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**SPECIAL PROVISION**

**REGARDING**

**PERFORMANCE BASED PAVEMENT MARKING INSTALLATION**

**Scope**

This provision covers the retroreflectivity requirements and testing methods used to determine the acceptability of installed performance-based traffic markings.

**Retroreflectivity**

Retroreflectivity in pavement markings is a measure of the amount of light from the vehicle's headlamps that is reflected back to the driver's eyes. In mathematical terms, it is a ratio of the reflected luminance to the headlamp illuminance at a certain viewing geometry.

The coefficient of dry retroreflective luminance shall be a minimum of 300 mcd/lux/sq m for white stripe and a minimum of 200 mcd/lux/sq m for yellow stripe

**Material Requirements**

All retraced pavement markings shall consist of the type designated in the Special Notes.

Performance Based spray thermo pavement markings (40 mil minimum thickness) and painted markings shall meet the minimum retroreflective values as stated above.

As a minimum, Performance Based spray thermoplastic pavement marking materials shall meet or exceed the material and physical requirements of Special Provision 716ST, except for drop on glass beads. Performance Based painted pavement markings shall meet or exceed the material and physical requirements in the Standard Specifications for Road and Bridge Construction 2006, Section 910.02, Quick Dry Traffic Marking Paint (White and Yellow), except for drop on glass beads. Drop on glass beads and their application rate shall be selected by the Contractor to meet the above retroreflective requirements after a minimum of 45 days wear on the installed traffic markings. Beads shall be applied uniformly across the entire line width to an embedment of 50-60% of the bead diameter.

**Testing Requirements**

Retroreflectivity values shall be measured in mcd/lux/sq m using a hand-held LTL-X retroreflectometer manufactured by Delta. Each retroreflectivity value recorded using the LTL-X retroreflectometer may be referred to as a measurement, a reading, or a test. A test however may also be a calculated value involving multiple measurements or reading values. Only readings made by the department representative with calibrated LTL-X retroreflectometers will be used in determining compliance with the retroreflectivity requirements above and payment calculations.

To facilitate the retroreflective measurement process, both colors on every route in a county are to be completed before beginning the marking in another county. Short sections of routes that enter another county may be marked at the same time as the current county if approved by the Engineer. Furthermore, yellow and white markings shall be tested and approved as separate quantities.

The Contractor shall provide the Engineer with Daily Work Reports using State Form DT-1296 Performance Paint Report to detail the work performed by each marking machine used each day. A copy of the approved and accepted DT-1296 form shall be provided to the Contractor at the pre-construction conference. Each report submitted to the Engineer by the Contractor shall provide, at minimum, the following information: county name, route number, marking limits per route, marking material applied and application rate, reflective beads applied and application rate, direction of application, and weather conditions.

The Engineer shall begin collecting retroreflectivity measurements approximately 45 calendar days after work has been completed in a county, and completed within approximately 30 days. In an effort to have an open testing environment, the Contractor is encouraged to be present, courteous, and professional during retroreflectivity testing conducted under this contract. Should the Contractor elect to participate in testing operations conducted under this contract the Contractor will be notified approximately 48 hours before planned retroreflectivity testing begins in a county. The Contractor's preference for notification, either by phone or email, shall be established or agreed upon in the Pre-construction Conference. The notification will include information regarding scheduling, establishing a rendezvous point for the testing team, weather forecast, and contingencies. It shall be the Contractor's responsibility, should he desire to participate, to meet the Engineer or his representative at the agreed-upon time and location. Testing shall be conducted as planned and at the Engineers discretion should the Contractor fail to appear. The privilege of accompanying the testing team may be rescinded if the Contractor's representatives do not conduct themselves in a cooperative, courteous, and helpful manner.

At least one measurement site will be established for every 20 line miles of retracing on each route in each county. The number of random testing sites per section may be listed in the general notes. A measurement site will consist of a randomly selected location 50 feet in length where retracing has been performed. All measurements shall be made in the direction of placement.

In a section of a two lane road, there will be a minimum of 30 tests conducted. There will be 10 tests conducted on the white outside line in the direction the line was placed and in the direction the site was determined. Five readings will be taken on each skip line or five per side if a double yellow or no passing/passing zone combination is present. Finally an additional 10 test will be conducted on the white line on the opposite side of the road and in the direction the line was placed.

In sections which contain more than 2 lanes where traffic is not separated by a median or longitudinal barrier there will be a minimum of 40 tests conducted. There will be 10 tests conducted on the white outside line in the direction the line was placed and in the direction the site was determined. Five readings will be taken on each of two skip lines in the section. Five readings per side shall be conducted for one instance of a double yellow or no passing/passing zone combination in the section. Finally an additional 10 test will be conducted on the white line on the opposite side of the road and in the direction the line was placed.

