbursed across and along a line or if the beads imbed improperly. Penalty shall be imposed for each instance that the Contractor fails take corrective action after one warning by the Engineer.
- n. **Work Outside the Scope/Limits of Project.** Payment for all pavement marking work performed shall be withheld in full until the Contractor (a) removes all pavement marking material placed outside the scope/limits of the project, and (b) repairs the pavement surface as directed by and to the satisfaction of the Engineer and the local entity, if different from the Engineer.
- o. **Timeliness.** All thermoplastic material shall be completely installed within one (1) calendar week of the road surface material being laid. Failure to install markings on schedule shall result in liquidated damage of \$1500 per day, separate from the project liquidated damages as stated elsewhere in the Contract documents, until pavement markings are installed on schedule, or completion of the markings completes the project. These liquidated damages shall be imposed each time the Contractor fails to install pavement markings within the one week window as described above.

16. METHOD OF MEASUREMENT

The thermoplastic pavement marking shall be measured by the linear foot for longitudinal and transverse lines, and per each for symbols as indicated in the Plans and other Contract documents. When measured per linear foot, it will be measured by the linear foot for each length of the various widths and colors complete in place.

SPECIAL PROVISION – THERMOPLASTIC PAVEMENT MARKING

17. BASIS OF PAYMENT

Payment for thermoplastic pavement marking shall be made at the contract lump sum price bid or the contract unit price bid per linear foot of specified width and color, and per each for each symbol, less any applicable penalties as described in section 12.0, or any liquidated damages.

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