

## SECTION 1600 PAVEMENT MARKING

1601 GENERAL. The Contractor shall furnish and apply painted reflectorized pavement marking materials at the locations and in conformance with the details shown on the plans. Three types of materials are allowed unless otherwise required in the Special Provisions or contract drawings.

- A. Scope. The Contractor shall furnish and apply white and yellow plastic, epoxy, preformed marking tape or painted reflectorized pavement marking materials at the locations and in conformance with the details shown on the plans. Five types of materials are required, as follows:
1. Epoxy applied type shall be used for all longitudinal line markings unless otherwise indicated on the plans. Epoxy pavement marking and drop on glass beads shall be placed at locations shown on the plans or as directed by the Engineer.
  2. Preformed pavement marking tape ( Type I or Type II) shall be used for all transverse lines, arrows, words and symbols and shall be placed at locations shown on the plans or as directed by the Engineer.
  3. Hot applied type may be used for longitudinal line markings unless otherwise indicated and shall be applied to the pavement surface in a molten state by mechanical means with 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.
  4. Cold applied type may be used for transverse and symbol markings unless otherwise indicated and shall consist of a homogeneous, extruded, prefabricated material of specified thickness and width, which shall contain reflective glass spheres uniformly distributed throughout the cross-section, and shall be applied to the pavement surface by means of a pre-coated adhesive and pressure.
  5. Paint applied type shall only be used for those markings as indicated on the plans and shall be of good commercial quality, adhere to the asphaltic concrete, and shall be approved by the Engineer.

### 1602 EPOXY PAVEMENT MARKING MATERIAL.

A. General.

This specification describes the materials and application procedures for epoxy pavement marking material and crop-on glass beads. Epoxy pavement marking material shall not contain toxic heavy metals. The material shall be two-component, 100 percent solids and formulated and tested to perform as a

pavement marking material with glass beads applied to the surface. The two components shall be epoxy resin and an amine curing agent.

B. Material.

**Epoxy Types.** Type A epoxy marking material shall be a slow cure material and Type B epoxy marking material shall be a fast cure material.

**Toxicity.** Upon heating to application temperature, the material shall not release fumes that are toxic to persons or property. Upon curing, the material shall be completely inert, with all components fully reacted and environmentally benign.

**No Track Time.** The material shall have a no-track time between 10 and 45 minutes for Type A and 10 minutes or less for Type B, when mixed in the proper proportions and applied at a 25-mil (0.635 mm) wet film thickness at  $75 \pm 2$  F ( $24 \pm 1$  C) with the proper application of glass beads and when tested in accordance with ASTM D 711. The material shall fully cure under a constant surface temperature of 32 F (0 C) or above.

**Adhesion to Concrete.** The pavement marking material shall have a high degree of adhesion to the concrete surface such that there is a 100 percent concrete failure when tested in accordance with ACI 503, Appendix A.1. The prepared specimens shall have a film thickness of  $15 \pm 1$  mil ( $0.381 \pm 0.025$  mm) and shall be applied to concrete with a minimum compressive strength of 4000 psi (28 MPa). The concrete surface shall be  $90 \pm 2$  F ( $32 \pm 1$  C) when the material is applied. The applied material shall be cured for 72 hours at  $75 \pm 2$  F ( $24 \pm 1$  C) before performing the test.

**Hardness.** The material shall have a minimum Shore D Hardness of 75 when tested in accordance with ASTM D 2240.

**Tensile Strength.** The material shall have a minimum tensile strength of 5000 psi (34 MPa) after 72 hours of cure at  $75 \pm 2$  F ( $24 \pm 1$  C) when tested in accordance with ASTM D 638.

**Compressive Strength.** The material shall have a minimum compressive strength of 10,000 psi (69 MPa) after 72 hours of cure at  $75 \pm 2$  F ( $24 \pm 1$  C) when tested in accordance with ASTM D 695.

