

**SECTION 02850
PAVEMENT MARKINGS**

PART 1 GENERAL

1.01 - Section Includes

- A. Traffic Paint.
- B. Thermoplastic Reflectorized Pavement Markings.
- C. Permanent Marking Tape.
- D. Preformed Polymer Marking Material

1.02 - Description Of Work

- A. Traffic Paint - Work involves the furnishing and installing of permanent traffic paint in accordance with the Contract Documents.
- B. Thermoplastic Reflectorized Pavement Markings - Work involves the furnishing and installing of thermoplastic reflectorized pavement markings in accordance with the Contract Documents.
- C. Permanent Marking Tape - Work involves the furnishing and installing of permanent marking tape in accordance with the Contract Documents.
- D. Preformed Polymer Marking Material - Work involves the furnishing and installing of preformed polymer marking material in accordance with the Contract Documents.

1.03 - Submittals

Submit detailed catalog cuts, manufacturer's specifications and test data of products proposed for use demonstrating conformance to requirements of this Section in accordance with the requirements of the Contract General Conditions.

1.04 - Special Requirements

- A. The completed thermoplastic reflectorized pavement marking installation shall be warranted to the Owner, from the date of final payment, against peeling, chipping, flaking, delamination, and shoving for a period of one year or until the markings are normally worn away by traffic.
- B. Thermoplastic material shall be accepted on the basis of sampling and inspection at the place of manufacture or in warehouse lots as determined by the Engineer. In addition, all samples shall be accompanied with the manufacturer's certified identification of the binder formulation (e.g. "formulated as a hydrocarbon resin"). Any unauthorized tampering, opening, or breaking of seals on the containers between the time of sampling and delivery to the construction site shall be cause for rejection of the material.
- C. The minimum batch size of thermoplastic material when tested shall not be less than 3000 lbs. unless the total order is less than that amount.
- D. Reflective glass spheres may be approved at the construction site on the basis of the manufacturer's certification.
- E. Type III primers will be subject to approval by the Engineer prior to use. Requests for approval shall be accompanied with technical data including brand name, instructions for use, hazard warnings, and 1-quart sample of the primer material.
- F. Upon prior approval by the Engineer of the Type III primer, the product may then be accepted at the construction site on the basis of the brand name labeled on the container.
- G. Any materials found to not meet these requirements shall be immediately replaced with materials meeting requirements of this Section.

PART 2 PRODUCTS

2.01 - Traffic Paint

Traffic paint shall meet the requirements of Iowa DOT Standard Specifications for Highway and Bridge Construction Section 4183. Before April 15 and after October 15, only fast dry, Volatile Organic Content (VOC) compliant, solvent borne paint shall be used. April 15 through October 15, only waterborne paint shall be used.

2.02 - Thermoplastic ReflectORIZED Pavement Markings

A. White and Yellow ReflectORIZED Thermoplastic

1. Composition Requirements

The thermoplastic material composition shall be specifically formulated for application at temperatures greater than 400 degrees F true*; and shall show no significant breakdown, or deterioration at a true temperature of 475 degrees Fahrenheit. (*True temperature as referenced above is measured with high precision laboratory grade equipment.)

- a. The binder component shall be formulated as hydrocarbon resin or formulated as alkaloid base product as shown on the Contract Drawings. The pigment, beads, and filler shall be uniformly dispersed in the binder resin.
- b. The thermoplastic material shall be free from all skins, dirt and foreign objects and shall comply with the following requirements:

<u>Component</u>	<u>% by Weight</u>	
	<u>White</u>	<u>Yellow</u>
Binder	17.0 Min.	17.0 Min.
Titanium Dioxide	10.0 Min.	---
Glass Beads	20.0 Min.	20.0 Min.
Calcium Carbonate & Inert Fillers	49.0 Min.	**
Yellow Pigments	---	**

** Amount and type of yellow pigment, calcium carbonate and inert fillers shall be at the option of the manufacturer, providing the other composition requirements of this specification are met.

