1086 - THERMOPLASTIC PAVEMENT MARKINGS

1086.1 DESCRIPTION

The Contractor shall furnish and install white and yellow permanent retro-reflectorized pavement marking materials at the locations shown on the plans, in conformance with the details, and the material specifications included herein.

The permanent pavement markings shall be installed immediately after surface treatment unless prior approval is received by the Engineer or City Inspector. The installation of the yellow markings (as required) is the first priority. If the permanent markings cannot be installed and thus the roadway would be unmarked overnight, interim removable markings shall be installed and remain until the permanent markings can be installed. The contractor shall make every possible effort to remove the interim pavement markings and install permanent pavement markings within 48 hours. Only under extreme circumstances and at the approval of the pavement marking inspector or the engineer, will the duration of the interim pavement markings be extended. Under no circumstance should the interim pavement markings be in place for more than 2 weeks. The interim removable markings shall be removed prior to installation of the permanent markings. If permanent markings cannot be installed within the specified time then temporary markings shall be installed following the guide lines as set forth in the latest edition of the Manual on Uniform Traffic Control Devices (MUTCD) Part VI, Sections 6F.78 and 6G.02.

1086.2 MATERIALS

This specification covers a white and yellow thermoplastic reflectorized pavement marking material of a type that is applied to asphalt road surfaces. The material shall be applied in a molten state by mechanical means to receive a surface application of glass spheres, and which upon cooling to normal pavement temperature, produces an adherent reflectorized stripe of specified thickness and width and is capable of resisting deformation. The material for shall be in accordance with this specification.

a. Pre-Qualification

All material for permanent pavement marking material used by the Contractor shall be from the City's approved list of vendors. It is important that users be completely knowledgeable of all application requirements and procedures prior to product application. It is the responsibility of the installer to contact the supplier of all permanent pavement marking materials if questions regarding application procedures or conditions arise. Manufacturers interested in pre-qualifying material under this specification shall submit a sample of the material along with a complete materials specification for each color of marking material to be considered. The sample will be reviewed for compliance with all requirements of this specification. No material shall be used unless the material has been pre-qualified. A complete list of pre-qualified materials is maintained by the Traffic Engineering Division of the Department of Public Works.

b. Glass Beads

The high performance glass beads for high performance pavement markings shall be clear, smooth and spherically shaped and shall conform to the following specific requirements.

(1) Gradation

US Sieve Mesh No.	Microns	% Retained	% Passing
16	1190	0-10	90-100
18	1000	20-35	65-80
30	600	50-70	30-50
50	300	95-100	0-5

(2) Roundness

The beads shall have a minimum of 80% true spheres above the 30 sieve by visual inspection by ASTM Method D 1155 or by Computerized Optical Method (AASHTO PP-74-13) or approved equivalent.

(3) Color / Clarity

Beads shall be colorless and clear and free of carbon residues.

(4) Refractive Index

The glass beads shall have a refractive index of 1.50 to 1.55.

(5) Coating

The bead coating shall meet or exceed the requirements for the particular pavement marking material that is used. This may include coatings for floatation, optimum adhesion and/or embedment.

(6) Air Inclusions

Air inclusions shall be less than 5% by visual count.

(7) Hardness

All beads above the 30 sieve shall exhibit an average crushing strength of not less than 60,000 psi when measured with the L/D2 method and with a minimum sampling of 100 glass beads.

(8) Chemical Resistance

The beads shall be resistant to hydrochloric acid, water, calcium chloride, and sodium sulfide as tested per methods outlined in sections 4.3.6 to 4.3.9 of the TT-B Federal Spec. 1325C.

c. Characteristics

The material shall not exude fumes that are toxic, obnoxious or injurious to person or property, when it is heated to the temperature range specified by the manufacturer for application. It shall remain stable when held for 4 hours at this temperature, or when subject to 3 reheatings after cooling to ambient temperature. The temperature-viscosity characteristics of the plastic material shall remain constant throughout repeated reheatings, and shall show like characteristics from batch to batch. There shall be no obvious change in color of the material neither as a result of repeated reheatings nor from batch to batch. The thermoplastic material shall easily extrude from the equipment to produce a cross-section of line 90 to 125 mil thick, which shall be continuous and uniform in shape, and have clear and sharp dimensions.

