

## SECTION 9XXX – RECESSED WET-REFLECTIVE POLYUREA PAVEMENT MARKINGS

**I. DESCRIPTION** - This work consists of furnishing and installing wet-reflective polyurea pavement markings of the color indicated, at the locations indicated.

### II. MATERIAL -

**(a) General.** Provide materials from a source listed in Bulletin 15. Certify materials as specified in Section 106.03(b)3.

**(b) Polyurea Resin.** Provide only those polyurea materials listed in Bulletin 15 and use per manufacturer's recommendation.

**1. Color.** Furnish white and yellow pavement markings that satisfy the following chromaticity coordinates:

	1		2		3		4	
	x	y	x	y	x	y	x	y
<b>White</b>	0.330	0.370	0.355	0.345	0.310	0.300	0.285	0.325
<b>Yellow</b>	0.515	0.465	0.505	0.430	0.440	0.415	0.420	0.443

Furnish black polyurea that satisfies color chip 37038 of Federal Standard 595B and is equal to the quality of the white polyurea being used.

White Cap Y without beads ~~shall must~~ measure > 90 following ASTM E 1349 45/0 (0/45) with CIE D65 Illuminant and CIE 2 degree standard observer.

Yellow Cap Y without beads ~~shall must~~ measure between 52 and 60 following ASTM E 1349 45/0 (0/45) with CIE D65 Illuminant and CIE 2 degree standard observer.

**2. No Track Time.** Dry to a no-track condition in 10 minutes or less when tested according to ASTM D 711 at a temperature of  $75^{\circ}\text{F} \pm 2^{\circ}\text{F}$  at a thickness of 20 mils  $\pm 1$  mil with glass beads applied at a rate of 20 pounds per gallon of polyurea.

**(c) Optics.** Provide beads as follows:

- Standard Glass Beads - Section 1103.14
- Potters Visibead Plus II Highway Safety Marking Spheres or approved equal
- 3M Connected Roads AW 70E Series elements containing microcrystalline ceramic beads~~or~~ or approved equal.

**(d) Black Aggregate.** Furnish with the following gradations and as recommended by the black polyurea manufacturer:

<b>Sieve Size</b>	<b>Retained (%)</b>
No. 20	17-37
No. 30	45-65
No. 40	14-25

### III. CONSTRUCTION -

**(a) General.** Hot apply the polyurea marking material by spray method onto clean and dry pavement

surfaces at the thickness and width specified. Apply the retroreflective optics to the hot polyurea paint using either a double or triple drop system.

Line marking configurations are according to the Standard Drawings. All lines are to be positioned 4 inches from the respective pavement joint or as otherwise indicated.

Wet-reflective pavement markings are to be recessed in the pavement and resistant to damage and deformation by traffic and damage from snow removal equipment.

Coordinate a pre-paint meeting at least thirty (30) days prior to starting the installation of any pavement markings. At the pre-paint meeting, provide the Representative with the following:

- The source of supply for the polyurea material and the polyurea manufacturer's written instructions for use. These instructions are to include, but not be limited to, material mixing ratios and application temperatures (for the polyurea material and the pavement surface).
- The source of supply for the black aggregate material as applicable.
- ~~Provide test plates of the exact pavement markings to be installed. Provide 3 test plates of each color. Include a minimum 6-inch wide by 24-inch long sample of the marking on a flat and rigid substrate for each test plate. Provide the dry and wet retroreflectivity levels of each sample as specified in Section (e). Provide at least one test plate of each color without beads or reflective optics.~~
- Procedures for cutting the grooves with gang-stacked diamond saw blades.
- Procedures for installing the wet-reflective pavement marking in the diamond cut saw groove.
- The source of supply for all retroreflective optics.

Apply pavement markings in the direction of traffic.

Provide protection to allow adequate time for the pavement markings to dry and be track-free from vehicular traffic. This operation must be done during allowable working hours. Remove, to the satisfaction of the Representative, all tracking marks, spilled polyurea, and polyurea markings applied in unauthorized areas.

Establish marking line points at 40-foot intervals throughout the length of the pavement as directed by the Representative.

