THERMOPLASTIC PAVEMENT MARKING SPECIFICATIONS

1.0 DESCRIPTION: The Contractor shall provide the necessary labor, materials, and equipment for the application of a preformed pliant polymer thermoplastic pavement marking material. The thermoplastic material shall be durable and provide stable adhesion to asphalt concrete pavements and Portland cement concrete pavements. The retro-reflective thermoplastic pavement marking material is to be 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 normal pavement temperature, it produces a retro-reflective marking of specified thickness and width capable of resisting deformation by high urban traffic volumes.

The successful bidder shall comply with the requirements within these specifications and all other applicable State and Federal laws and statutes, City ordinances, laws, and regulations. The City of Wichita Department of Public Works (hereinafter referred to as the City) will administer the contract of the thermoplastic pavement marking program. The decisions made by designated representative(s) of the City will be final.

Examination Of Work And Conditions: The Contractor is expected to examine, investigate, and research the proper methods for performing the specified thermoplastic pavement marking work prior to submitting a bid. Additional compensation will not be approved if the Contractor determines that the work will require additional labor, equipment, or methods which were not anticipated prior to submission of the bid.

2.0 CLASSIFICATION: The thermoplastic material shall be homogeneously composed of pigment, filler, resins and glass beads. The thermoplastic material shall be available in white (Class A) and yellow (Class B).

3.0 MATERIALS

3.1 The vendor shall have the option of formulating the material according to their own specifications; however, the solid resin shall be in "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 8 percent by weight of the entire material formulation. The alkyd binder shall 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 which are toxic, or injurious to persons, animals, or property. The pigment, beads and filler shall be well dispersed in the resin.

3.2 Glass Beads

3.2.1 Pre-Mix: The pre-mix beads shall be uncoated and conform to AASHTO M247-81 (1986) type 1. The preformed marking material shall have a minimum of 30 percent uniformly distributed glass beads throughout its entire cross section and a protruding exposed layer of glass beads that provide immediate retro-reflectivity without additional glass beads being dropped on the material during application

3.2.2 Drop-on: The drop-on beads shall be moisture resistant coated. The beads shall have a minimum of 70 percent true spheres on each sieve and 80 percent true spheres overall. The beads shall meet the following gradation requirements:

Sieve Size	Percent Retained
16	0 - 3
20	5 - 20
40	65 - 95
50	0 - 5

4.0 REQUIREMENTS OF THE THERMOP0LASTIC MIXTURE

4.1 Specific Gravity: The specific gravity of the thermoplastic materials shall not exceed 2.3.

4.2 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 (Percentage by Weight)

Component	White	Yellow
Binder	18.0 min.	18.0 min.
Glass Beads	30-48	30-48
Titanium Dioxide	10.0 min.	N/A
Calcium Carbonate & Inert Fillers	42.0 max.	50.0 max.
Yellow Pigment	N/A	2.0 min.*

*Percentage may be reduced if lead pigments are eliminated from formulation.

4.3 Physical Characteristics

4.3.1 Color: The thermoplastic material after heating for 4 hours ± 5 minutes at 425° ± 3° Fahrenheit (F) [218° ± 2° Celsius (C)] under agitation shall meet the following luminosity and color requirements:

4.3.1.1 Luminosity:

White: Daylight reflectance at 45 degrees, 0 degrees - 75 percent minimum
Yellow: Daylight reflectance at 45 degrees, 0 degrees - 45 percent minimum

The preformed markings shall upon application exhibit uniform adequate night-time reflectivity. The markings shall average minimum intensities of 200 millicandelas for white and 100 millicandelas for yellow as measured with a Mirolux 12 Retroreflectometer.

