SECTION 646 PAVEMENT MARKINGS

646.1 Description

(1) This section describes furnishing and applying, or removing, pavement line markings.

646.2 Materials

646.2.1 General

(1) The department approves pavement marking materials based on a combination of manufacturer or department-performed tests and proven performance history. Provide the information specified for each individual material and additional material samples as the engineer requests.

(2) Deliver paint and epoxy materials to the job site unopened, in manufacturer's containers legibly marked with the contents, color, batch number, date manufactured, and manufacturer's name and address. Do not use paint or epoxy more than 1 1/2 years after its date of manufacture.

646.2.2 Paint

(1) Furnish paint from the department's approved products list. Have the manufacturer furnish a 2-quart sample from each batch before shipping. Contact the department for submittal requirements and submit as the department directs.

646.2.3 Glass Beads

(1) Furnish glass beads conforming to AASHTO M247, except for gradation conform to the following:

SIEVE	PERCENT PASSING BY WEIGHT	
SIZE	FOR EPOXY	FOR PAINT
No. 20	100	95-100
No. 30	75-95	70-90
No. 40	____	60-80
No. 50	15-35	10-30
No. 80	____	0-3
No. 100	0-5	0-1

(2) For each batch of beads actually furnished for the work, submit the following:

1. A certificate of compliance certifying that the beads supplied under the contract conform to these specifications.
2. A certified report of test or analysis indicating the results of gradation tests.

(3) Furnish manufacturer-treated beads with minimal surface scratching or scarring, and having at least 75 % true spheres. Use dual coated beads treated for both moisture resistance and adherence. Ensure that beads do not contain more than 75 ppm total arsenic or 100 ppm total lead when tested according to both EPA method 3052 and 6010C.

(4) Provide bulk containers or pallets of bags labeled with the bead type, net weight, lot or batch number, Wisconsin test number for that lot or batch, or blend date, and manufacturer's name and address.

(5) Have the manufacturer furnish a one-quart random sample representing each shipment before shipping. Contact the department for submittal requirements and submit as the department directs.

646.2.4 Epoxy

(1) Furnish epoxy from the department's approved products list. Submit a certificate of compliance certifying that the epoxy supplied under the contract conforms to these specifications.

646.2.5 Preformed Markings

Revise 646.2.5(1) to require 90 mil thick preformed thermoplastic marking materials.

(1) Under the Pavement Marking Preformed Thermoplastic bid items, furnish 90 mil thick preformed thermoplastic pavement marking materials from the department's approved products list.

(2) Under the Pavement Marking Preformed Plastic bid items, furnish preformed plastic pavement marking tape conforming to ITE standards.

(3) Deliver preformed marking materials to the project in manufacturer's containers legibly marked with the contents, color, batch number, and manufacturer's name and address.

646.3 Construction

646.3.1 General

646.3.1.1 Surface Preparation

(1) Prepare the surface receiving marking to promote a good bond. Use equipment with a dust control system. Remove dust, dirt, oil, grease, loose paint, gravel, debris, or other materials and contaminants that might prevent bonding. Ensure that the surface is dry and free from frost, except the contractor may apply epoxy to damp pavement.

(2) Prepare concrete surfaces using brush-off blasting to remove curing compound, protective surface treatment on structures, and laitance. Conform to the "Steel Structure Painting Council Surface Preparation Specification Number 7" and expose at least 85 % of the concrete receiving marking.

(3) After the marking can sustain exposure to traffic, re-apply clear protective surface treatment conforming to 502.2.11 where it was removed from structures to prepare the surface for pavement marking. Seal exposed concrete, including grooves for tape, and over the pavement marking.

(4) Air blast or sweep milled asphaltic surfaces.

(5) Do not remove epoxy overlay materials in areas receiving pavement marking. Use only epoxy pavement marking where the contract requires marking placed on epoxy overlays.

646.3.1.2 General Marking Requirements

(1) Under the Pavement Marking bid items, apply centerlines, no-passing barrier lines, lane lines, channelizing lines, edgelines, and other lines of the width the bid item indicates.