**(b) Equipment.** Equip the grinding equipment with a free-floating cutting or grinding head to provide a consistent groove depth over irregular pavement surfaces. Equip the grinding or cutting head with gang-stacked diamond saw blades. The grinding equipment must be capable of producing a final pavement surface that is flat and free of ridges.

Provide a mobile applicator that is a truck mounted, self-contained pavement marking machine, specifically designed to apply polyurea resin materials and retroreflective optics in continuous and skip line patterns. The application equipment ~~shall~~must be maneuverable to the extent that straight lines can be followed and normal curves can be made in true arc.

At any time throughout the duration of the project, provide free access to the polyurea application equipment for the inspection by the Representative.

Provide application equipment capable of installing a minimum of 100,000 feet of wet-reflective pavement markings in an eight-hour day and includes the following features:

- Individual tanks for the storage of Part A and Part B of the polyurea resin and for the storage of reflective glass spheres.

- Heating equipment of sufficient capacity to maintain the individual polyurea resin components at the manufacturer's recommended temperature for spray application.
- Equipment capable of mixing Part A with Part B of the polyurea resin material to manufacturer's recommendations.
- Retroreflective optic dispensing equipment and the capacity of applying the optics as specified.
- Metering devices or pressure gauges on the proportioning pumps, positioned to be readily visible to the Representative.
- All necessary spray equipment, mixers, compressors, and other appurtenances for the placement of wet-reflective pavement markings in a simultaneous sequence of operations.

**(a)(c) Surface Preparation.** Clean the roadway surface where the wet-reflective pavement markings will be applied. Remove all surface treatment, laitance, curing compound, or any other contaminants that would hinder adhesion. Clear any loose dirt and other debris from the area where the wet-reflective pavement markings will be applied. Surface preparation is incidental to the application of wet-reflective pavement markings, except for the removal of pavement markings which is performed and paid for under Section 963. Use material and equipment that will not damage the final pavement surface and that will show the final lines on which the pavement markings will be placed. Place guide markings for all permanent pavement markings. Identify the location of the permanent pavement markings by applying spots on the pavement at 40-foot intervals. The Representative will approve the locations.

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**(d) Installation.** Recess the pavement markings into the final pavement surface. This includes newly paved asphalt after the final rolling of the surface, concrete pavement, concrete bridge decks and interchange ramps. Newly paved asphalt surfaces must not be grooved within 14 days of placement of the final course of pavement. Diamond cut the recessed area to a depth of 90 to 110 mils and 1 inch wider than the width of the pavement marking. For skip lines, cut the recessed area 10 feet in length with a maximum tolerance of +6 inches on either end. If a microsurface is present, and mill depth of the recessed groove is greater than the depth of the microsurfacing material, the groove must be cut into the material below the microsurface to allow for a clean bonding surface.

For dry saw blade operation, clean and remove debris and dust from the entire roadway surface by self-contained vacuuming immediately after grinding.

Wet saw blade operation is only permitted allowed for use on concrete surfaces. When water is used, flush the groove with clean high-pressure water immediately following the cut to avoid build-up and hardening of the slurry in the groove. The concrete surface must be clean and dry before the application of the wet-reflective pavement markings.

Properly dispose of the waste resulting from the grinding operations. Dumping of any milling or grinding waste within the Department's right-of-way is strictly prohibited.

Apply black markings on cement concrete roadways or bridges in accordance with the Standard Drawings exceeding 500 feet in length. Recess the black markings, flooded with black aggregate, immediately after all white skip line patterns. When black markings are installed at the same time as the broken white markings, cut the recessed area 20 feet in length with a maximum tolerance of +6 inches on either end. A 2-inch gap between the white and black markings is allowable. When black markings are installed for existing broken white markings, cut the recessed area 10 feet in length immediately following the existing broken white markings. A 6-inch gap between the white and black markings is allowable. Cut the recessed area 20 feet in length with a maximum tolerance of +6 inches on either end. The line dimensions and configurations are according to the Standard Drawings.

The use of temporary shadow lines within the recessed area is prohibited.

