DMS-4200, Pavement Markers (ReflectORIZED)

Overview

(Formerly D-9-4200, Pavement Markers [ReflectORIZED])

Effective Date: August 1998 – April 2003.

This specification shall govern for the materials, composition, quality, sampling, and testing of pavement markers (reflectORIZED).

Bidders’ and/or Suppliers’ Requirements

All prospective bidders and/or suppliers are notified, that before any material is considered, it shall be of manufacture and product code or designation shown on the list of approved manufacturers of materials covered by this specification and maintained by the General Services Division (GSD) of TxDOT.

Prequalification and Performance History

Prequalification

Manufacturers who desire to prequalify their product should contact the Texas Department of Transportation, Construction Division, Director of Materials & Pavements Section (CP51), 125 East 11th Street, Austin, Texas 78701-2483.

Manufacturers who desire to have a new or redesigned pavement marker evaluated for conformance with this specification shall submit 50 markers of each color and/or type for laboratory testing and evaluation.

Upon successful completion of the laboratory tests and notification of same, the manufacturer shall submit to TxDOT 200 markers of each color and/or type to perform road tests. The road test period will not exceed one year and shall be performed in accordance with ‘Road Test’ of this specification.

All materials for prequalification tests shall be submitted at no cost to TxDOT.

Manufacturers will be notified, after their material has been evaluated, as to conformance with the requirements of this specification.

Material failing to meet any of the specification requirements may be submitted for re-evaluation only after one year has elapsed from the time of the original evaluation request.

This time limit will be waived if the manufacturer submits to CST/M&P documentation from an independent testing facility that the materials meet all the requirements of this specification. If after retesting by CST/M&P, the materials again fail any of the specification
requirements, the one-year time limit will be enforced from the time of the original evaluation request.

TxDOT reserves the right to perform any or all of the tests required by this specification as a check on the tests reported by the manufacturer. In the case of any variance, TxDOT’s tests will govern.

**Performance History**

Some of the tests required by this specification extend over a prolonged period of time. Therefore, testing for acceptance of materials supplied on any contract or state purchase order will only be considered on those materials which are determined by the Director of CST/M&P, to be identifiable as a material having an established performance history of compliance with the criteria established by this specification.

**Re-evaluation**

When, in the opinion of the Director of CST/M&P, changes have been made in the composition and/or manufacturing process of a prequalified material, a re-evaluation of the performance may be required.

TxDOT may conduct additional tests to identify changes in the material. Changes that are detected in composition and/or manufacturing process, which have not been reported by the manufacturer, may be cause for removal of that material from the list of prequalified materials.

**Periodic Evaluation**

TxDOT reserves the right to periodically evaluate the performance of materials.

Samples for periodic evaluation of performance will be selected at random from materials submitted to TxDOT on contracts or direct state purchase orders.

Failure of materials to comply with the requirements of this specification, as a result of periodic evaluation, may be cause for removal of those materials from the list of prequalified materials.

**Sampling and Testing**

**Sampling**

Sampling will be in accordance with Test Method "Tex-729-I, Sampling Traffic Markers."

**Testing**

Testing will be in accordance with the methods listed in 'Material Requirements' of this specification.
All quality monitoring tests will be performed by CST/M&P.

The producer will be responsible for quality control and independent assurance testing.

Material Requirements

This specification covers the general and specific requirements for five (5) types of pavement markers (reflectorized).

All pavement markers (reflectorized) shall meet all requirements of this specification except for specific requirements specified for a specific type.

ReflectORIZED Pavement Marker Types

♦ Type I-A shall contain one (1) face that reflects amber light. The body, other than the reflective face, shall be yellow.
♦ Type I-C shall contain one (1) face that reflects white light. The body, other than the reflective face, shall be white.
♦ Type I-R shall contain one (1) face that reflects red light. The body, other than the reflective face, shall be white.
♦ Type II-A-A shall contain two (2) reflective faces oriented 180 degrees to each other, each of which shall reflect amber light. The body, other than the reflective faces, shall be yellow.
♦ Type II-C-R shall contain two (2) reflective faces oriented 180 degrees to each other, one (1) of which shall reflect white light and one (1) of which shall reflect red light. The body, other than the reflective faces, shall be white.

Appearance Requirements

The outer surface of the pavement marker shall be smooth except for the molding or stamping of the manufacturer’s unique model imprint.

♦ All corners and edges exposed to traffic shall be rounded.
♦ The interface between the reflective face(s) and the body of the marker shall be solid.

The bottom surface of marker(s) shall have a minimum roughness comparable to that of fine sandpaper, but shall not be of such roughness or grooved such that air will be entrapped when pressed into the adhesive.

Optical Requirements

The reflective device(s) shall be capable of providing reflection of amber, red, or white light as required by the requisition or plans.