In sections which contain 2 or more lanes separated by a median or longitudinal barrier there will be a minimum of 30 tests conducted in the section. There will be 10 tests conducted on the white outside line in the direction the line was placed and in the direction the site was determined. Five readings will be taken on each of two skip lines in the section. Finally an additional 10 test will be conducted on the yellow barrier line on the opposite side of the road and in the direction the line was placed.

For route sections from the tabulated quantities which require 2 or more testing sites and contain a median or barrier between opposing directions of traffic, the Engineer and/or the Inspector shall alternate the testing from one side of the roadway to the other until testing is completed for all randomly selected sites in the section. Additional measurements may be taken on skip lines of multilane cross sections provided that there are at least two skip lines and that 5 readings are collected from each skip line in the direction of placement.

For retraced markings which contain profiled rumbles and/or rumble stripes the following procedure will be used to determine the retroreflective performance of the line for determination of the site acceptance factor. Beginning from the center of a rumble depression (peak for profiled rumbles) take one reading, move forward 1 inch and take a second reading, move forward an additional 1 inch and take a third reading. Three readings taken as described will represent one rumble placement. A total of 10 rumble placements will be taken on each retraced line which contains a continuous run of rumbles at each measurement site. When encountering a measurement site which contains a retraced marking in a non-continuous run of rumbles one (1) rumble placement will be tested for every 5 feet of the retraced marking which contains a rumble, the remainder of the required readings for the marking not containing rumbles will be collected using the standard method. The three readings for each rumble placement will be averaged and the calculated value will represent a single test. The resulting values for 10 tests on each retraced line containing rumbles will be summed with other tests for the same color to determine the site acceptance factor.

Retroreflective readings for each color (white, yellow) will be averaged separately by measurement site to determine if that measurement site meets the retroreflectivity requirements set forth in this contract. A site acceptance factor for each color will be determined using the table below for each site.

<b><u>Site Acceptance Factors</u></b>				
<b><u>White</u></b>			<b><u>Yellow</u></b>	
Average Measurement	Factor		Average Measurement	Factor
$X \geq 300$	1.0		$X \geq 200$	1.0
$300 > X \geq 290$	0.8		$200 > X \geq 190$	0.8
$290 > X \geq 270$	0.5		$190 > X \geq 180$	0.5
$270 > X \geq 255$	0.3		$180 > X \geq 170$	0.3
$X < 255$	0.0		$X < 170$	0.0

.The variable "X" in the table above represents the calculated average retroreflectivity score for a color at a site.

Randomly selected testing sections may be adjusted at the Engineers discretion when encountering contaminated lines or any other condition affecting line performance beyond the control of the Contractor. However in the event markings are placed after the designated completion date as defined in the Special Notes, no adjustments will be made for damage done by snow plows or other equipment due to winter operations at the time of testing.

For retraced markings on non-paver placed mixes, such as chip seals, the markings shall be inspected and accepted visually by the Engineer.

**Reporting**

The acceptance testing reports by TDOT shall include the following:

- Test date and time;
- Date and time of application of pavement marking (Information taken from the Contractor’s daily work report);
- The location of the measurement;
- The color of line being tested;
- The direction of placement;

- The description of the instrumentation;
- Recorded readings in millicandelas per square meter per lux (mcd/lux/sq m).

**Method of Measurement**

The conditionally accepted quantity of Pavement Markings shall be measured in accordance with Subsection 716.08 of the Standard Specifications for Road and Bridge Construction.

**Basis of Payment**

Conditionally accepted quantities of reflective markings will be paid for at the contract unit price which shall be full compensation for cleaning and preparing the pavement surface, furnishing and placing all materials including labor, tools, equipment, and incidentals necessary to complete the work. Based on the continuance of work by the Contractor within a county all conditionally accepted marking quantities will be paid on the current engineers estimate. A minimum of one marking crew working in a county shall be required to fulfill the continuance of work described above. Following completion of retroreflectivity testing in a county, a Low Performance Deduction will be calculated using the equation below for markings of each color and pay item combination. The sum of the Low Performance Deductions will be deducted from monies due the contractor on the next Engineer's Estimate.

$$\text{Low Performance Deduction (LPD)} = \left[ 1 - \left( \frac{A}{B} \right) \right] * (\text{\#of Line Miles})$$

Where:

A = SUM OF SITE ACCEPTANCE FACTORS BY COLOR

B = TOTAL MEASUREMENT SITES