d. Serviceability

The compound shall resist deterioration by contact with sodium chloride, calcium chloride or other chemicals used to prevent roadway ice, or because of the oil content of pavement materials or from oil droppings or other effects of traffic. The markings shall remain intact under normal traffic conditions at temperatures below 60 degrees C (140 degrees F).

e. Specific Gravity

The material's specific gravity shall not be less than 1.8 nor exceed 2.15 referred to water at 25 degrees C (77 degrees F) when determined by a water displacement method at 25 degrees C (77 degrees F).

f. Set Time

When applied at the specified temperature and thickness, the material shall set to bear traffic in not more than 2 minutes when the air temperature is 10 $\pm$ 2 degrees C (50 $\pm$ 3 degrees F) and not more than 10 minutes when the air temperature is 32 $\pm$ 2 degrees C (90 $\pm$ 3 degrees F).

g. Composition

The thermoplastic pavement marking material shall be homogeneously composed of pigment, filler, resin binder and glass reflectorizing spheres. The solid resin shall be a "maleic-modified glycerol ester resin" (alkyd binder) comprising at least one-third of the binder compositions and be no less than eight (8) percent by weight of the entire material formulation. 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. The material shall not contain any petroleum derived ingredients. Yellow pigment shall be heat stabilized encapsulated lead chromate. The thermoplastic pavement marking material shall contain the following ingredients:

INGREDIENT (Percent by Weight)	WHITE	YELLOW
Binder (See Note A below)	18.0% min.	18.0% min.

Titanium Dioxide	10.0% min.	--
Glass Spheres	20.0-50.0%	20.0-50.0%
Lead Chromate	--	--
Inert Fillers	42.0% max.	50.0% max.

The material shall be thoroughly mixed and furnished in a free flowing granular form. The material shall meet the requirements of this specification for a period of one year. The material shall readily melt in a uniform mixture. The material shall be free from all skins, dirt, and foreign objects. It shall be of such composition that it will not bleed, stain or discolor when applied to bituminous pavement. The manufacturer shall replace material not meeting the above requirements.

h. Color

The color of the thermoplastic material after heating for 4 hours ± 5 minutes at 218± 2 degrees C (425 ± 3 degrees F) and cooled to 25 ± 2 degrees C (77 ± 3 degrees F) shall conform to the following when tested by Federal Test Method Standard 141 Method 4252:

White:	Federal Color Chip No. 17875 (Fed. Std. No. 595)
Yellow:	Federal Color Chip No. 13538 (Fed. Std. No. 595)

i. Reflectance

The daylight luminous reflectance of the white material shall be not less than 75% when tested according to A.S.T.M. E1347. The yellow shall have a minimum brightness of 45% relative to magnesium oxide, and shall be within the green and red tolerance of the "Standard Color Chips for Highway Signs (January 1939)" obtainable from the United States Bureau of Public Roads, Washington, D.C. (TT-P-115a).

j. Retroreflectivity

The marking shall upon application exhibit uniform adequate nighttime retroreflectivity when tested in accordance to ASTM E1710-97. The applied material must have an initial minimum intensity reading of 350 millicandelas for white and 250 millicandelas for yellow as measured with an LTL-2000 Retroreflectometer with a 1.05 degree observation angle, 88.76 degree entrance angle and 30 meter geometry (viewing distance).

k. Softening Point

After heating the thermoplastic material for 4 hours ± 5 minutes at 218 ± 2 degrees C (425 ± 3 degrees F) and testing in accordance with ASTM D36, the material shall have a softening point 102 ± 9.5 degrees C (215 ± 15 degrees F).

l. Flowability

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

After heating the thermoplastic material for 8.5 hours ± 5 minutes at 218 ± 1.4 degrees C (425 ± 3 degrees F) and testing for flowability, the thermoplastic shall have a maximum percent residue of 28 percent.