The reflected light of each reflective face shall conform to the minimum reflective intensity requirements as follows:
### Specific Intensity per Reflective Face at 0.2 Degrees Observation Angle

<table>
<thead>
<tr>
<th>Horizontal Entrance Angle</th>
<th>Crystal</th>
<th>Amber</th>
<th>Red</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 degrees</td>
<td>3.00</td>
<td>2.00</td>
<td>0.75</td>
</tr>
<tr>
<td>20 degrees</td>
<td>1.50</td>
<td>1.00</td>
<td>0.30</td>
</tr>
</tbody>
</table>

Horizontal entrance angle is defined as the angle, in a plane parallel to the base of the marker, between a line in the direction of the incident light and a line perpendicular to the leading edge of the reflective surface.

Observation angle is defined as the angle at the reflector between the observer's line of sight and the direction of the light incident on the traffic button.

Specific intensity shall mean candelas of the returned light at the specified observation and entrance angles for each lux of incident light per reflective face. Test Method "Tex-842-B, Measuring Retroreflectivity," will be used to determine specific intensity.

#### Analysis of Design and Optical Requirements

The lot passes appearance and optical requirements if a combined total of 21 or less nonconformities are recorded. (Nonconformity is a measurement that fails to meet specifications.) It is possible for a marker to have more than one (1) nonconformity. In this case, all the nonconformities for that marker would be counted. If 22 or more nonconformities are recorded then the lot fails.

#### Physical Requirements

When tested in accordance with Test Method "Tex-434-A, Breaking Strength of Traffic Buttons," the minimum strength of five (5) markers shall be 8900 Newtons (2000 pounds) with none exhibiting a deformation of more than 3.18 millimeters (0.125 inch) prior to achieving the minimum strength.

A random sample of five (5) markers will be tested in accordance with Test Method "Tex-434-A, Breaking Strength of Traffic Buttons."

The average compression results shall have a quality index value equal to or greater than 1.23.

The quality index value shall be calculated from the lower specification limit of 8900 Newtons (2000 pounds) load.

The following equation is used to determine the quality index value.

\[ Q_L = \frac{(X - LSL)}{s} \]

Where:

- \( Q_L \) = quality index value
♦ LSL = lower specification limit
♦ X = average result from test
♦ s = standard deviation from test.

The quality index is a measure used to determine the percent within limits (PWL) for a given sample size. The PWL relates the total percent of the normal distribution curve, calculated from the average and standard deviation from the test, which is above or below the specification limit. A quality index value of 1.23 or greater, for a sample size of five (5), corresponds to a PWL of 90 or greater. This means that 90 percent or greater of the normal distribution curve, therefore 90 percent or greater of the lot the sample represents, is above or below the specification limit.

**Heat Resistance**

The marker(s) shall show no change in physical or optical properties when subjected to the requirements of Test Method "Tex-846-B, Testing the Heat Resistance of Reflector Units." The temperature will be 60 °C (140 °F) with the marker in a vertical position.

The specific intensity of the pavement marker shall not be less than 80 percent of its initial value after being subjected to the heat test.

**Adhesion**

A set of five (5) markers will be tested for adhesion strength in accordance with Test Method "Tex-611-J, Adhesion Test for Traffic Buttons, Markers, and Jiggle Bars."

*Note:* Adhesion strength is not required for markers with homogeneous body construction.

**Road Test**

The road test will be performed on a four- (4) lane divided highway with an average-daily-traffic-count of 4000 to 6000 vehicles per lane.

The product will be road tested concurrently with a set of control pavement markers.

The retention rate of the product shall be no less than five (5) percent below that of the control markers.

Markers, which are road tested, shall not exhibit any discoloration or blackening.

The visual performance of the test product shall be equal to or better than the control markers.

The test product’s reflectivity shall be functional when viewed at a minimum distance of 60 meters (approximately 200 feet) at night from a standard sedan automobile using low beam setting of the headlights.
All types shall be functional when viewed at a minimum distance of 120 meters (approximately 400 feet) in the daytime.

After six weeks, 10 nonadjacent samples will be removed from the pavement and tested, unwashed in the laboratory for reflectivity as determined by Test Method "Tex-842-B, Measuring Retroreflectivity." Of the 10 markers pulled, five (5) shall pass the following minimum reflective values (crystal values only based on 0.2-degree observation angle and four-[4] degrees horizontal entrance angle.)

<table>
<thead>
<tr>
<th>Reflective Values for Tiles to Meet Six Week Test Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tile Type</td>
</tr>
<tr>
<td>Low Volume Tile</td>
</tr>
<tr>
<td>High Volume Tile</td>
</tr>
</tbody>
</table>

If the markers do not meet these values, they will be retested, twice within a 12-month period, in the same manner as above.

