

646 Pavement Marking

646.1 Description

- (1) This section describes providing and removing pavement marking.

646.2 Materials

646.2.1 General

- (1) Furnish pavement marking products from the [APL](#). Submit certificates of compliance certifying that the products supplied under the contract conform to these specifications.

646.2.2 Glass Beads

- (1) Furnish dual coated glass beads treated for both moisture resistance and adherence conforming to [AASHTO M247](#), Type I, except with a minimum of 80 percent true spheres. For each batch of beads actually furnished for the work, submit a certificate of compliance certifying that beads supplied under the contract conform to these specifications.
- (2) Furnish beads in containers or bags labeled with the bead type, net weight, lot or batch number, blend date, and manufacturer's name and address.

646.3 Construction

646.3.1 General

646.3.1.1 General Marking

- (1) Prepare the surface and apply marking as the manufacturer specifies. Provide manufacturer specifications as the engineer requests. Do not remove polymer overlay materials in areas receiving pavement marking. Use only epoxy pavement marking where the contract requires marking placed on polymer overlays.
- (2) On projects with a net length of 1 mile or more, complete department forms [DT2130](#) and [DT2131](#) daily and submit to the engineer weekly unless the engineer agrees otherwise.
- (3) 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. 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.
- (4) On one-way roadways, operate marking train vehicles in the direction of traffic. Provide the same marking train as specified for 2-way traffic in [646.3.1.1\(2\)](#) 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.
- (5) After the marking can sustain exposure to traffic, re-apply clear protective surface treatment conforming to [502.2.11](#) where removed from structures during marking surface preparation. Seal exposed concrete including grooves for tape. Cover marking during resealing with a system that will not degrade the marking's retroreflectivity when removed. Uncover marking before opening to traffic.
- (6) If the roadway is open to traffic use temporary raised pavement markers or apply temporary same day marking. Apply permanent marking within 7 days of completing mainline paving, or pavement surface treatment. If the roadway is closed during construction, apply permanent marking before opening to traffic.
- (7) Apply marking to the width and color the bid item indicates. Provide a sharp cutoff for both sides and ends of the marking with a uniform cross-section. Do not damage existing marking that will remain in place.

646.3.1.2 Liquid Marking

- (1) If the engineer requests, provide calculations demonstrating that the 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 or individual special marking have a calculated application rate less than 90 percent of that specified, remove and remark this section or special marking.
- (2) Protect freshly applied marking until the line is dry or cured enough to prevent pickup under traffic. Place 28-inch traffic cones on wet marking or use a convoy of moving vehicles to keep traffic from crossing the wet marking. Remove cones promptly after the line dries or cures.
- (3) 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.

(4) Apply liquid marking and glass beads across the line at or exceeding the following:

LIQUID MARKING	PAVEMENT TYPE	THICKNESS (mils)	BEAD APPLICATION (pounds per gallon)
Paint	all	16	10
Epoxy	SMA, seal coats, and polymer overlays	25	25
Epoxy	all other	20	22.5
Wet Reflective Epoxy	all	20	[1]

[1] Use the product specific bead application rate for wet reflective epoxy specified on the [APL](#).

646.3.1.3 Cold Weather Marking

646.3.1.1 *Revise to state that cold weather marking within rumble strip may remain.*

- (1) Do not place permanent paint or permanent tape marking if the ambient or pavement temperature is below 50 F. Choose an epoxy marking compatible with field conditions when placed. Do not place permanent epoxy marking if the ambient or pavement temperature is below 35 F unless the engineer allows in writing.
- (2) If the engineer allows or requires marking below the specified minimum temperatures, apply epoxy from the [APL](#) in the exact location and width where permanent marking would be installed. Place epoxy at the mil thickness and the glass bead application rate specified for permanent epoxy. Maintain until weather permits permanent placement.
- (3) Using the failure criteria specified in [646.3.1.5](#), perform corrective maintenance whenever the failure rate exceeds 25 percent of any section of marking. Completely remove and replace cold weather marking with permanent marking when weather permits. **Cold weather markings within a pavement rumble may remain in place.** The proving period for the final marking begins after replacement.