Do not begin marking operations until surface preparation work is completed and approved by the Representative. Install polyurea on dry pavement only if the road surface and ambient temperatures are 32°F or higher unless otherwise approved by the Representative and acceptable to the manufacturer.

Apply pavement markings by the following simultaneous operation:

1. Clean the grooved pavement surface to remove dirt and residues
2. The polyurea resin, mixed and heated in accordance with the manufacturer's recommendations, is uniformly hot-sprayed into the groove at a wet thickness of 22 mils  $\pm$  1 mil.
3. Retroreflective optics are dropped onto the liquid polyurea marking so that they are uniformly distributed. Drop the retroreflective optics according to the following requirements for the option chosen:

**OPTION A – Triple Drop**

- First Drop - All-weather (AW) elements at a rate of 4 pounds per gallon
- Second Drop - Visibead Plus II Highway Safety Marking Spheres or approved equal at a rate of 5 to 7 pounds per gallon
- Third Drop - Standard glass beads at a rate of 5 to 7 pounds per gallon

or

**OPTION B – Double Drop**

- First Drop - All-weather (AW) elements at a rate of 4 pounds per gallon
- Second Drop - Visibead Plus II Highway Safety Marking Spheres or approved equal at a rate of 10 to 12 pounds per gallon

**(b)(e) Observation-Guarantee Period.** Be responsible for any defects in materials and workmanship of the wet-reflective pavement markings for a period of ~~180~~ days from the date that the pavement area in which the markings are applied is open to traffic. Before the end of the observation guarantee period, but after the indicated number of days listed in Table 2 (AADT dependent), have an agreed-upon independent third party inspect the pavement marking for adhesion, color and retroreflectivity, and inform the Representative in writing of ~~all pavement markings that have failed and require replacement~~the testing results. ~~The Perform the adhesion and retroreflectivity testing by the independent third party must be performed under the direction and supervision of~~Testing results are to be provided to the Representative. ~~Provide and testing results must be provided to the Representative~~ within 5 days after the measurements are taken. The pavement marking will be considered failed for any of the following conditions:

- Insufficient thickness
- Insufficient line width, uneven cross-section.
- Inadequate adhesion as determined by the adhesion testing results. Averaged scores less than 6 using Table 1 rating system shown in ASTM D 6677 will be considered unacceptable.
- Insufficient depth of the groove.
- Retroreflected luminance ( $R_L$ ) levels according to Table 1 below.
- Marking is discolored based on a visual inspection. Color chips provided by the manufacturer will be used to assess discoloring. The initial color of the white and yellow pavement markings ~~shall must~~ meet the criteria established in 23 CFR 655.601 (required color criteria are included in the appendix to subpart F).

**Table 1. Minimum Required Retroreflectivity Levels**

<b>WHITE</b>	<b>DRY</b>	<b>CONTINUOUS WET</b>
Entrance Angle	88.76°	88.76°
Observation Angle	1.05°	1.05°
Retroreflected Luminance $R_L$ (mcd/m <sup>2</sup> /lx)	500	250
<b>YELLOW</b>	<b>DRY</b>	<b>CONTINUOUS WET</b>
Entrance Angle	88.76°	88.76°
Observation Angle	1.05°	1.05°
Retroreflected Luminance $R_L$ (mcd/m <sup>2</sup> /lx)	300	200

Note: The test instrument shall-must use an Entrance Angle of 88.76° and Observation Angle of 1.05° which represent a simulated driver viewing geometry at a 30-meter distance.

Initial retroreflectivity readings shall-must be taken on properly applied markings that have been opened to traffic, during the Lane AADT dependent Initial Reading Period defined in Table 2.

**Table 2. Initial Retroreflectivity Reading Period per Lane AADT**

Lane AADT	Initial Reading Period (days of traffic exposure)
Lane AADT <5000	15–30 Days
Lane AADT 5000–15000	7–15 Days
Lane AADT >15000	2–7 Days

**Retroreflectance.** Test both dry and wet retroreflectivity before the end of the observation-guarantee period, but at least 30 days after the pavement markings are installed in the direction of traffic on each line (left edge, skip(s), right edge) at every whole milepost. Refer to ASTM E 1710 for retroreflective measurements under dry conditions and ASTM E 2832 for retroreflective measurements under continuous wet conditions.