**Abrasion Resistance.** The material shall have a maximum abrasion resistance of 150 mg at  $15 \pm 1$  mil ( $0.375 \pm 0.025$  mm) thickness after 72 hours of cure and with a CS-17 wheel under a load of 1000 grams for 1000 cycles, when tested in accordance with ASTM C 501.

**Yellowness Index.** The material shall have a maximum yellowness index of 6 before the QUV test and a maximum of yellowness index of 23 after the 72-hour QUV test, when tested in accordance with ASTM D 1925.

**Color.** The finished white color shall be free from tint, furnishing good opacity

and visibility under both daylight and artificial light. The finish finished yellow color shall closely match Federal Test Standard 595 - Color Chip Number 13538.

Type A epoxy pavement marking shall be a slow-cure material suitable for pavements not open to traffic.

Type B epoxy pavement marking shall be a fast-cure material suitable for all applications of pavement marking.

C. Construction Requirements.

Equipment. The application equipment shall have a system capable of spraying epoxy pavement marking material in the proportions recommended by the manufacturer. The application equipment shall include the following features.

Individual material reservoirs or space for storage of Part A and Part B of the epoxy material, equipped with the necessary stirring or blending equipment to ensure delivery of uniformly mixed components to the mixing unit.

Heating equipment of sufficient capacity to maintain the individual components at the manufacturer's recommended temperature and the capability of producing the required amount of heat at the mixing head and gun tip to maintain those temperatures within the tolerances recommended by the manufacturer for spray application.

Drop-on Glass beads shall be mechanically applied to the wet epoxy paint directly behind the spray guns at a rate required to meet Retroreflectivity requirements for stop lines, arrows, words, and symbols, glass beads may be applied by hand. Glass beads shall be applied evenly and shall completely cover the painted area. If beads do not embed properly in the paint, all marking operations shall cease until corrections are made.

Each proportioning unit shall have individual metering devices or pressure gauges and stroke counters to monitor gallon usage. All such devices shall be visible to the engineer.

The equipment shall be capable of thoroughly mixing the components to the manufacturer's recommendations prior to application.

The contractor shall provide all necessary equipment to adequately mix each shipping container. At any time that partial shipping containers are transferred to the reservoirs on the striping equipment, complete mixing of that container shall be performed prior to beginning transfer operations.

The pavement surface on which the pavement marking is to be placed shall be free of all debris, laitance and any other contaminants that may hinder the adhesion of the system to the surface. Whenever grinding, scarifying, sandblasting, shot blasting or other operations are performed, the debris generated shall be contained through vacuum type equipment or equivalent. The pavement

surface shall not be left scarred with an image that might mislead traffic. Any excess damage or scarring of the pavement shall be repaired by the contractor, at the contractor's expense.

Removal and cleaning work shall be conducted in such a manner as to control and minimize airborne dust and similar debris that may become a hazard to motor vehicle operation or a nuisance to property owners.

Care shall be taken on bituminous and Portland cement concrete surfaces when performing removal and cleaning work to prevent damage to transverse and longitudinal joints.

After all cleaning operations are completed, the pavement surface shall be power broomed and then blown with compressed air to remove residue and debris resulting from the cleaning work. All such debris shall be properly contained and disposed of as approved by the engineer.

Cleaning and surface preparation work shall be confined to the area specified for the application of the pavement marking material, to the surface area of existing pavement markings that are specified for removal on the plans, or to the area specified by the engineer.

Surface preparation work shall include cleaning for lines, letters and symbols.

The area of preparation shall be the width of the new pavement marking or existing line, plus one inch (25 mm) on each side of the line. For letters and symbols, the area of preparation shall be sufficiently large to accommodate the new marking or to remove existing markings.

On new Portland cement concrete pavement, cleaning operations shall not begin until the concrete has attained the minimum design compressive strength. The extent of the curing compound removal work shall be to clean and prepare the concrete surface such that there is no visible evidence of curing compound and the extent of the removal shall ensure that any laitance is removed from both old and new concrete.