2. Physical Properties of Composition.

- a. Colors: White thermoplastic composition, as placed, shall be white, free from dirt or tint. Yellow thermoplastic composition, as placed, shall be yellow, free from dirt or tint, and shall be a reasonable visual match to Munsell book notation 10YR8/14 in accordance with ASTM D 1535.
- b. Drying Time: When installed on pavement at air temperature of 70 degrees F, and in thickness between 1/8 inch and 3/16 inch, the thermoplastic material shall be completely solid and shall show no damaging effect from traffic after 10 minutes.
- c. Color Retention: The thermoplastic material shall not change color during the warranty period.
- d. Yellowness Index: White thermoplastic material shall not exceed a yellowness index of 0.12 when tested in accordance with AASHTO Designation T 250.
- e. Softening Point: The thermoplastic material shall have a softening point of not less than 194 degrees Fahrenheit true when tested in accordance with ASTM E 28.
- f. Specific Gravity: The specific gravity of the thermoplastic material as determined by a water displacement method at 25 degrees Celsius shall be between 1.8 and 2.2 (referred to water at 25 degrees Celsius true).
- g. Fumes: The thermoplastic material shall not exude fumes, which are toxic or obnoxious or injurious to persons or property when it is heated during applications.

2.03 - Thermoplastic ReflectORIZED Pavement Markings Equipment

A. Thermoplastic application equipment shall be subject to approval by the Engineer prior to the start of Work.

- 1. The equipment used for the placement of thermoplastic pavement markings shall be of two general types: mobile applicator and portable applicator.
- 2. Unless otherwise approved by the Engineer, all longitudinal pavement-marking lines shall be striped using only mobile applicator equipment. Longitudinal pavement marking lines include broken lines (skipline), edge lines, barrier lines, and solid lines as defined by the FHWA Manual on Uniform Traffic Control Devices.

- a. Portable applicator equipment will be acceptable for placing all other markings; and for longitudinal marking where use of mobile applicator equipment is impractical, as approved by the Engineer.
 3. Thermoplastic material shall be applied to the primed pavement surface by the extrusion method, wherein one side of the shaping die is the pavement and the other three sides are contained by, or are part of, suitable equipment for maintaining the temperature and controlling the flow of the material.
 4. Applicators shall be equipped and constructed in such a manner as to satisfy the requirements of the National Board of Fire Underwriters.
 5. For heating the thermoplastic material, the applicator equipment shall include melting kettle(s) of such capacity as to allow for continuous marking operations. The melting kettle(s) may be mounted on a separate "supply" vehicle or included as part of the applying equipment. The kettle(s) shall be capable of automatically heating the thermoplastic material to, and maintaining it at an indicated gauge temperature of 420 degrees Fahrenheit to 430 degrees Fahrenheit. The heating mechanism shall be by means of thermostatically controlled indirect heat transfer medium. Direct heating of the melting kettle by flame will not be allowed.
 6. Thermoplastic material temperature gauges accurate to plus or minus 15 degrees Fahrenheit shall be provided at both ends of each kettle and reservoir, and in each extrusion shoe, in such a manner as to be visible and capable of monitoring the thermoplastic material temperature throughout the marking operation.
 7. Applicator equipment including separate "supply" kettles shall be constructed to provide continuous mixing and agitation of the thermoplastic material. Conveying parts of the equipment between the main material reservoir and the extrusion shoe(s) shall be so constructed as to prevent accumulation and clogging. All parts of the equipment that come into contact with material shall be so constructed as to be easily accessible and exposable for cleaning and maintenance. The equipment shall be constructed so that mixing and conveying parts, up to and including the extrusion shoe(s), maintain the material at the required application temperature.
 8. The applicator equipment shall be so constructed as to insure continuous uniformity in the dimensions of the stripe; shall provide a means for cleanly cutting off stripe ends squarely; shall provide a method of applying "skip" lines; and shall be capable of applying various widths of traffic markings from 3 to 12 inches wide.
 9. The applicator equipment shall be equipped with a drop-on type bead dispenser capable of uniformly dispensing reflective glass spheres at controlled rates of flow up to 10 pounds per 100 square feet of thermoplastic material. The bead dispenser shall be automatically operated in such a manner that it will only dispense beads while the thermoplastic material is being applied.
 10. Applicator 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.
- B. Mobile Applicator Equipment
1. The mobile applicator shall be defined as a truck mounted, self-contained pavement-marking machine that is capable of hot applying thermoplastic by the extrusion method. The unit shall be equipped to maintain and apply the thermoplastic material at an indicated gauge temperature of 420 degrees Fahrenheit, and at the widths and thicknesses specified herein. The mobile unit shall be capable of operating continuously and of installing a minimum of 20,000 linear feet of longitudinal markings in an 8-hour day.
 2. The mobile applicator shall be equipped with melting kettle(s) or materials storage reservoir(s) and glass bead hopper of such capacity as to allow for continuous marking operations. The kettle(s) or reservoir(s) shall be capable of heating and/or holding the thermoplastic material at an indicated gauge temperature of 420 degrees Fahrenheit.
 3. The mobile applicator shall be equipped with an extrusion shoe(s), and shall be capable of marking edge-line and centerline stripes. The extrusion shoe(s) shall be closed, heat