m. Indentation Resistance

Hardness shall be measured by a Shore Durometer, Type A2, as described in A.S.T.M. D-2240, except that the Durometer and the panel shall be at 25 degrees C (77 degrees F), and a 2 kg (4.4 lb.) load applied. After 15 seconds, the reading shall be not less than 55.

n. Abrasion Resistance

The material shall not show a maximum loss of 0.5 g (0.02 ounces) subjected to 200 revolutions on a Taber Abraser at 25 degrees C (77 degrees F), using H-22 calibrate wheels, weighted to 500 g (17.6 ounces). The wearing surface should be kept wet with distilled water throughout the test. The panel for this test shall be prepared by forming a representative lot of

material at a thickness of 3 mm (125 mil) on a 100 mm (4") square panel (thickness 1.3 ± 0.025 mm) [thickness 0.050 ± 0.001 inch] on which a suitable primer has been previously applied.

o. Low Temperature Impact Resistance

The materials shall not fracture when subjected to an impact of 7.23 N-m at –20 degrees C (64 inch pounds at –4 degrees F), for at least 3 hours. The panel is then placed in an instrument also maintained at -20 degrees C (–4 degrees F), consisting of a 4.7 kg (10.5 pound) freely falling weight controlled to drop vertically for 150 mm (6") onto the surface of the panel, which it strikes with a hemispherical indent or having a radius of 7 mm (0.28 inches).

p. Water Absorption

Materials shall have a maximum of 0.5 percent by weight of retained water when tested by ASTM designation D-570, "Water Absorption of Plastics", procedure (A).

q. Yellowness Index

The white thermoplastic material shall not exceed a yellowness index of 0.12.

r. Flash Point

The thermoplastic material shall have a flash point not less than 475 degrees F when tested in accordance with ASTM D92.

s. Cracking Resistance

After heating the thermoplastic material for 4 hours ± 5 minutes at 218 ± 2 degrees C (425 ± 3 degrees F); applying to concrete blocks, and cooling -9.4 ± 1.7 degrees C (15 ± 3 degrees F), the material shall show no cracks. Properly applied, the material shall show less than six stress cracks per three lineal meters (ten lineal feet) of markings independent of pavement fracturing and faulting, for at least six months.

1086.3 CONSTRUCTION REQUIREMENTS

The proposed permanent markings shall be laid out by the contractor in advance of the marking installation. Markings shall not be applied until the layout and conditions of the surface have been approved by the City Inspector. If a paint line is used for layout purposes (in lieu of a chalk line or string line) the paint line shall not be wider than ½ inch) in width. If wider, the paint shall be removed following the application of the final permanent marking. New markings shall match existing markings as applicable in areas abutting existing road surfaces. The surface shall be dry and all dust, debris, oil, grease, dirt, temporary markings, existing markings, and other foreign matter shall be removed from the road surface prior to the application of the permanent marking material.

The Contractor shall be responsible for keeping traffic off freshly applied markings until they have set sufficiently to bear traffic. Traffic control is the responsibility of the Contractor and shall conform to the City of Overland Park Traffic Control Handbook. Failure to comply with traffic control guidelines will result in the Pavement Marking Contractor being directed to stop operations and leave the site until proper and approved traffic control has arrived and put in place on site.

a. Application

The thermoplastic material shall be applied in a melted state at a temperature of 400 – 425 degrees F from approved equipment to produce an extruded line that shall be continuous and uniform in shape having clear and sharp dimensions. The temperature of the material within the shaping dies shall be maintained at the manufacturer's recommendations for application temperatures, but in no case shall the temperature fall below 400 degrees F or exceed 450 degrees F.

Thermoplastic markings shall be applied to the pavement surface in a molten state by mechanical means with surface application of glass spheres, and upon cooling to normal pavement temperature, produce an adherent retro-reflectorized stripe of specified thickness and width and capable of resisting deformation.

b. Surface Moisture Conditions

Thermoplastic material will not properly adhere to pavement if moisture is present. Should rainfall occur within 24 hours prior to application, the surface moisture test (plastic wrap

or roofing paper method as approved by the inspector) must be performed, and approval obtained from the Inspector. The moisture test can be conducted according to the following methods:

(1) Place a 12×12 inch square piece of plastic wrap on the pavement surface using duct tape to affix the edges. Let stand approximately 15 minutes. Remove the plastic wrap at the end of the waiting period. Visibly inspect and touch the underside of the plastic wrap. If there is no indication of moisture, striping may begin. Otherwise, the pavement contains too much excess water.