All existing pavement marking, except epoxy pavement marking, shall be removed to the extent that 95 to 100 percent of the existing marking is removed. Existing epoxy pavement markings that are in good condition and that will not interfere with or otherwise conflict with newly applied markings, as determined by the engineer, may remain. Removal operations shall be conducted in such a manner that no more than moderate color or surface texture change results on the surrounding pavement surface. The engineer will make the determination of acceptable removal.

The pavement marking material shall be applied to the road surface at 25 mils (0.64 mm) on concrete or asphalt pavement through the use of equipment designed to precisely meter the two components in the ratio recommended by the material manufacturer.

The pavement marking shall only be applied during dry weather and on dry pavement surfaces. At the time of installation, the pavement surface temperature and ambient temperature shall be above 45 F (7 C).

Both components shall be brought to the temperature recommended by the manufacturer, prior to mixing and application and shall remain at that temperature throughout the operation.

#### 1602 HOT APPLIED TYPE.

##### A. General.

This specification describes the materials and application procedures for heated white and yellow thermoplastic pavement markings extruded or sprayed to the roadway surface in a molten state. After cooling to normal temperature, the materials shall produce an adherent reflectorized stripe of specified thickness and width. The sprayed or extruded materials shall be used for edge lines, lane lines, centerlines, medians, no passing zones and gore areas.

The compound shall not deteriorate upon contact with sodium chloride, calcium chloride, or other chemicals used to prevent formation of ice on roadways or streets or because of the content of pavement materials or from petroleum falling from vehicular traffic. In the plastic state, the material shall not give off fumes which are toxic or otherwise injurious to persons or property. The material shall not break down or deteriorate if held at the plastic temperature for a period of four (4) hours or by reason of three (3) reheatings to the plastic temperature (400 degrees F. to 450 degrees F.) The temperature versus viscosity characteristics and the color of the plastic material shall remain constant through reheatings, and shall be the same from batch to batch.

##### B. Material.

The material shall be a mixture of resins and other materials providing an essentially nonvolatile thermoplastic compound specifically developed for traffic marking.

1. Binder. The binder shall be composed entirely of alkyd type resins, 70 percent minimum of which shall be a maleic modified glycerol ester of rosin. The total binder content of the thermoplastic compound shall be no less than 18 percent by weight.
2. Pigment. The pigment used for the white thermoplastic compound shall be titanium dioxide, meeting the requirements of ASTM D 476-73, Type II. The titanium dioxide pigment content shall be no less than 10 percent by weight of the white thermoplastic compound and be uniformly distributed throughout the thermoplastic compound. The yellow thermoplastic compound shall be no less than 2.5 percent by weight of yellow pigment provided that yellow thermoplastic material shall be "Federal Yellow" in color (Federal Test Method Standard 141 Method 4252). The material shall not change its color or brightness character even after prolonged exposure to sunlight.

3. Filler. The filler to be incorporated with the resins as binder shall be a white calcium carbonate or equivalent filler.
4. Glass Beads. During manufacture, Type II B (Missouri State Highway Department Specifications for reflectorizing glass spheres) spheres shall be mixed into the material at the rate of not less than 30 percent nor more than 40 percent by weight of thermoplastic compound immediately after the thermoplastic material is applied. Glass beads shall meet the following requirements:
  - a. General Properties. Glass beads shall be manufactured from high quality material of a composition design to be highly resistant to traffic wear and to effects of weathers and shall be clean, clear, colorless and free from foreign matter.
  - b. Sieve Analysis. The glass beads shall meet the following gradation requirements:

<b>US Standard Sieve Numbers</b>	<b>Type IIA</b>		<b>Type IIB</b>	
	Percent Passing			
	<u>Min.</u>	<u>Max.</u>	<u>Min.</u>	<u>Max.</u>
16	100	---	---	---
18	98	100	---	---
30	60	90	100	---
40	---	---	80	100
50	15	50	---	---
80	---	---	0	10
100	0	10	---	---
200	0	5	---	---

- c. Index of Refraction. The index of refraction of Type IIA and IIB glass beads shall be at least 1.50 when tested by the immersion method at 77 degrees F.
- d. Irregular Shapes. Glass beads shall be spherical in shape containing not more than 30 percent irregular shapes, when tested in accordance with ASTM Method D 1155-53 (1975).
- e. Tests. Glass beads, when subjected to the following tests shall show no readily discernable darkening and/or dulling.
  1. Ten grams + 0.5 grams of glass beads placed in Whitman single thickness cellulose extraction thimble, 33 by 80 millimeters, are refluxed for one (1) hour in a Soxhlet extractor having an 80 millimeter siphon capacity using 150 millimeters of distilled water. All connections shall be ground glass. At the end of the refluxing period, allow the filtrate to cool to room temperature and titrate with 0.1 normal hydrochloric acid (not to exceed 4.5 milliliters) using

phenolphthalein indicator. The beads shall be dried to 110 degrees C and examined for dulling under 60 power magnification.

2. Method of Determining Calcium Chloride Resistance. Immerse approximately 10 grams of glass beads in a 1.0 normal calcium chloride solution for 3 hours. Rinse well, by decantation, with distilled water. Spread beads on clean filter paper and allow to dry. Examine the beads for darkening under 60 power magnification.
  3. Method of Determining Sodium Sulfide Resistance. Immerse approximately 10 grams of glass beads in a 50 percent solution of Sodium Sulfide for one hour. Rinse well by decantation, with distilled water. Spread beads on a clean filter paper and allow to dry. Examine the beads for darkening under 60 power magnification.
- f. Binder-Sealer. Binder-Sealer shall be a butadiene styrene, neoprene, epoxy or other material recommended by the manufacturer of the thermoplastic material.
- g. Packaging and Marking. The granulated thermoplastic material shall be packaged in suitable bags to which it will not adhere during shipment and storage. Each bag shall weigh approximately 50 pounds (23kg). Each container label shall designate the color, manufacturer's name, 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 to 211 degrees + 7 degrees C. (412.5 degrees +/- 12.5 degrees F.) during application. The Contractor shall assume all costs resulting from the use of patented materials, equipment, devices, or processes used on, or incorporated in, the work, and shall agree to indemnify and save harmless the purchaser and his duly authorized representatives from all suits at law, or action of every nature for, or on account of, the use of any patented materials, equipment, devices, or processes.

C. Characteristic Requirements.

1. The material shall be capable of being applied at a temperature range of 400 degrees to 450 degrees F and to a thickness of 0.09 or 0.125 inch. It shall set to withstand vehicular traffic in not more than 2 minutes when the air temperature is 50 degrees F. and not more than 10 minutes when the air temperature is 90 degrees F. After application and setting, the material shall show no appreciable deformation or discoloration, shall remain free from track, and shall not leave from the pavement under normal traffic conditions within a pavement temperature range of -20 degrees F to 150 degrees F. The stripe shall maintain its original dimensions and placement.

- a. Color. White thermoplastic material shall, after setting, be pure white and free from dirt or tint. Yellow thermoplastic shall match Federal Test Standards Number 595A-Color 13538. The material shall not change its color and brightness characteristics after prolonged exposure to sunlight.
2. Manufacturer's Certification. The contractor shall furnish a manufacturer's certification in triplicate, to the engineer, attesting that all materials supplied conform to the requirements of these specifications. The certification shall include or have attached, a certified test report from an approved independent testing laboratory, showing specific test results conforming to all test requirements of these specifications. The following tests shall be made on at least 10 pounds of thermoplastic material from each batch manufactured.
- a. White material shall not show deviations from a magnesium oxide standard greater than the following data, using a standard color difference meter:

<u>Scale Definition</u>	<u>Magnesium Oxide Std.</u>	<u>Sample Minimum</u>
RE Reflection	100	75
A-Redness-Greenness	0	-5 to +5
B-Yellowness Blueness	0	-10 to +10

- b. Materials shall be tested in accordance with ASTM D 1501-71, Procedure A, "Standard Recommended Practice for Exposure of Plastic to Fluorescent Sunlamps." There shall be no darkening of color after 100 hours of exposure.
- c. Material shall have not more than 0.5 percent by weight of retained water when tested by ASTM D 570-63 (1972), "Water Absorption of Plastics." The procedure for 24 hour immersion, Paragraph 6.1, shall be used for this test.
- d. The softening point of the thermoplastic compound (as measured by the ball and ring method ASTM E 28-67 (1972) shall not occur at a temperature less than 200 degrees F.
- e. There shall be no cracking, checking, flaking or separation of the sample material from the sample base prepared as follows:
- A clean standard concrete block having uniform temperature of 75 degrees F to 80 degrees F shall have the surface primed with a binder-sealer proposed for use by the manufacturer. A 4-inch wide 1/8 inch thick stripe of the thermoplastic material shall be applied and the sample conditioned for 24 hours at 12 degrees F to 18 degrees F.
- f. Specific gravity of the compound at 77 degrees F shall be 2.15.

- g. Bond strength of the compound applied to Portland Cement concrete shall exceed 180 psi.
- h. Freeze/Thaw bond strength of the compound subjected to 5 cycles of 16 hours at 15 degrees C, then 8 hours submerged in water, the bond strength to primed Portland Cement concrete shall exceed 120 psi.
- i. The material shall meet the requirements of this specification for a period of one year. The thermoplastic must also melt uniformly with no evidence of skins or unmelted particles for this one year period. Any material not meeting the above requirements shall be replaced by the manufacturer.

The City of Liberty reserves the right to sample test and reject any and all materials provided and installed under this project.

3. Application.

Marking on this project shall be applied only on clean, dry pavement and at pavement surface and air temperatures above 50 degrees F. The contractor shall remove loose debris (such as dust, dirt, sand and gravel) from the pavement surface, where the marking is to be located, immediately prior to application of the binder-sealer or marking material.

- a. When required, binder-sealer shall be applied to the pavement surface in sufficient quantities to completely cover the area occupied by the thermoplastic material.

- 1. Sprayed Thermoplastic.

- A binder-sealer shall be applied to the pavement surface prior to application of sprayed marking material if recommended by the manufacturer of the marking material.

- 2. Extruded Thermoplastic.

- A binder-sealer shall be applied to Portland Concrete pavement surfaces prior to application of thermoplastic markings.

- On bituminous pavement mixtures and seal coats, a binder-sealer shall be applied prior to marking application if recommended by the manufacturer of the marking material.

- b. Application Temperature.

Thermoplastic material shall be applied at a temperature between 400

degrees and 450 degrees F.

c. Marking Dimensions.

Longitudinal and transverse dimensions shall be as shown on the plans. Application of the marking material shall be performed in a manner which will provide continuous uniformity in the dimensions of the stripe. The cutoff ends of each stripe shall be square. The sides of each stripe shall be uniform and straight (excluding final bead application and binder-sealer). Width and thickness dimensions shall be as follows:

- |    |                           |                     |
|----|---------------------------|---------------------|
| 1. | White Markings            |                     |
|    | (1) Lane Line             | 4" by 0.09"         |
|    | (2) Edge Line             | 6" by 0.09"         |
|    | (3) Stop Line             | 24" by 0.125"       |
|    | (4) Block Style Crosswalk | 24" by 0.125" by 6' |
|    | (5) Symbols and Legends   | M.U.T.C.D. Standard |
| 2. | Yellow Markings           |                     |
|    | (1) Center Line           | 4" by 0.09"         |
|    | (2) Cross-hatch Line      | 12" by 0.09"        |

d. Immediate Reflectance.