(2) Apply markings at the locations and to the dimensions and tolerances the plans show, or as the engineer directs. Complete marking within specified time limits. Match the marking cycle at both project ends to be continuous from the existing marking to the new marking. Use the color the plans show. Ensure that lines have a uniform cross section and color. Reflectorize the lines with glass beads distributed uniformly throughout the specified thickness. Provide a sharp cutoff on both sides and ends of the line. Do not damage existing pavement markings that will remain in place.

(3) On contracts without the Locating No-Passing Zones bid item, reference the beginning and end of all existing no-passing barrier lines before pavement resurfacing that covers the pavement markings. After completing the resurfacing, accurately re-mark the no-passing barrier lines.

(4) Apply permanent edgeline markings to the upper layer of new asphaltic pavement or surfacing within 7 days after completing mainline paving, but before a scheduled work suspension, unless the contract requires or the engineer directs or allows otherwise.

(5) Apply permanent pavement markings to new concrete pavements, or roads closed during construction, before opening those pavements to traffic, unless the engineer allows otherwise.

(6) If removing existing markings before applying new markings, remove as specified in 646.3.4 exposing at least 85 % of the pavement surface. If installing new pavement marking without removing existing marking, retrace existing pavement markings or layout as the engineer directs.

(7) On highways open to 2-way traffic, in addition to the marking vehicle, provide a leading vehicle and at least one trailing vehicle. Do not use flashing arrow panels to direct traffic to pass; otherwise equip each leading and trailing vehicle with the following:

1. A slow-moving vehicle emblem.
2. One or more flashing or revolving yellow lights showing to the front and rear.
3. Signs to advise traffic of the wet line and number of vehicles in the marking train.

(8) On one-way roadways, operate all marking train vehicles in the direction of traffic. Provide the same marking train as specified for 2-way traffic in 646.3.1.2(7) except as follows:

- A leading vehicle is not required, but use 2 trailing vehicles.
- The contractor may use flashing arrow panels to direct traffic to pass.

(9) Protect freshly applied markings until the line is dry or cured enough to prevent pickup under traffic. Place traffic cones on wet lines immediately behind the marking train or use a convoy of moving vehicles to keep traffic from crossing the wet line. Remove cones promptly after the line dries or cures.

646.3.1.3 Permanent Same Day Marking Requirements

(1) Under the Pavement Marking Same Day bid item, apply centerlines and no-passing barrier lines on the same day the upper layer is placed, or on the same day existing markings are removed. If weather conditions preclude same-day application, apply as soon as weather allows. Conform to the general requirements of 646.3.1.1 and 646.3.1.2.

(2) Apply permanent no-passing barrier lines and centerline markings to the upper layer of pavements open to traffic on the same day the layer is placed. Do not resume next-day construction operations until these markings are completed unless the engineer allows otherwise. As an option, the contractor may use temporary pavement markings to conform to these same-day requirements. Remove all temporary markings before placing same day permanent pavement markings.

646.3.1.4 Late Season Marking Requirements

(1) Do not place permanent pavement marking after November 15 and before April 15 of the following calendar year. Instead apply any marking material from the department's approved products list in the exact locations the plans show for permanent marking. Maintain that marking until April 15, then unless the engineer allows otherwise, completely remove and replace it with permanent pavement marking.

(2) From November 15 to April 15, evaluate the marking for required maintenance using the failure criteria specified in 646.3.3.4. Perform corrective maintenance whenever the failure rate exceeds 25 percent for any section of marking.

646.3.2 Equipment

646.3.2.1 Paint Equipment

(1) Use a marking vehicle with a paint tank that has calibrated dipsticks or other volume-measuring device. The equipment shall also have a device to register the daily-accumulated installed length for each gun.

646.3.2.2 Glass Bead Equipment

(1) Use automatic, mechanical devices to apply glass beads to centerline, lane line, edgeline, and no-passing barrier line markings.

646.3.2.3 Epoxy Equipment

(1) Use equipment that can spray both yellow and white material to produce uniform lines of the specified dimension. The equipment shall also be able to do the following:

1. Apply lines both on the left and right sides, not necessarily simultaneously.
2. Apply 2 lines simultaneously, with either line in a solid or intermittent pattern, in yellow or white.