jacketed, or suitably insulated units; shall apply the molten thermoplastic at an indicated gauge temperature greater than 415 degrees Fahrenheit; shall be capable of extruding a uniform line pre-set at 3 to 12 inches wide at a thickness of not more than 1/8 inch nor more than 3/16 inch.

4. The mobile applicator shall be equipped with an electronic and programmable line pattern control system, or mechanical control system, so as to be capable of applying skip or solid lines in any sequence, and through any extrusion shoe in any cycle length.

C. Portable Applicator Equipment

1. The portable applicator shall be defined as hand operated equipment, specifically designed for placing hot extruded thermoplastic installations such as crosswalks; stop bars; legends; arrows; and short lengths of lane, edge, and centerlines. It is intended that the portable applicator reservoir will be loaded with hot thermoplastic material from the supply vehicle melting kettle(s).
2. The portable applicator shall be equipped with all the necessary components, including the material storage reservoir, glass bead hopper, temperature gauges, bead dispenser, extrusion shoe, and heating accessories, so as to be capable of holding and applying the molten thermoplastic at indicated gauge temperatures greater than 415 degrees F; of extruding a line of generally uniform cross-section, pre-set at 3 to 12 inches in width at a thickness of not less than 1/8 inch nor more than 3/16 inch.

2.04 - Reflective Glass Spheres (Pre-Mix and Drop-On)

Reflective glass spheres for use in the composition and for drop-on shall conform to the following requirements:

- A. The glass spheres shall be colorless, clean, transparent, free from milkiness or excessive air bubbles, and essentially free from surface scarring or scratching. They shall be spherical in shape and at least 70% of the glass beads shall be true spheres when tested in accordance with ASTM D 1155.
- B. The refractive index of the spheres shall be a minimum of 1.50 as determined by the liquid immersion method at 25 degrees Celsius true.
- C. The silica content of the glass spheres shall not be less than 60%.
- D. The crushing resistance of the spheres shall be as follows: A 40-lb dead weight, for 20 to 30 mesh spheres, shall be the average resistance when tested in accordance with ASTM D 1213.
- E. The glass spheres shall have the following grading when tested in accordance with ASTM D 1214.

<u>U.S. Standard Sieve</u>	<u>Mass % Passing</u>
No. 20	100
No. 30	79-95
No. 50	15-60
No. 80	0-15

- F. Glass spheres for drop-on shall be treated with a moisture-proof coating meeting the flow requirements of AASHTO M 247 Section 4.4.2, shall not absorb moisture during storage, shall remain free from clusters, and shall flow freely from dispensing equipment.

2.05 - Permanent Marking Tape

A. Permanent marking tape shall have a nominal width of 4 inches and shall consist of a yellow or white, weather and traffic resistant film on a conformable, metallic foil backing precoated with a pressure sensitive adhesive. The tape shall be flexible and formable, and following application, shall remain conformed to the texture of the pavement surfaces.

1. Thickness

The average thickness of the film, including glass spheres, shall be not less than 15 mils or more than 50 mils.

2. Retroreflectance

The white or yellow tapes shall have the following initial minimum retroreflectance values at 1.05-degree observation angle and 88.76-degree entrance angle, measured by a Retrolux Model 1500 retroreflectometer:

	<u>White</u>	<u>Yellow</u>
Specific luminance, med/sq.ft./ft.-cdl.	550	325

B. Permanent marking tape materials shall conform to Iowa Department of Transportation (IDOT) IM 483.06.

2.06 - Preformed Polymer Marking Material

A. The preformed polymer marking material shall consist of glass beads imbedded in a white or yellow, polymer film precoated with a pressure sensitive adhesive. The Contract Documents will specify precut symbols and legends or tape to be made of preformed polymer marking material. The preformed polymer marking tape shall be a nominal width of 4 inches.