<table>
<thead>
<tr>
<th>Minimum Values for Samples not Meeting the Six Week Reflectivity Test Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tile Type</td>
</tr>
<tr>
<td>Low Volume Marker</td>
</tr>
<tr>
<td>High Volume Marker</td>
</tr>
</tbody>
</table>

♦ Markers, which meet the six-week values, will be prequalified on a provisional basis pending the results of the six-month retroreflectivity determination.
♦ If the markers meet or exceed the six-month values, they will be prequalified.
♦ If the markers’ six-month reflectivity values are below the minimums, they will be removed from provisional prequalification and will be retested at one year after the initial submission.

Quality Monitoring Program (QMP)

Producer Qualification

Upon passing prequalification, a representative from CST/M&P will inspect the producers’ facilities.

The producer shall show that it has quality control (QC) facilities, which actively participate in the QC of the product as determined by Test Method "Tex-820-B, Accrediting Quality Control (QC) Facilities."

Product Qualification

The product shall then meet the following requirements:
♦ Be of stable design, which means that there have been no substantive design changes (changes in composition or manufacturing process) that might affect the quality of the product

♦ Have been manufactured on a continuous basis for at least six months

♦ Have 10 consecutive lots pass all the 'Material Requirements,' and

♦ Meet the cumulative sample size in the 'Minimum Cumulative Sample Size to Initiate Skip Lot Inspection' table, for the last 10 consecutive lots.

<table>
<thead>
<tr>
<th>Nonconformities or Nonconforming Items</th>
<th>AQL 25.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>2</td>
<td>23</td>
</tr>
<tr>
<td>3</td>
<td>29</td>
</tr>
<tr>
<td>4</td>
<td>34</td>
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<tr>
<td>5</td>
<td>39</td>
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<td>6</td>
<td>44</td>
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<td>7</td>
<td>49</td>
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<td>54</td>
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<td>64</td>
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<td>93</td>
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<td>17</td>
<td>98</td>
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<tr>
<td>18</td>
<td>102</td>
</tr>
<tr>
<td>19</td>
<td>107</td>
</tr>
<tr>
<td>20</td>
<td>112</td>
</tr>
<tr>
<td>Each Additional</td>
<td>+ 5</td>
</tr>
</tbody>
</table>

The last two (2) lots each shall have 17 or less nonconformities. The minimum cumulative sample size is determined by adding the combined number of nonconformities of the last 10 lots and cross-referencing that number to the Acceptable Quality Level (AQL) of 25. For example, if the total combined number of nonconformities for the last 10 lots were 20 then the minimum cumulative sample size required to initiate quality monitoring would be 112 samples. If any of these requirements are not met then the product cannot be placed on the QMP.
**Sampling Frequencies**

If the product took more than 20 lots to qualify for the QMP, then the initial sampling frequency will be one (1) in five (5) lots.

If the product qualified within 20 lots, then the sampling frequency will be determined by the following:

<table>
<thead>
<tr>
<th>Products Qualifying within 20 Lots Sampling Frequency</th>
<th>If . . .</th>
<th>Then . . .</th>
</tr>
</thead>
<tbody>
<tr>
<td>Each of the lots had 17 or less total nonconformities,</td>
<td>the sampling frequency will be one (1) in 20 lots.</td>
<td></td>
</tr>
<tr>
<td>The number of nonconformities for each lot were</td>
<td>the sampling frequency will be one (1) in 10 lots.</td>
<td></td>
</tr>
<tr>
<td>more than 17, but less than 22,</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The sampling frequency will move to the next lowest level by meeting the following conditions:
- The preceding 10 inspected lots are accepted
- The cumulative results from the preceding 10 lots satisfy the ANSI/ASQC table above
- Each of the last two (2) inspected lots had 17 or less nonconformities, and
- The lowering of the frequency is approved by the Director of CST/M&P.

A minimum of two (2) check samples, within a 12-month period, will be taken by CST/M&P.

**Probation and Disqualification**

Once on the QMP, if an inspected lot does not meet any of the 'Material Requirements,' then the product will be placed on probation. During probation, all lots will be inspected. Skip-lot inspection will be reinstated if four (4) consecutive lots meet all the 'Material Requirements' of this specification.

If any of the following conditions are met then the product will be disqualified from the QMP:
- A lot is rejected during probation
- Requalification is not achieved within 10 lots
- There is no production activity for two months (this requirement may be waived by the Director of CST/M&P)
- The supplier deviates from supplier qualifications or product qualifications
- The Director of CST/M&P decides to return to lot by lot inspection.

**Requalification**
Material disqualified from the QMP may be submitted for requalification only after one year has elapsed from the time of disqualification.

To requalify, the material shall pass the prequalification and qualification phases again.