646.3.1.4 Removing Marking

- (1) Completely remove marking from locations the plan show or as the engineer directs. Unless the bid item designates water blasting, the contractor may use one or a combination of air blasting, water blasting, grooving, and grinding. Do not damage pavement and limit scaring. Provide a dust control system and remove accumulated sand or other materials. Collect, haul, and dispose of dust or residue from removals.
- (2) Perform air blasting conforming to the following:
 - If air blasting within 10 feet of a lane open to traffic, remove dust and other residue continuously while blast cleaning.
 - If removing existing marking before applying new marking, expose at least 90 percent of the marking surface.
 - If removing yellow center lines for no passing zone changes, ensure that the cycling mechanism on line removal equipment produces a uniform cycle or alternatively remove by hand.
- (3) Perform water blasting only if the ambient temperature is at least 36F and rising. Use a truck mounted ultra-high pressure pump and water tank capable of delivering up to 40,000 psi to water jet nozzles. Adjust water pressure to avoid damaging the pavement. Provide a vacuum recovery system that contains waste water and debris to provide a clean, damp-dry surface, without a secondary cleanup operation.
- (4) Grind using a truck-mounted or hand system capable of complete removal of the marking. Provide a vacuum system to completely collect dust and debris.

646.3.1.5 Marking Acceptance

- (1) The department may measure initial retroreflectivity conducted when the contractor completes the work as a part of the marking acceptance decision. The department will take initial day dry retroreflectivity readings between 15 and 60 days after installation or before the first snow fall whichever comes first.
- (2) Conform to [ASTM D6628](#) color requirements. The department measures reflectivity in the direction of travel. Ensure that the initial reflectivity, in millicandelas/lux/m², meets or exceeds the following:

MATERIAL	COLOR	INITIAL DAY RETROREFLECTIVITY
Paint	White	275
	Yellow	185
Epoxy	White	275
	Yellow	185
Wet Reflective Epoxy	White	290
	Yellow	195
Permanent Tape	White	650
	Yellow	425

- (3) The engineer will inspect each marking section defined as follows:
1. Each edge line, lane line, or center line, measured through any 0.5 mile section.
 2. Gore marking or turning lane marking at a single interchange or intersection.
 3. Each roundabout.
- (4) Replace all marking in sections with failing initial retroreflectivity and repair or replace marking that the engineer deems improperly constructed. Remove existing marking in the groove before replacement. If post-acceptance inspections uncover evidence of defective material or improper construction, the department may revoke acceptance under [105.11.2.3](#).

646.3.1.6 Proving Period

646.3.1.6.1 General

- (1) The engineer may conduct post acceptance inspections periodically during a proving period to evaluate the physical presence of pavement marking and, for grooved-in marking only, the retroreflectivity. The proving period begins on the last day of the week, for all marking placed within that week. 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 end of the proving period, the engineer may extend the proving period.
- (2) The engineer will determine the percent failing at the end of the proving period. The engineer will exclude failures due to abrasion loss at private entrances and within intersections, except for roundabouts. The department defines failure as discoloration, chipping, or substrate exposure.
- (3) Remove and replace all marking in sections, as defined in [646.3.1.5](#), with more than 10 percent failing and repair, or remove and replace, marking that the engineer deems improperly constructed.

646.3.1.6.2 Retroreflectivity

- (1) For grooved-in markings, the engineer will also evaluate the percent failing retroreflectivity at the end of the proving period. Ensure that the 180-day reflectivity, in millicandelas/lux/m², meets or exceeds the following:

MATERIAL	COLOR	180 DAY DRY RETROREFLECTIVITY
Wet Reflective Epoxy	White	250
	Yellow	150
Permanent Tape	White	400
	Yellow	335

646.3.2 Long-Line Marking

646.3.2.1 General

- (1) Long lines are center lines, lane lines, edge lines, channelizing lines, and dotted extension lines.
- (2) On contracts without the Locating No-Passing Zones bid item where pavement resurfacing covers the marking, mark the beginning and end of all existing center lines. After completing the resurfacing, accurately re-mark the center lines.