Type II-A glass beads shall be applied by an automatic dispenser to the top surface of the hot applied thermoplastic stripe immediately after the stripe is formed on the pavement. The glass shall be embedded into the top surface of the stripe to at least one-half of the bead diameter and at an application rate of 3.0 pounds of beads per 100 lineal feet.

4. Equipment.

All sprayed or extruded marking shall be applied using a vehicle (or vehicles) of sufficient size and stability to provide smooth, straight, uniform markings. The equipment used to install hot thermoplastic materials under this specification shall be constructed to provide mixing and agitation of the material. Conveying parts of the equipment between the main material reservoir and the shaping die or sprayer head shall be so constructed as to prevent accumulation and clogging. All parts of the equipment which come in contact with the material shall be so constructed as to be easily accessible and exposable for cleaning and maintenance.

The equipment shall be constructed so that all mixing and conveying parts up to and including the shaping die or sprayer head will maintain the material at a temperature not less than 375 degrees F. (191 degrees C.).

To assure that the thermoplastic does not fall below the minimum

temperature, the shaping die or sprayed head shall be heated by means of a gas-fired infrared heater or a heated, oil-jacketed system.

The equipment shall be so 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 use of pans, aprons or similar appliances which the die overruns will not be permitted under this specification. The equipment shall be so constructed as to provide for varying die widths and to produce varying widths of traffic marking.

A special kettle shall be provided for melting and heating the thermoplastic material. The kettle must be equipped with a thermostat so that the 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. The heating kettle 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.

Glass spheres applied to the surface of the completed stripe shall be applied by an automatic bead dispenser attached to the striping machine in such a manner that the beads 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 so arranged as to permit preheating of the pavement immediately prior to application of the thermoplastic material if pre-heating is recommended by the thermoplastic manufacturer. 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 applicator shall be capable of containing a minimum of 125 pounds of molten material.

Application Techniques. The surface shall be dry and all dust, debris and other foreign matter shall be removed from the road surface prior to the application of the binder-sealer and the thermoplastic material. A rough-textured surface shall be cleaned by air blast. A smooth-textured surface may be cleaned by brooming but if there is any doubt about the resulting cleanliness the Engineer can require use of air blast.

Those sections of pavement where extra dust and grime collects, such as gore areas and adjacent to raised islands, may require a water wash and scrubbing in addition to brushing and air blast.

To insure proper adhesion, the Contractor shall apply the binder-sealer over the application area prior to the actual thermoplastic installation. The binder-

sealer shall be applied by spraying, shall form a continuous wet film of approximately 2 -3 mils thickness and shall be at least 2 inches wider than the applied thermoplastic so as to assure adhesion at the edges. The binder-sealer shall be allowed to set long enough for the solvent to evaporate and become tacky. This can be as much as one hour or longer but not less than 30 minutes. If there is doubt, the longer time shall be used even though some tackiness might be lost.

For bituminous surfaces less than two months old and having less than 20% bare, exposed aggregate, the application of binder-sealer may be waived. Bubbles forming in the applied thermoplastic is evidence that solvent remains in the binder-sealer. Rather than reduce the rate of application of the binder-sealer more time should be allowed for evaporation of the solvent before continuing.