4.3.1.2 Color: The colors shall match Federal Highway Administration yellow and white color specifications.

4.3.2 Set Time: When applied at a temperature of 412.5° ± 12.5° F (211° C) and thickness of 60 mils to 185 mils (1.5 mm to 4.7 mm) the material shall set to bear traffic in not more than 2 minutes when the air and road surface temperature is approximately 50 ° ± 3° F (10° ± 2° C) and not more than ten minutes when the air and road surface temperature is approximately 90° ± 3° F (32° ± 2° C).

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

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

4.3.5 Impact Resistance: After heating the thermoplastic material for 4 hours ± 5 minutes at 425° ± 3° F (218° ± 2° C) and forming test specimens, the impact resis6tance shall be a minimum of 10 inch pounds (1.13J).

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

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

4.3.8 Yellowness Index: The white thermoplastic material shall not exceed a yellowness indes of 0.15.

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

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

4.4 Storage Life: The material shall meet the requirements for a period of 1 (one) year. The thermoplastic must also melt uniformly with no evidence of skins or unmelted particles for this 1 (one) year period. Any material not meeting the above requirements shall be replaced by the Contractor.

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

4.6 Skid Resistance: The surface of the preformed thermoplastic markings shall provide a minimum skid resistance value of 45 BAV when tested according to ASTM E 303-74.

5.0 APPLICATION PROPERTIES

5.1 The thermoplastic material shall readily apply to the pavement at temperatures of 400-440° F (204-226° 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 inch (2.286 - 3.175 mm). Low wear longitudinal and special markings, i.e., edge lines, gore, island, diagonal strip markings, and bike lane symbols and legends, shall have a minimum thickness of 0.090 inch (2.286 mm) at the edges and a maximum of 0.120 inch (3.048 mm) at the center with a minimum of 0.090 inch (2.286 mm) maintained throughout. high wear and transverse markings, i.e., lane lines, center lines, transverse marking and markings in high traffic wearing areas, shall have a minimum thickness of 0.125 inch (3.175 mm) at the edges and a maximum of 0.188 inch (4.775 mm) at the center with a minimum of 0.125 inch (3.175 mm) maintained throughout.

5.2 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 their product.

5.3 The application of additional glass beads by drop-on method shall be at a uniform minimum rate of 10 pound (4.53 kg) of glass spheres every 100 square feet (9.39 m^2) of marking.

5.4 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 tot he old markings in such a manner that no splitting of separation takes place.

5.5 The preformed markings shall conform to pavement contours, breaks, and faults through the action of traffic at normal pavement temperatures. The markings shall have resealing characteristics and be capable of fusing to itself, and previously applied, hydrocarbon and alkyd thermoplastic.

6.0 PACKAGING AND MARKINGS

6.1 The thermoplastic material shall be packaged in suitable containers which will not adhere to the product during shipment and storage. The container of thermoplastic material shall weigh approximately 50 lbs. (23 kg). 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 400-440° F (204-226° C). No mislabeled containers shall be allowed for any reason.

6.2 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; agrees to indemnify and save harmless the City of Wichita from all legal suits or action of every nature for, or on account of, the use of any patented materials, equipment devices, or processes.

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

A. Compliance with the specification for material composition requirements.
B. Compliance with the physical properties of the thermoplastic material or glass spheres with the specification.
C. Manufacturer's test results for each lot of thermoplastic material or glass spheres.
D. Identification requirements are satisfactory.

Written certification shall be delivered to the City of Wichita's Street Services Supervisor via the Contractor no less than 48 hours prior to the placement of the thermoplastic.

8.0 METHODS OF SAMPLING AND TESTING

8.1 The minimum batch size of thermoplastic material when tested shall not be less than 2000 lbs. (907 kg) 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 the special provision.

8.2 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 Street Services Supervisor's discretion, the material may be tested by State or independent laboratories following ASTM test methods D-4960-89, D-4797-88, and D4796-88.

9.0 THERMOPLASTIC PERFORMANCE AND APPLICATION CHARACTERISTICS.

9.1 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, contact with oil droppings, exposure to sunlight, water, gasoline, adverse weather conditions, or effects of traffic.