646.3.2.2 Liquid Marking Equipment

- (1) Use equipment that can spray both yellow and white material to produce uniform lines of the specified dimension. Ensure the equipment can do the following:
 - Applies lines both on the left and right sides, not necessarily simultaneously.
 - Applies 2 lines simultaneously, with either line in a solid or intermittent pattern, in yellow or white.
 - Reports a daily-accumulated installed length for each gun.
 - Reports a volume of paint used each day.

- (2) Use automatic, mechanical devices to apply glass beads and report the volume used.

646.3.2.3 Grooving

646.3.2.3 Revise to increase groove depth and add information for black epoxy grooving.

646.3.2.3.1 General

- (1) Provide a groove depth as follows:

PRODUCT	GROOVED DEPTH
Grooved Wet Reflective Epoxy	90 +/- 10 mils
Grooved Tape	175 +/- 10 mils

- (2) Groove a maximum of 4 inches from both ends and 1 inch wider than the width of the marking segment. Achieve straight alignment with the grooving equipment, not to exceed a 3/8 inch variation in any 40-foot section of travelled way. Use a high-pressure air blower to clean the groove.
- (3) For grooving concrete, if water is used in the grooving process, allow the groove to dry a minimum of 24 hours before cleaning. Before applying the marking, ensure that the groove surface is clean and dry.
- (4) For grooving asphalt, wait 48 hours or longer after paving. Notify the engineer immediately if the structural integrity of the asphalt pavement is inadequate to support grooving operations.
- (5) For grooving black epoxy match the groove depth of the adjacent white marking. Groove as one grooved slot for both the white and black markings.

646.3.2.3.2 Wet Reflective Epoxy

- (1) Apply wet reflective epoxy binder in a grooved slot. and provide a double drop bead system as follows:
1. Wet reflective/recoverable elements at the application rate specified in the [APL](#).
 2. Glass beads conforming to [646.2.2](#) at the application rate specified in the [APL](#).

646.3.2.4 Black Epoxy

646.3.2.4 Rename from "Contrast Marking" to "Black Epoxy". Change from an oreo pattern to a black lag pattern.

- (1) Apply black epoxy in a grooved slot with a matte finish directly after the white marking. Apply epoxy at a wet mil thickness of 20. Apply black aggregate at a rate of 10 pounds per gallon of epoxy. Do not apply glass beads to black epoxy.

646.3.2.5 Permanent Same-Day Marking

- (1) Under the Marking Line Same Day bid item, apply liquid marking conforming to [646.3.1.2](#). Apply long line marking on the same day the final surface is placed or on the same day existing marking is removed. If weather or pavement conditions prohibit same-day applications, delineate the travel lanes with flexible delineators or type II temporary raised pavement markers and provide signing as the engineer directs. Apply long-line marking as soon as conditions allow. The engineer may restrict operations until this marking is completed.
- (2) As an option, the contractor may use temporary marking to conform to these same-day requirements. Remove temporary marking before placing same-day permanent marking.

646.3.3 Special Marking

- (1) Under the Marking Railroad Crossings bid items, apply the RXR symbol and 3 transverse lines as the plans show. Also apply edge lines, lane lines, and center lines adjacent to the railroad crossing.
- (2) Under the Marking Curb bid items, mark the vertical face and the top of the curb.
- (3) Under the Marking Aerial Enforcement Bars bid items, the department will locate the marking. Notify the engineer at least one week before marking so the State Patrol can provide exact locations.

646.4 Measurement

- (1) The department will measure the EACH bid items under this section as each individual unit acceptably completed and as follows:
- The department will measure the Marking Yield Line bid items as each individual triangle in the yield line.
 - The department will measure the Marking Aerial Enforcement Bar as each individual block.