(2) Using roofing felt paper, place a 12×12 inch square of felt on the asphalt and install the thermoplastic material directly onto the felt paper. Let it cool for approximately 10 seconds, then lift the paper to check for moisture on the back side. If the paper shows no signs of wetness or visible water droplets, striping may begin. Otherwise, the pavement contains too much excess water.

c. Application Temperatures

To insure optimum adhesion, the pavement and ambient air temperature shall be 50 degrees F and rising. Where manufacturer's application temperatures differ from those as specified, the manufacturer's temperatures shall apply upon approval of the Engineer.

d. Equipment

The equipment used to install the thermoplastic shall be as follows:

A self-propelled machine is required in order to fulfill the timing needs of the marking installation for longitudinal lines.

The equipment shall be constructed to provide mixing and agitation of the materials. Conveying parts between the main material reservoir and the shaping die shall be constructed as to prevent accumulation and clogging. The mixing and conveying parts up to and including the shaping die will maintain the materials at a temperature not less than 400 – 450 degrees F. To assure that the material does not fall below the minimum temperature, the shaping die shall be heated by means of a gas-fired infrared heater or a heated, oil-jacketed system. It shall be constructed as to insure continuous uniformity in the dimensions of the stripe. The applicator shall provide a means for cleanly cutting off square stripe ends and shall provide a method of applying "skip" lines. The equipment shall be constructed to be able to provide for varying die widths and to produce varying widths of traffic markings. The use of pans, aprons, or similar appliances with die overruns will not be permitted.

Liquid thermoplastic shall not be used for word or symbol markings or transverse lines.

All conditions apply as stated above for material temperatures, line definition and workmanship when a hand pushcart is used for cross walks. The Inspector will verify measurement. The pushcart shall be equipped with a special kettle for melting and heating the material shall be provided. The kettle shall be equipped with a thermostat so that heating can be done by controlled heat transfer liquid rather than by direct flame so as to provide positive temperature control and prevent overheating of the material. It shall be constructed for a nominal application of 90 – 125 mil thickness. The heater and applicator shall be so equipped and arranged as to meet the requirements of the National Board of Fire Underwriters of the National Fire Protection Association, of the state, and of the local authorities. The pushcart shall be equipped with an automatic glass sphere dispenser attached to the striping machine in such a manner that the spheres are dispensed almost instantaneously upon the installed line. The glass sphere dispenser shall be equipped with an automatic cut-off control synchronized with the cut-off of the thermoplastic material.

The equipment shall be arranged as to permit preheating of the pavement immediately prior to application of the thermoplastic material, if preheating is recommended by the thermoplastic manufacturer. The applicator shall be capable of containing a minimum of 1000 pounds of molten material (not applicable for hand-liner use). The applicator shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc.

The Contractor's striper shall be equipped with electrical foot counters. The counters shall individually tabulate the length of line applied by each gun whether solid or dashed. The Contractor shall determine the accuracy of the foot counters and establish an adjustment factor as

required to determine the pay item quantities. The foot counters shall be periodically checked to assure accurate measurements. No thermoplastic shall be applied without the accurate operation of the foot counters. The Contractor shall provide the Engineer with a certified document on these calibrations.

e. Application Over Existing Markings

Existing thermoplastic markings on asphalt road surfaces may be over laid with thermoplastic material providing that the existing markings (thermoplastic) are less than 30 mils thick, and are securely bonded to the substrate. If the thermoplastic is greater than 30 mils, or not securely bonded to the substrate, then it shall be ground to 30 mils, or removed completely if not securely bonded to the road.

Existing solvent based paint on asphalt road surfaces may be over laid with thermoplastic provided that more than 75% of the road surface is exposed, and there is no more than a single coat of paint on the remaining unexposed area. If more than one layer of paint exists, the paint is not securely anchored to the substrate, or there is less than 75% of the road surface exposed, then the paint must be thoroughly removed.