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Dry retroreflectivity measurements are to be taken within a 400-foot evaluation section at every whole milepost. Average a minimum of 20 retroreflectivity readings per line within the 400-foot evaluation section. Each average for each line will be used to determine a grand average for each line for the length of the project. The grand average of each line will be used to determine compliance. Directional data will be treated independently. See Figure 1 in ASTM D 7585 for an example of how to space individual readings. For dry measurements, mobile equipment can be used as a substitute for handheld equipment.

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Take at least one wet retroreflectivity reading on each line at every whole milepost. The grand average for each line will be determined from the respective wet readings. The grand average of each line will be used to determine compliance. Directional data will be treated independently. Take wet readings within the same 400-foot evaluation section used to obtain dry retroreflectivity readings.

Provide reports with all dry and wet retroreflectivity readings and their averages to the Representative within 5 days after the measurements are taken.

**Adhesion.** Test the adhesion of the wet-reflective pavement markings before the end of the observation-guarantee period, but at least 30 days after the pavement markings are installed on each line (left edge, skip(s), right edge) at every whole milepost using the test method described in ASTM D 6677. The rating system described in Table 1 of ASTM D 6677 shall-must be used to rate the adhesion. The average of these tests will be used to determine compliance. Directional data will be treated independently. Take geocoded digital photographs of each test result.

Provide reports with all adhesion tests, their averages, and geocoded digital photographs to the Representative within 5 days after the measurements are taken.

**(e)(f) Defective Markings.** During the observation-guarantee period, remove and replace wet-reflective pavement markings, which after application and curing are determined by the Representative to be defective and not in conformance with this specification, within 30 days of receiving written notification from the Representative at no additional cost to the Department. Work shall-must be in conformance with the manufacturer's recommendations and as approved by the Representative before the project is accepted. The replacement markings shall-must conform to the same requirements as the original markings. Repair defective markings to the satisfaction of the Representative as follows:

- Defect: Insufficient film thickness and line width; insufficient glass bead coverage or inadequate glass bead retention; insufficient groove depth; uneven cross-section; retroreflected luminance ( $R_L$ ) levels below those shown in Table 1 above.

Repair Method: Prepare the surface of the defective wet-reflective pavement markings by grinding or blast cleaning. No other cleaning methods are permittedallowed. Prepare the surface so that a substantial amount of the reflective glass spheres are removed and a roughened polyurea marking surface remains. Immediately after surface preparation, remove loose particles and foreign debris by vacuuming. Re-stripe over the cleaned surface in accordance with the requirements of this specification and at full thickness.

- Defect: Uncured or discolored polyurea\*; inadequate adhesion (to pavement surface or existing durable marking).

\*Uncured polyurea is defined as applied material that fails to cure (dry) within a reasonable time period under actual field conditions, as defined by the Representative. Discoloration is defined as localized areas or patches of brown, grayish or black colored polyurea marking material. These areas often occur in a cyclic pattern and often are not visible until several days or weeks after markings are applied.

Repair Method: Completely remove the defective polyurea to the underlying pavement surface in accordance with the requirements of this specification. Remove the defective area plus any adjacent wet-reflective pavement marking material extending a minimum of three feet in any direction. After surface preparation work is complete, re-apply new polyurea over the cleaned pavement surface in accordance with the requirements of this specification.

Repair or replace other defects not noted above, but determined by the Representative to need repair, as directed by and to the satisfaction of the Representative.

**(d)(g) Emergency Repair.** If the Department determines that emergency repairs are necessary due to pavement marking failure prior to final acceptance, perform the repairs within 24 hours of notification. If the Contractor fails to respond within the 24 hour period, the Department reserves the right to perform the repairs and will charge the Contractor for all costs. The Department's determination of costs incurred is final and conclusive.

#### **IV. MEASUREMENT AND PAYMENT -**

**(a) Line.** Linear Foot, for the type indicated.

**IV.(b) Pavement Marking Removal,** Section 963.4 Linear Foot, for the type indicated. This item includes all of the construction related activities listed in III. Construction.

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