### 1603 COLD APPLIED TYPE.

#### A. Materials.

1. The preformed markings shall consist of a yellow or white conformable ribbon or other flat shape as specified and shall be fabricated of resins, plasticizers, fillers, suitable pigments, reflective glass beads, and a pressure sensitive adhesive.
2. The reflective glass beads shall be distributed evenly throughout and applied into the top surface to produce immediate and continuous retro reflection. The marking material shall be so formulated and the top dressing of glass beads so distributed over the surface that the applied lines and shapes will show a high initial visibility which will remain during the effective life of the material. The material which permits or promotes adherence of excessive amounts of road film so as to decrease markedly visual impact shall not be acceptable regardless of compliance with other provisions of this specification. The glass bead adhesion shall be such that beads are not easily removed when the material surface is scratched with a thumbnail.
3. The daylight reflectance of white marking material shall not be less than 50% when tested according to ASTM E97. The color of yellow marking material shall be within the red and green tolerance limits of the highway Yellow Color Tolerance Chart issued by the U.S. Department of Transportation.
4. Preformed words and symbols shall conform to the applicable shapes and sizes as prescribed in the latest revision of the Manual on Uniform Traffic Control Devices for Streets and Highways.
5. The preformed markings shall be capable of being adhered to asphalt concrete or portland cement concrete pavement with a pre-coated, factory applied, pressure sensitive adhesive. A primer may be used to precondition the pavement surface, when recommended by the manufacturer, due to climate or pavement conditions. When the adhesive backing is supplemented

by a solvent or other type of adhesive, the material used and the application procedure shall be in accordance with the manufacturer's recommendation.

6. The thermoplastic pavement marking material shall mold itself to pavement contours, breaks and faults by action of traffic at normal pavement temperatures, and shall be formulated with resealing characteristics enabling the material to fuse with itself and with previously applied marking materials of the same composition without externally applied tackifiers or adhesives.
7. Materials will be considered only from manufacturers of reflectorized plastic pavement markers and legends, who can submit evidence of successful product use over the past 5 years, under climatic conditions similar to that of the work location.
8. The marking material shall be a minimum of .06 inches in thickness when measured without the precoated adhesive.
9. Retroreflectance: The material, when tested under actual conditions, shall conform to those requirements set forth in Texas Test method 828-B, entitled "Method for Determining Retro reflectance of Pavement Markings".
10. Skid Resistance: The surface of the retroreflective pavement marking film shall provide a minimum skid resistance value of 35 BPN when tested according to ASTM E 303.
11. Glass Sphere Retention: The plastic shall have glass sphere retention qualities. A 2" x 6" specimen of plastic shall be cut at a right angle to the beveled edge and bent parallel to the beveled edge of a 1/2" mandrel. While the specimen is bent, a strip of 1/2" wide masking tape (such as Utilitape, manufactured by Permacel) shall be applied firmly along the length of the area of maximum bend and then removed. Should any glass spheres remain on the masking tape when the strip is removed, the sample shall be rejected.
12. Reflectivity Retention: To have a good effective performance life, the glass beads must be strongly bonded and not be easily removed by traffic wear.

One of the following tests shall be employed to measure reflectivity retention:

a. Taber Abraser Simulation Test

Using a Taber Abraser with an H-18 wheel and a 125 gram load to sample shall be inspected at 200 cycles, under a microscope to observe the extent and type of bead failure.

No more than 15% of the beads shall be lost due to popout and the predominant mode of failure shall be "wear down" of the beads.

or

b. Federal Test Method Standard No. 141a

Using H-18 calibrate wheels with a 1000 gram load on each wheel, the sample shall be inspected at 500 cycles to determine the extent and type of bead failure.

The maximum loss in weight shall be 0.25 grams due to bead abrasion.

13. Tensile Strength: The film shall have a minimum tensile strength of 150 pounds per square inch of cross-section when tested according to ASTM D 638-76.
14. Effective Performance Life: The film, when applied according to the recommendations of the manufacturer, shall provide a neat durable marking that will not flow or distort due to temperature if the pavement surface remains stable. Although reflectivity is reduced by wear, the pliant polymer shall provide a cushioned, resilient substrate that reduces bead crushing and loss. The film shall be weather resistant and, through normal traffic wear, shall show no fading, lifting or shrinkage which will significantly impair the intended usage of the marking throughout its useful life and shall show no significant tearing, roll back or other signs of poor adhesion.