All existing polyester, epoxy, or other type pavement marking paints on asphalt or concrete road surfaces must be completely removed from all road surfaces prior to the installation of thermoplastic material.

f. Line Quality

The finished lines shall have well defined edges and be free of waviness. Pavement marking lines shall be straight or of uniform curvature and shall conform with the tangents, curves, and transitions as specified in the pavement marking standards and/or as directed by the Inspector.

g. Line Thickness

The minimum thickness of the lines as viewed from a lateral cross section shall be not less than 90 mil. Drop-on glass spheres shall not be included in the measurement, or if so, then appropriate allowances shall be made for the added mil thickness. A device for gauging the installed material thickness shall be furnished to the City Inspector as requested for use on the project. The gauge shall be easy to read and shall readily indicate excessive variations.

h. Drop-on Glass Beads

The drop-on glass beads shall be applied at a rate of 10 to 12 pounds per 100 square feet or as recommended by the manufacturer to achieve the minimum retroreflectivity as specified herein.

i. Clean Up

The Contractor shall be responsible for removing all pavement markings material spilled upon the roadway surface or adjoining area. The Contractor shall use methods acceptable to the Engineer/Inspector for removing the spilled material.

j. Line Repair

Any pavement marking which is crossed by a vehicle and tracked shall be replaced and any subsequent marking made by the vehicle shall be removed by methods acceptable to the Inspector at NO additional cost to the City.

1086.4 INSTALLATION PERFORMANCE MEASURES

To ensure total understanding of what is expected in the application of any permanent pavement marking material on new pavement surfaces in the City of Overland Park, the following guidelines shall be followed. On streets receiving a thin surface treatment only, such as micro-surfacing or slurry seal, some of the performance measures may be waived by the inspector.

All thermoplastic lines shall be of uniform thickness, with well-defined edges and squared off beginnings and endings of all lines.

All thermoplastic lines will have minimal dribbles, runs and overlaps. In the event thermoplastic long lines must stop and then continue, the restart shall line up to within ½ inch of the existing long line and maintain a totally straight line. Hand pushcarts shall be used when

doing crosswalks. When the crosswalk cannot be laid continuous, the startup of the line shall be within ¼ inch of the initial line.

The application equipment shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc.

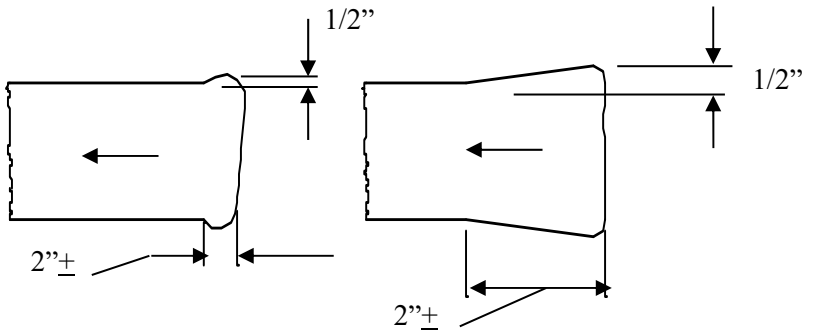
Lack of specified thickness: The full unit price bid per meter (foot) shall be withheld if lack of thickness is found more than three (3) times per mile, or project if less than 1 mile in length. Each line shall be checked a minimum of six (6) times per mile, or project if less than 1 mile in length, 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.

Lack of specified width: Payment shall be made with penalty being equal to 25% of the unit price bid per foot for each ¼" 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.

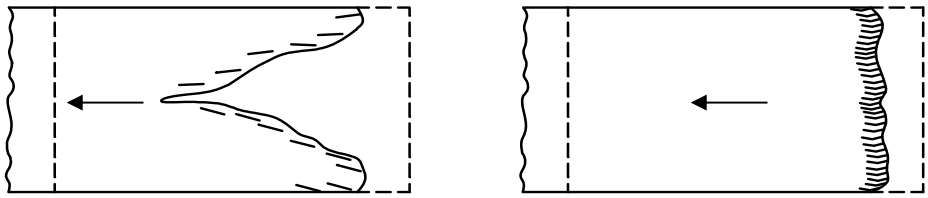
Lack of specified length/cycle: Payment shall be made with penalty being equal to 25% of the unit price bid per foot for each 1" of length lacking or exceeding the specified length for broken lane line and/or broken center line not to exceed 100% of the unit price bid per foot for the length of the line less than specified length. Penalty shall be imposed upon the first occurrence and every occurrence thereafter.