1. Color

The color shall be white or yellow, conforming to standard highway markings.

2. Thickness

The thickness of the marking film shall be from 60 mils to 90 mils, as measured to include adhesive and glass beads.

3. Retroreflectance

The white or yellow tapes shall have the following initial minimum retroreflectance values at 1.05-degree observation angle and 88.76-degree entrance angle, measured by a Retrolux Model 1500 retroreflectometer.

	<u>White</u>	<u>Yellow</u>
Specific luminance, med/sq.ft./ft.-cdl.	325	150

B. Preformed polymer marking material shall conform to IDOT IM 483.06.

2.07 - Primer

Type III primer for use on both bituminous and Portland cement concretes shall be of the type recommended by the manufacturer of the thermoplastic material and shall be designed to dry track-free in under 5 minutes.

2.08 - Packaging and Shipment

A. The thermoplastic material shall be manufactured in block form and packaged in suitable corrugated containers to which it will not adhere during shipment or storage. Each container shall weigh approximately 50 pounds and shall consist of blocks approximately 14 inches x 28 inches x 2¼ inches in size. Each container shall be sealed at the point of manufacture and plainly marked with the color, basic resin type (either hydrocarbon or alkaloid), 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 not be heated in excess of 440 degrees Fahrenheit gauge.

B. The reflective glass spheres for drop-on application shall be shipped in strong moisture resistant bags containing approximately 50 pounds. Each bag shall be marked with the name and address of the manufacturer, and the name and weight of the material, date of manufacture and batch number.

- C. Type III primer shall be shipped in pails, drums or other strong substantial containers. Each container shall be plainly marked with the brand name of the product, the name and address of the manufacturer, the date of manufacture, the quantity of material, the date of expiration or shelf life, and appropriate hazard warnings. Type III primers shall be shipped to the construction site with instructions for use affixed to each container.

PART 3 EXECUTION

3.01 - General

- A. Pavement Cleaning
 - 1. Prior to executing the Work of this specification section, the pavement surface shall be cleaned by brooming, use of air hoses, or other methods, as necessary. At the time of placing permanent pavement markings, the entire pavement shall be made free of foreign material. The Contractor shall determine the amount of cleaning effort required to achieve desired results.
 - 2. Sufficient time shall elapse after rain, sleet, snow, ice, dew or frost to permit the surface to become thoroughly dry both internally and externally.
- B. Pavement markings shall not be applied to any surface until the Engineer has inspected the surface and approved as being satisfactory for the application of striping materials.
- C. Pavement markings shall be applied at the locations and in accordance with the patterns and dimensions shown on the Contract Drawings and the FHWA Manual on Uniform Traffic Control Devices.
- D. Before any pavement marking work is begun, a schedule of operations shall be submitted to the Engineer for approval.
- E. When pavement markings are applied under traffic conditions the Contractor shall provide all necessary qualified personnel, flags, markers, signs, etc. to maintain and protect traffic, and to protect marking operations and the new markings until thoroughly set. Short duration lane and work area closures shall be done in accordance with specification section 01200.
- F. The application of pavement markings shall be done in the general direction of traffic. Striping against the direction of traffic flow shall not be allowed.
- G. The Contractor shall be responsible for removing, to the satisfaction of the Engineer, all tracking marks, spilled thermoplastic, and thermoplastic applied in unauthorized areas.
- H. When necessary, the Contractor shall establish marking alignment points at 25-foot intervals throughout the length of the marking area or as otherwise approved by the Engineer.
- I. Unsatisfactory lines, resulting from the presence of dirt, scale, moisture or where pavement striping has been erroneously applied due to mistakes, spillage or drippage, shall be removed by the Contractor at his own expense to the approval of the Engineer.
- J. On all sections of a primary road open to traffic, the Contractor shall place temporary or permanent pavement markings on any part where construction operations have obliterated the existing marking.
- K. If, due to unavoidable circumstances, the Contractor is not able to complete the temporary or permanent pavement marking or removal specified for that day, the Contractor shall provide or continue to provide traffic control until the pavement marking work is completed.
- L. When the installation of preformed polymer pavement marking material is in conjunction with placement of hot mix asphaltic mixtures, the performed polymer shall be inlaid by positioning on the hot mixture prior to the final rolling. Install preformed polymer marking material in accordance with the manufacturer's recommendations.
- M. When permanent markings are placed on newly completed Portland cement concrete pavements, the existing curing compound film shall be removed from horizontal surfaces. Curing compound film need not be removed from curbs or other vertical surfaces. Removal shall not damage the underlying Portland cement concrete pavement.