9.2 Application: The material shall be applied to the pavement by ribbon extrusion or by screed extrusion. When the screed extrusion method is used, 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 melters and application die(s) to prevent loss of temperature. 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 equipment shall be approved by the Street Services Supervisor prior to use on the project. Walk-behind carts with open-air systems for use on symbols and transverse lines shall be

approved by the Street Services Supervisor 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.

9.3 The equipment used to install hot applied thermoplastic material shall be constructed to provide continuous uniform heating to temperatures of 400-440° F (204-226° 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 which 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 which the dispenser overruns will not be permitted under this special provision. The equipment shall provide for varying traffic marking application widths.

Prior to execution of the contract, the City will inspect the Contractor's equipment to ensure compliance with these specifications. If the Contractor's equipment does not pass the City's inspection, then the Contractor will be allowed 10 (ten) calendar days to obtain the necessary equipment. If the Contractor does not meet the equipment requirements, then they will be removed from contract consideration.

Additional inspections will be conducted at frequent intervals during the term of the contract to assure that appropriate equipment levels are being maintained. Failure of the Contractor to correct any deficiencies within 7 (seven) calendar days will result in forfeiture of the contract unless otherwise authorized by the City.

9.3.1 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.

9.3.2 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.

9.3.3 A special kettle shall be provided for uniformly melting and heating the thermoplastic material. The kettle must be equipped with an automatic thermostat control devise and material thermometer for positive temperature control and to prevent overheating and underheating of the material. The heating kettle and application equipment shall meet the requirements of the National Fire Underwriters and the National Fire Protection Association of the state and local authorities.

9.4 Installation Techniques

9.4.1 Surface Preparation

9.4.1.1 Moisture: All surfaces shall be inspected for moisture content prior to application of thermoplastic. Approximately two square feet (9.372 m^2) of a clear plastic or tar paper shall be laid on the road surface and held in place for 15-20 minutes. The underside of the plastic or tar

paper shall then be inspected for a build-up of condensed moisture 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 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 condensed moisture on the underside of the plastic or tar paper.

9.4.1.2 Cleaning: All surfaces shall be clean of all non-asphaltic materials and dry before thermoplastic can be applied. Loose dirt and debris shall be removed by blowing compressed air over the area to be striped. If the thermoplastic is to be applied over existing paint lines on asphalt, 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. On Portland cement concrete surfaces, the thermoplastic markings shall not be placed over painted lines. By grinding or sandblasting, all painted lines shall be removed from Portland cement concrete surfaces prior to applying the primer sealer. The Contractor shall take full responsibility for pavement/shoulder damage due to surface cleaning.

9.4.1.3 Layout: The pavement marking shall be placed in proper alignment with guidelines established on the roadway. All guidelines greater than one-half inch (12.7 mm) in width shall be completely covered by thermoplastic material or removed by a method approved by the Street Services Supervisor after thermoplastic application. Deviation from the alignment established shall not exceed two inches (50.88 mm), and, in addition, the deviation in alignment of the marking being placed shall not exceed one inch (25.4 mm) per 200 feet (70 m) of roadway nor shall any deviation be abrupt. Longitudinal markings shall be offset at least two inches (50.8 mm) from construction joints and pavement seams/edges. All temporary/ construction pavement marking shall be removed prior to the application of the thermoplastic. Configuration of the straight lines, symbols, and legends shall conform to the most recent edition of The Manual on Uniform Traffic Control Devices for Streets and Highways.

9.4.1.4 A primer sealer of the type recommended by the manufacturer of the thermoplastic material shall be applied on all Portland cement concrete pavement surfaces, and, if recommended by the manufacturer, on other types of pavement surface, 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 thermoplastic application.

9.4.2 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 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, application of thermoplastic material will not be allowed.