Lack/Excess of Surface Spheres 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 spheres. The same penalty shall apply if the spheres are not evenly disbursed across and along a line or if the spheres imbed improperly. This penalty shall be imposed for each instance that the Contractor fails to take corrective action after one warning by the Engineer.

Bell ends: The full unit price bid per foot shall be withheld for wide "bell" ends greater in length than 2 inches. This penalty shall be for the full 6 feet of a lane line or broken centerline or for no more than 6 feet of a long line.

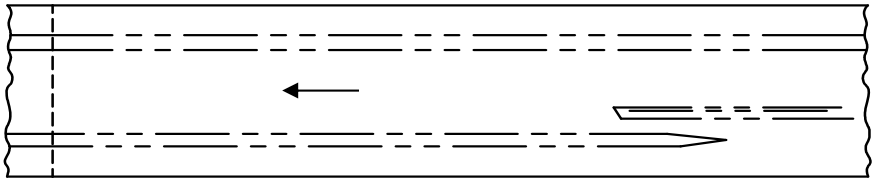


Lack of adhesion: The full unit price bid per foot shall be withheld for one foot for each occurrence if found more than three (3) times pe or project if less than 1 mile in length.

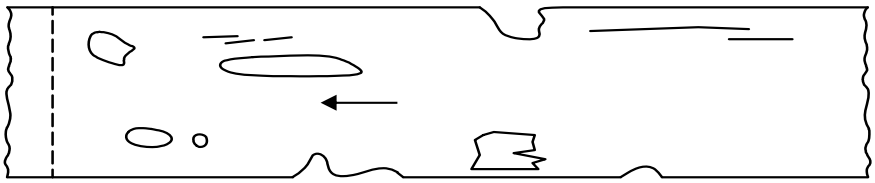


Line Deviation: A line that in the judgment of the Engineer deviates from the specified layout by an unreasonable amount shall be replaced. The Contractor shall be responsible for removal of the deviated marking material/repair of the pavement as designated by, and to the satisfaction of, the Engineer at no additional compensation.

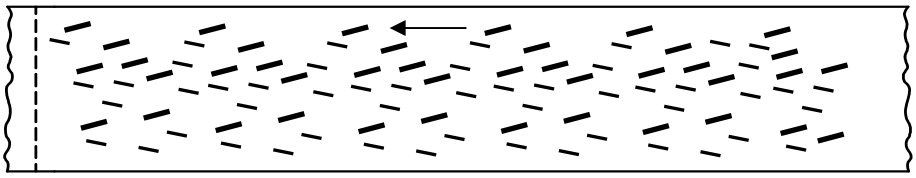
Pitted Line: The full unit price bid per foot shall be withheld for each pit greater than 10 feet in length.



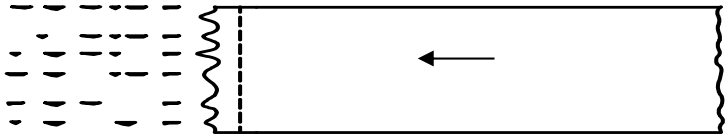
Gaps in Line or Crumbly Edges: The full unit price bid per foot shall be withheld for the entire length of the portion of any line receiving less than the required amount of thermoplastic material. This penalty shall be imposed when the Contractor fails to correct line quality after the second warning within 1 mile, or project if less than 1 mile in length.