B. Installation.

1. Cold applied thermoplastic materials shall be applied to clean, dry pavement surfaces, free of dirt and foreign matter, by removing the release paper and placing the plastic on the surface with continuous pressure for a period of about 30 seconds, then permitting traffic to pass over it.
2. All markings shall be applied in accordance with the manufacturers recommendations. Marking configurations shall be in accordance with the "Manual on Uniform Traffic Control Devices".
3. New Pavement: In all areas where pavement markings are to be placed on new asphalt pavement, installation shall be performed by rolling the material into the surface course with the final pass of the roller.
4. Existing Pavement: In areas where pavement markings are specified to be used on existing pavement, a pavement primer should be used as recommended by the manufacturer in addition to the precoated adhesive.
5. The plastic and its adhesive shall be sufficiently free to tack so that it can be easily handled without the protective backing, and be repositioned on the surface to which it is to be applied, before permanently fixing it in this position with a downward pressure.

C. Submittals.

1. The Contractor shall furnish a manufacturer's certification attesting that all materials supplied conform to the requirements of these Specifications. The certification shall include, or have attached, specific results of laboratory tests for the specified physical and chemical properties as determined from samples representative of the lot or lots of thermoplastic compound, glass spheres and reflectorized plastic marker material supplied. These submittals shall be the basis of acceptance of these materials.
2. The manufacturer shall supply instructions describing the application of this material and identify all activators and additional adhesives which are to be used at the time of application, if any.
3. Each work and symbol marking shall be supplied with a diagram with each section numbered to correspond with the completed layout.
4. The Contractor shall identify proper solvents and/or primers (where necessary) to be applied at the time of application, all equipment necessary for proper application, and recommendations for application that will assure the materials shall be suitable for use for one year after the date of receipt.

#### 1604 PAINT APPLIED TYPE.

##### A. Materials.

The paint shall be of good commercial quality which conforms with Federal Specifications TT-P-85D. The traffic paint shall provide optimum adhesion for glass spheres when both binder and glass spheres are applied in recommended quantities. The Contractor shall have the manufacturer submit material specifications to the Engineer prior to approval.

##### B. Construction Requirements.

1. The Contractor shall be responsible for laying out the lines accordance with the plans.
2. The pavement shall be clean and dry prior to applying the paint.
3. The traffic paint should be applied at a wet film thickness of 15 mils (0.38 mm) and glass spheres should be applied at the rate of 6 pounds per gallon (0.7 kg per liter) of paint.
4. The glass beads shall be sprayed into the wet traffic paint through a pressurized glass gun set 1" to 4" (2.5 to 10.2 cm) behind the paint spray gun.

1605 MEASURING AND PREMARKINGS. The Contractor shall do all measuring and premarking required for application of the pavement markings.

1606 REMOVAL OF EXISTING PAVEMENT MARKINGS. The Contractor shall remove the

necessary existing pavement markings by grinding, or obliterating them by some other approved means. Painting them will not be acceptable. The Engineer will direct the Contractor to which markings need to be removed and the extent of the removal shall meet the approval of the Engineer.

1607 PLOWABLE REFLECTORS. Plowable reflector pavement markers shall be low profile, two-way, blue colored reflector pavement markers and shall have cast iron housing with acrylic prismatic reflectors measuring 9.25" x 5.86" x 1.69" with a .025" maximum projection above the roadway. Each reflector shall be visible from both directions and shall have a 1.87 square inch reflective face. Plowable reflectors shall be Model 96L as manufactured by Stimsonite Corporation of Niles, Illinois or approved equal. Installation shall be as per manufacturer's recommendations. All excess epoxy used in the installation process shall be removed from the face and surrounding area of the marker.

Blue markers are to be installed adjacent to each fire hydrant. The marker shall be located 2 1/2 feet from the centerline of all roadways on the side nearest to the fire hydrant.