3.02 - Traffic Paint

- A. Waterborne traffic paint materials shall not be applied when air or surface temperature is below 40°F.
- B. Volatile Organic Content (VOC) compliant solvent borne paint shall not be applied when air or surface temperature is below 32°F.
- C. The application of the traffic paint, including mixing and thinning of traffic paint, equipment pressures and operating speed of equipment shall be in accordance with the material manufacturer's instructions and recommendations.
- D. The Contractor shall apply 4-to-6-inch wide line striping, at the locations and of the color specified on the Contract Drawings or required by the Engineer. Included in this area are letters or traffic arrows and symbols as shown on the Contract Drawings.
- E. The traffic paint shall be applied at a coverage rate of not less than 100 square feet, and not more than 110 square feet of surface per gallon of binder, yielding a film thickness of 0.015 inch.
- F. The Contractor shall schedule striping operations so as to permit the paint to have set and hardened (generally 1 hour after application) before the roadway is opened to traffic.
- G. Striping machines shall be cleaned at the end of each day and more frequently if necessary to insure the application of lines the specified quality and physical requirements.

3.03 - Thermoplastic Reflective Pavement Markings

- A. All pavement surfaces (new and existing) to be marked shall be primed with Type III primer applied to bituminous concrete and/or Portland Cement concrete pavements at the rates and in accordance with the recommendations of the manufacturer of the thermoplastic material. The primer shall dry tack-free in less than 5 minutes.
- B. Thermoplastic pavement markings shall be placed upon dry pavement surfaces. At the time of installation the pavement surface temperature shall be a minimum of 55 degrees Fahrenheit and the ambient temperature shall be a minimum of 49 degrees Fahrenheit and rising. The Engineer will determine when atmospheric conditions are such as to produce satisfactory results.
- C. The thermoplastic material shall be applied at an indicated gauge temperature no lower than 415 degrees Fahrenheit at the point of deposition. For purposes of these Specifications, the point of deposition shall be defined as within the extrusion shoe.
- D. Immediately following application, reflective glass spheres shall be dropped onto the molten thermoplastic marking at the rate of 5 lb per 100 square feet of composition.
- E. Upon cooling to ambient pavement temperature, the resultant marking shall be an adherent reflectorized strip of the specified thickness and width, capable of resisting deformation by traffic.

3.04 - Removal of Pavement Markings

- A. Existing pavement markings in the newly marked traffic lanes that are confusing, conflicting, or misleading to traffic shall be removed. The Engineer may designate other pavement markings for removal to maximize the effectiveness of the traffic control plan.
- B. Pavement markings remaining after the removal process is completed shall not be visible during daytime or nighttime. Tape markings shall be removed in accordance with manufacturer's recommendations. Removal process shall not cause functional damage to the transverse or longitudinal joint sealant materials.
- C. Pavement marking removal operations shall be conducted in a manner so that the finished pavement surface is not damaged or left in a pattern that may mislead or misdirect the motorist. When the operations are completed, the pavement surface shall be power broomed and any marking removal debris shall be removed from the pavement surface before the pavement is open to public traffic. The limits of pavement marking removal shall be not less than the width of the existing or new pavement markings plus 1 inch. When symbols or legends are removed, the area of removal shall cover the entire area of the existing symbol or legend.
- D. Removal will not be required prior to being covered by a construction process unless specified in the Contract Documents. Removal of pavement markings may be by vacuum blasting, vacuum dry grinding, wet grinding, shot blasting, or high pressure water blasting. Open abrasive blasting or dry grinding without containment will not be allowed.

- E. Pavement marking removal equipment shall provide the following:
 - 1. Operate without the release of dust.
 - 2. Recover all removed material.
 - 3. Include a waste collection and transfer system. For dry wastes, the system shall incorporate High Efficiency Particulate Absolute (HEPA) methods and equipment.
- F. Removal operations may be halted if the process and final result is not acceptable to the Engineer.
- G. Material collected shall be removed and disposed of in accordance with all applicable Federal and State regulations.

END OF SECTION 02850