(2) The cycling mechanism used for applying lane skip lines shall produce uniform cycles. The equipment shall also have a device to register the daily-accumulated installed length for each gun.

646.3.3 Line Marking

646.3.3.1 Applying Paint

(1) Apply paint as the manufacturer specifies. Do not apply below the minimum pavement temperature the manufacturer recommends. If the engineer requests, provide manufacturer specifications.

Revise 646.3.3.1(2) to require 8-10 pounds of glass beads per gallon of paint.

(2) Apply paint uniformly across the line at or exceeding 17.6 gallons per mile of continuous 4-inch line. Apply glass beads uniformly across the width of the line at a rate of 8 to 10 pounds per gallon of paint.

(3) If the engineer requests, provide calculations demonstrating that the paint application rate is consistent with the specified dimensions and that the bead application rate is consistent with the specified rate. If on any 0.5-mile section the calculated application is less 90 % of that specified, remark that section.

646.3.3.2 Applying Epoxy

(1) Apply epoxy as the manufacturer specifies. Do not apply below the minimum pavement temperature the manufacturer recommends. If the engineer requests, provide manufacturer specifications.

(2) For both concrete and asphalt surfaces, remove surface contaminants by sweeping, air jetting, or water blasting immediately before applying the epoxy.

(3) Do not apply epoxy over marking materials with less adherence than the epoxy. Prepare the surface to ensure a permanent bond. If surface preparation techniques prove inadequate to ensure a permanent bond, the engineer may direct the contractor to remove the marking as specified in 646.3.4.

(4) Prepare stone matrix asphalt (SMA) by scarifying to expose 75 percent or more of the stone substrate. Limit scarification to no more than the following:

- 3 inches from the beginning and end of the applied line.
- 1/2 inch on either side of the applied line.

Revise 646.3.3.2(5) to require 22.0 gallons per mile for epoxy marking on rumble strip surfaces.

(5) For the initial application, apply epoxy uniformly across the line at or exceeding the application rate for a continuous 4-inch line as follows:

- 27.5 gallons per mile for SMA pavement and epoxy overlay surfaces.
- 22.0 gallons per mile for rumble strip surfaces.
- 22.0 gallons per mile for tined or diamond ground concrete pavement surfaces.
- 17.6 gallons per mile for all other pavement surfaces.

(6) For subsequent applications, apply epoxy uniformly across the line at or exceeding 17.5 gallons per mile of continuous 4-inch line for all pavement surfaces.

(7) Apply glass beads uniformly across the width of the line. For the initial application on SMA pavements, apply at or exceeding 25.0 pounds per gallon of epoxy. For other pavement surfaces and subsequent applications on SMA, apply at or exceeding 22.5 pounds per gallon of epoxy.

(8) If the engineer requests, provide calculations demonstrating that the epoxy application rate is consistent with the specified dimensions and that the bead application rate is consistent with the specified rate. If on any 0.5-mile section the calculated application is less 90 % of that specified, remark that section.

646.3.3.3 Applying Preformed Markings

(1) Apply preformed markings as the manufacturer specifies. If the engineer requests, provide manufacturer specifications.

(2) For asphalt surfaces, apply preformed plastic marking tape just before the final rolling and roll it into the surface.

646.3.3.4 Proving Period

(1) The department will accept the work based on a final inspection conducted when the contractor completes the work. The engineer will, however, conduct post-acceptance inspections periodically during a proving period to evaluate the performance of all paint, epoxy, and preformed markings. The proving period begins on the last day of the month, for all marking placed within each calendar month. For paint, the proving period is 180 days. For epoxy and preformed markings, the proving period extends through April 15 of the next calendar year or 180 days, whichever is longer. If weather or road surface conditions prevent the engineer from fully evaluating the marking at the specified end of the proving period, the engineer may extend the proving period.