10.0 CONTRACTOR RESPONSIBILITY: The Contractor shall notify the Street Services Supervisor of the manufacturer and the lot numbers of the thermoplastic that he intends to use. A check should be made by the Contractor to ensure that the approved lot numbers appear on the material package. Failure to complete this requirement shall be cause for rejection of the thermoplastic.

11.0 INSPECTION: The Contractor will notify the Street Services Supervisor (268-4079 or 268-4072) a minimum of 24 hours prior to the placement of the thermoplastic to schedule an inspector to be present during the application operation. The Contractor shall not be compensated when the City has not received prior notification about the schedule for each work day.

The City will assign an inspector to monitor the Contractor's work performance, notify the Contractor concerning any neglect or disregard of these specifications, and verify work satisfactorily completed. The Contractor will only be allowed to work Monday through Friday between 8:00 a.m. and 4:30 p.m., unless authorized by the City. Notice of any insufficient work to any supervisor, employee, or agent of the Contractor shall be considered notice to the Contractor. The Contractor will immediately correct any deficient work.

12.0 PENALTIES: It is agreed to by the Contractor that aesthetics 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 City determines the substandard work to be correctable by the Contractor. Items A, B, C, D, E, F, G, H and I are illustrated for example only.

A. Lack of Specified Thickness: Payment shall be made with penalty being equal to the average percentage lack of thickness if lack of thickness is found more than three (3) times per mile, or per 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 Kansas Department of Transportation (KDOT) Construction Manual. (See figure A.)

B. Lack of Adhesion: Ten percent of the unit price bid for one foot shall be penalized for each occurrence if found more than three (3) times per mile, or per project, if less than one mile in length. (See figure B.)

C. Pitted Line: Ten percent of the unit price shall be penalized for each pit greater than ten feet in length. Penalty shall be for the length of the pit. (See figure C.)

D. Gaps in Line or Crumbly Edges: The full unit price shall be penalized 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. (See figure D.)

E. Rough Line Surface: The full unit price shall be penalized 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. (See figure E.)

F. Excessive Dripping Between Lines. Fifty percent of the unit price shall be penalized for the length of any dribbled open space between broken lines that is not

cleaned before leaving the project site that work day. Penalty shall be imposed upon the first occurrence and every occurrence thereafter. (See figure F.)

G. Swollen Line of Excessive Width: Ten percent of the unit price shall be penalized for each one-quarter inch of line width in excess of the specified width. (See figure G.)

H. Smeared Line Edges: Twenty-five percent of the unit price shall be penalized for occurrence of length greater than fifteen feet. (See figure H.)

I. Wavy Line: Twenty-five percent of the unit price shall be penalized for the entire length of waviness in a line caused by poor operation by the driver/operator of the application equipment. (See figure I.)

J. Lack of Surface Beads or Improper Application: Twenty-five percent of the unit price shall be penalized for each lineal foot of material with insufficient 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 embed improperly. This penalty shall be imposed if the Contractor fails to correct the problem after one warning from the Engineer.

13.0 CLOTHING, CONDUCT, APPEARANCE: The work included in this program will be highly visible to the general public. Citizens' impressions of the Contractors' employees, equipment, work procedures, and finished product will reflect on both the Contractor and the City of Wichita. For this reason, it is of utmost importance that the Contractors' employees and equipment present a professional appearance and that employees conduct themselves in a proper manner.

The City shall have the authority to order the dismissal of any Contractor employee who refuses or neglects to obey any instruction relating to the carrying out of the provisions and intent of these specifications, or who is incompetent, unfaithful, abusive, threatening or disorderly in his/her conduct, and such persons shall not be re-employed in this work.

14.0 DAMAGES: The Contractor shall be responsible for all property damages and injuries caused by his personnel and/or equipment in the execution of this work. If the Contractor damages any property, the City and the owner of the damaged property shall be immediately notified.

If the City repairs any damages caused by the Contractor, then all associated costs will be deducted from the Contractor's payment.