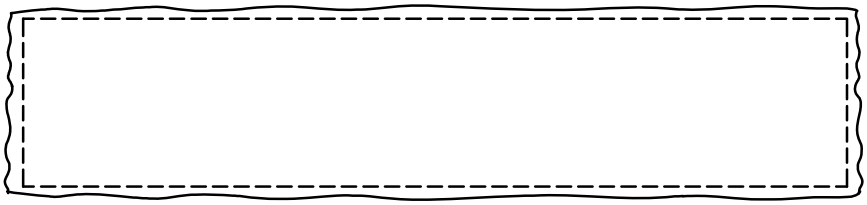
Rough Line Surface: The full unit price bid per foot shall be withheld for the entire length of the portion of any line with a rough or "burlap" surface. Penalty shall be imposed upon the first occurrence and every occurrence thereafter.



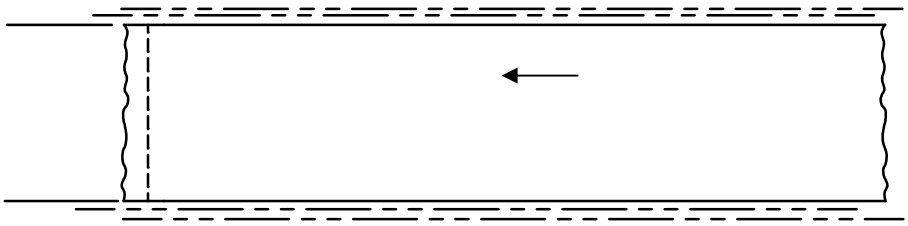
Excessive Dripping between Lines: The full unit price bid per foot shall be penalized for the length of any dribbled open space between broken lines that is not removed to the satisfaction of the Engineer before leaving the project site that work day. Penalty shall be imposed upon the first occurrence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



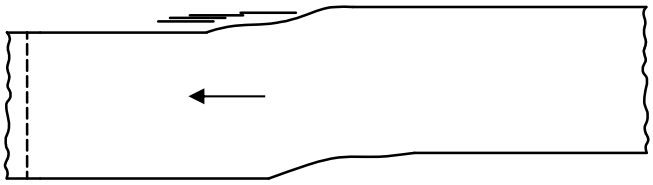
Swollen Line of Excessive Width: The full unit price bid per foot shall be penalized for swollen lines in excess of the specified width.



Smeared Line Edges: Fifty (50) percent of the unit price bid per foot shall be penalized for each occurrence of a length greater than 15 feet.



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.



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.

Timeliness: All thermoplastic material shall be completely installed within two (2) calendar weeks of the road surface material being laid. Failure to install markings on schedule shall result in liquidated damages 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 two-week window as described above.

1086.5 MEASUREMENT AND PAYMENT

a. Lump Sum

The Engineer will measure the pavement markings, as indicated on the plans, complete-in-place and accepted, as a unit lump sum quantity for all work necessary.

Payment for “Permanent Pavement Markings” at the contract lump sum price bid is full compensation for the specified work, which shall include all materials, labor, equipment and incidentals necessary to complete the work. The removal of existing pavement markings prior to installing new markings in the same location shall be considered subsidiary to the bid item “Permanent Pavement Markings”.

b. Unit Bid Prices

Measurement for Thermoplastic Pavement Markings shall be as listed in the bid proposal, which includes all labor, materials, tools and equipment necessary to fully complete the installation according to the plans and specifications. No measurement will be made for the removal of existing pavement markings prior to installing new markings in the same location.

The Engineer will measure the various widths, type and color of pavement marking material along the marking centerline by the linear foot complete in place. Each line of double median approach lines, double centerlines, solid and broken centerline or other parallel lines will be measured separately. Crosshatch lines, chevron lines, crosswalk lines, solid lane lines, stop lines and edge lines, etc. will be measured by the linear foot, measured along the centerline of all markings for each length of the various widths, type and color of material complete in place.

The Engineer will measure broken lines, composed of short line segments separated by a specified gap, by the linear foot of the various widths, type of material and color for the actual marked line only complete in place.

Payment for "Thermoplastic Pavement Markings" as listed in the proposal, at the contract unit price bid is full compensation for the specified work.

All traffic control necessary for installation of the "Thermoplastic Pavement Markings" shall be subsidiary to other bid items. The removal of existing pavement markings prior to installing new markings in the same location shall be considered subsidiary to other bid items.