(2) The engineer will determine the percent failing during the proving period. The engineer will exclude failures due to abrasion loss at private entrances or within intersections. The department defines failure as discoloration, chipping, substrate exposure, or inadequate reflectivity. The department measures reflectivity with a LTL 2000, LTL 2000Y or LTL 2000X retroreflectometer in the direction of travel. Failing reflectivity, in millicandelas/lux/m^2, is defined as follows:

COLOR	PAINT	EPOXY	PREFORMED PLASTIC TAPE	PREFORMED THERMOPLASTIC
White	<125	<200	<200	<150
Yellow	<85	<150	<150	<150

(3) The engineer will assess marking sections defined as follows:

1. Each edgeline, lane line, or each combination of center and no-passing barrier lines, measured through any 2000 foot length of highway, constitutes a separate section.
2. All gore markings or turning lane markings at a single interchange or intersection constitute a separate section, regardless of length.

(4) Replace all marking within sections with a percent failing more than 10 % and repair or replace all markings that, in the engineer's assessment, show evidence of improper construction. If post-acceptance inspections uncover evidence of defective materials or improper construction, the department may revoke acceptance under 105.11.2.4.

(5) If the manufacturer provides a warranty beyond 180 days, provide the warranty and supplier information to the engineer.

646.3.4 Removing Pavement Markings

(1) Remove pavement markings from locations the plans show or as the engineer directs. Do not damage, discolor, leave a detrimental residue on the surface, or paint over existing markings. Provide a dust control system and remove accumulated sand or other materials.

(2) If blast cleaning within 10 feet of a lane open to public traffic, remove all dust and other residue continuously while blast cleaning. Collect, haul, and dispose of dust or residue from removals. Repair damage caused by the contractor's removal operations.

646.4 Measurement

(1) For items measured by the linear foot of line, the department will calculate quantities as follows:

1. For solid lines; by adding the linear feet of solid line measured end to end.
2. For intermittent lines; by multiplying the specified length of the individual markings of the line by the number of markings in the intermittent line end to end.

(2) The department will measure the Pavement Marking bid items by the linear foot of line acceptably completed.

(3) The department will measure Removing Pavement Markings by the linear foot of 4-inch wide line acceptably completed.

(4) The department will measure substitute epoxy marking placed on epoxy overlays, as required under 646.3.1.1, under the Pavement Marking Epoxy bid items, or absent those bid items as extra work.

646.5 Payment

(1) The department will pay for measured quantities at the contract unit price under the following bid items:

ITEM NUMBER	DESCRIPTION	UNIT
646.0100 - 0199	Pavement Marking (material) (width)	LF
646.0400 - 0499	Pavement Marking Same Day (material)	LF
646.0600	Removing Pavement Markings	LF

(2) Payment for the Pavement Marking bid items under this section is full compensation for preparing the surface, including brush-off blasting of concrete; for providing all marking, including reflectorization with glass beads; for protecting marking until dry or cured; for resealing areas of clear protective surface treatment on structures as required in 646.3.1.1; and for replacing marking improperly constructed or that fails during the proving period. Payment for paint and epoxy items also includes remarking if initially applied at less than 90 % of the specified rate.

(3) Late season marking required under 646.3.1.4 because of delays the department is not responsible for is incidental to the contract. If required because of an excusable compensable delay under 108.10.3, the department will pay for late season marking as extra work. If the Pavement Marking Late Season bid item is added to the contract by special provision, the department will pay separately for late season marking as specified under that bid item.

(4) Payment for the Pavement Marking bid items under this section also includes placing and removing all temporary pavement marking placed under the contractor option of same-day pavement marking as allowed in 646.3.1.3(2).

(5) For the Pavement Marking Epoxy bid items, the department will pay separately for engineer-directed removals as Removing Pavement Markings if removal is required to prepare the surface for the initial marking application. Removals required to replace defective markings are incidental to the Pavement Marking Epoxy bid items.

(6) Payment for Removing Pavement Markings is full compensation for removal, repairing associated damage, dust collection, and disposal of residue.

(7) The department will pay for substitute epoxy marking placed on epoxy overlays, as required under 646.3.1.1, under the Pavement Marking Epoxy bid items, or absent those bid items as extra work.