646.4 Revise measurement for marking block crosswalks.

- (2) The department will measure the LF bid items under this section by the linear foot of line acceptably completed. The department will measure the Marking Block Crosswalk bid items as linear foot of each line placed.
- (3) The department will measure the Marking Corrugated Median bid items by the square foot acceptably completed.

- (4) The department will measure the Marking Removal bid items under this section as follows:
- Marking Removal Lines bid items by the linear foot of line acceptably completed.
 - Marking Removal Special Marking bid items as each individual arrow, symbol, or word acceptably removed. The department will count removing an RXR symbol as 3 individual symbol removals.
- (5) The department will measure the Cold Weather Marking Epoxy bid items by the LF of initial marking acceptably placed, maintained, and removed. The department will not measure work under these bid items as follows:
- If the contractor fails to maintain and remove the initial marking as required in [646.3.1.3\(2\)](#).
 - If initial marking is placed on days when the department is assessing liquidated damages.

646.5 Payment

646.5.1 General

646.5.1 Revise to add pavement marking items for 6-inch and 10-inch.

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

ITEM NUMBER	DESCRIPTION	UNIT
646.1000 - 1020	Marking Line (material) 4-Inch	LF
646.1021 - 1999	Marking Line Grooved (material) 4-Inch	LF
646.2000 - 2020	Marking Line (material) 6-Inch	LF
646.2021 - 2999	Marking Line Grooved (material) 6-Inch	LF
646.3000 - 3020	Marking Line (material) 8-Inch	LF
646.3021 - 3999	Marking Line Grooved (material/type) 8-Inch	LF
646.4000 - 4020	Marking Line (material) 10-Inch	LF
646.4021 - 4999	Marking Line Grooved (material) 10-Inch	LF
646.4500 - 4820	Marking Line Same Day (material) (width)	LF
646.5000 - 5099	Marking Arrow (material)	EACH
646.5100 - 5199	Marking Word (material)	EACH
646.5200 - 5299	Marking Symbol (material)	EACH
646.5300 - 5399	Marking Railroad Crossing (material)	EACH
646.5400 - 5499	Marking Aerial Enforcement Bar (material)	EACH
646.5500 - 5599	Marking Outfall (material)	EACH
646.6000 - 6199	Marking Stop Line (material) (width)	LF
646.6200 - 6299	Marking Yield Line (material) 18-Inch	EACH
646.6300 - 6399	Marking Dotted Extension (material) 18-inch	LF
646.6400 - 6499	Cold Weather Marking Epoxy (width)	LF
646.7000 - 7199	Marking Diagonal (material) (width)	LF
646.7200 - 7399	Marking Chevron (material) 24-inch	LF
646.7400 - 7599	Marking Crosswalk (material/type) (width)	LF
646.8000 - 8099	Marking Corrugated Median (material)	SF
646.8100 - 8199	Marking Curb (material)	LF
646.8200 - 8299	Marking Island Nose (material)	EACH
646.8300 - 8399	Marking Parking Stall (material)	LF
646.9000 - 9299	Marking Removal Line (various)	LF
646.9300 - 9399	Marking Removal Special Marking (method)	EACH
646.9400 - 9499	Marking Removal Plowable Raised Pavement Marker	EACH

- (2) Payment for the Marking bid items under this section is full compensation for providing the marking; and for resealing areas of clear protective surface treatments on structures.
- (3) Payment for liquid markings includes remarking as required under [646.3.1.2\(2\)](#).
- (4) Payment for the Marking bid items under this section also includes installing and removing temporary marking installed under the contractor option of same-day marking.
- (5) Payment for the Marking Removal bid items is full compensation for removing the marking and for resealing areas of clear protective surface treatments.

646.5.2 Cold Weather Marking

- (1) Payment for the Cold Weather Marking Epoxy bid items is full compensation for providing the initial marking including maintenance and removal. If the associated Cold Weather Marking bid item is not in the contract, the department will pay for the initial marking, maintenance, and removal as extra work.
- (2) The department will pay separately for the final marking under the associated Marking bid items.