

## DMS-8300, Flat Surface Reflective Sheeting

### Overview

Effective Date: February 2003 – April 2003.

This specification governs for the materials, composition, quality, sampling, and testing of five (5) types of flat-surface, reflective sheeting.

- ◆ Type A, engineer-grade
- ◆ Type B, super engineer-grade
- ◆ Type C, high specific intensity (typically glass beads)
- ◆ Type D, super high specific intensity (nonfluorescent prismatic)
- ◆ Type E, super high specific intensity (fluorescent prismatic).

### Manufacturers' and/or Suppliers' Requirements

At TxDOT's request, furnish satisfactory evidence of the ability to furnish the product(s) in accordance with the terms and conditions of this specification. TxDOT reserves the right to make the final determination as to the material supplier's ability.

Pending Problem Resolution - Prospective material supplier or bidder with unresolved pending issues may not be considered for award in connection with any advertisement in connection with this specification unless the item being offered is significantly different.

### Prequalification and Performance History

#### *Prequalification Requirements and Restrictions*

Only products listed by manufacturer and product code or designation shown on the TxDOT Prequalified Products List (QPL) maintained by the General Services Division (GSD) will be considered for purchase in connection with this specification. Find the GSD QPL using the following URL: <http://www.dot.state.tx.us/gsd/purchasing/supps.htm>

Under the heading "Prequalified Products List," click on the specification number associated with the QPL covered by this specification.

Bidders wishing to have their product(s) considered for future advertisements should contact the Texas Department of Transportation, General Services Division Director, 125 E. 11<sup>th</sup> Street, Austin, TX 78701-2483.

## **Establishment of Performance History**

Submit all materials for prequalification tests at no cost to TxDOT.

TxDOT may grant provisional approval after successful completion of the accelerated weathering requirements. TxDOT may also grant provisional approval for material that has undergone a full evaluation by AASHTO's National Transportation Product Evaluation Program and whose test results meet the minimum durability values required by this specification. Full prequalification will be granted after successful completion of the exterior exposure requirements. Failure to complete successfully all exterior exposure requirements is grounds for cancellation of provisional approval.

Material failing to meet any of the specification requirements may be resubmitted for re-evaluation only after the submitter has offered a reasonable explanation for the failure and evidence that the cause of the failure has been identified and, in the opinion of the Director of CST/M&P, sufficiently corrected to ensure conformance with the specification in the future.

### ***Performance History***

Some tests required by this specification extend over a prolonged period and some tests cannot be made after the material is applied. Therefore, for acceptance of materials supplied on any contract or state purchase order, TxDOT will only test materials having a satisfactory performance history of compliance with this specification. The Director of CST/M&P determines what constitutes a satisfactory performance history.

### ***Re-evaluation***

Report changes in the composition, and/or manufacturing process, or both of any material to CST/M&P.

Significant changes reported by the manufacturer, as determined by the Director of CST/M&P, require a re-evaluation of performance.

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

### ***Periodic Evaluation***

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

TxDOT will select samples, at random, from materials submitted to TxDOT on contracts or purchase orders, for periodic evaluation of performance.

Failure of materials to comply with the requirements of this specification resulting from periodic evaluation, may be cause for removal of those materials from the QPL for reflective sheeting materials.

### **Comprehensive Manufacturer’s Warranty Requirements**

Comply with all requirements of the following warranty. Failure to comply with the requirements of this warranty may be cause for removal from the QPL.

Submit, in writing, to the address shown under ‘Prequalification and Performance History,’ a statement that the manufacturer understands the provisions of the warranty and will abide by the provisions. Include the name, address and telephone number of the person to contact regarding potential claims under the warranty provisions.

The warranty shall also warrant the use of one manufacturer’s reflective sheeting directly applied to a different manufacturer’s reflective sheeting. If a failure occurs, the manufacturer of the sheeting that fails will be responsible for the failure. (i.e., If the sheeting separates from the substrate, the manufacturer of the sheeting, which is attached to the substrate, will be responsible. If sheeting used for legend loses adherence to the sheeting attached to the substrate, the manufacturer of the legend material will be responsible).

Comply with the following warranty components.

#### ***Certification***

Submit a certification with each lot or shipment, which states that the material supplied will meet the requirements listed.

Show individual lot numbers on the certification.

#### ***Field Performance Requirements***

Reflective sheeting, processed and applied according to the sheeting manufacturer’s recommendations (or as specified in this specification when there is an exception to the manufacturer’s recommendations), shall perform satisfactorily for the number of years stated in Minimum Performance Period under ‘Comprehensive Manufacturer’s Warranty Requirements’ for that type.

Sheeting Failure - The sheeting shall be considered unsatisfactory if it has deteriorated due to natural causes (precluding unnatural causes such as vehicle impact or vandalism), to the extent that the sign is ineffective for its intended purpose, when viewed from a moving vehicle under normal day and night driving conditions or shows any of the following defects:

- ◆ Cracks discernible with the unaided eye from the driver’s position while in an outside lane at a distance of 15 meters (50 feet) or greater from the sign
- ◆ Peeling in excess of 6.4 millimeters (1/4 inch)
- ◆ Shrinkage in excess of 3.2 millimeters (1/8 inch) total per 1.2 meters (48 inches) of sheeting width

- ◆ Fading or loss of color to the extent that color fails to meet the requirements in ASTM D 4956, "Standard Specification for Retroreflective Sheeting for Traffic Control," latest revision.
- ◆ Loss of reflectivity to a level below 40% (20% for Types C, D and E sheeting) of the minimum values specified in ASTM D 4956 or in this specification for new sheeting when measured at the angles specified for each type.

The sheeting manufacturer shall:

- ◆ Provide manuals, training videos, or both, to the applicators describing the proper application method
- ◆ Submit a copy of the current training materials provided (and any updates as they occur) to GSD at the address shown in the 'Prequalification and Performance History' section.

### ***Minimum Performance Period***

All signs, except construction and maintenance work signs and barricades, shall meet the following minimum performance periods:

- ◆ Type A – three years
- ◆ Types B, C, and D – seven years plus three additional years with obligation for sheeting replacement only
- ◆ Type E – five years plus two additional years with obligation for sheeting replacement only.

### ***Sheeting Manufacturer's Replacement Obligation***

Where and when it can be shown that retroreflective traffic signs processed in accordance with the sheeting manufacturer's recommendations (or as specified in this specification when there is an exception to the manufacturer's recommendations) have not met the field performance requirements above, the sheeting manufacturer shall cover the costs of replacement of the sign on the roadway or of restoring the sign surface to its original effectiveness as determined by TxDOT and at no cost to TxDOT for materials or labor. The replacement sheeting shall be the same type of sheeting originally specified, meet all the requirements of this specification, and be prequalified by TxDOT.

The sheeting manufacturer shall schedule with designated TxDOT personnel, within 30 days of notification of potential replacement obligation, an on-site investigation to determine if the sheeting manufacturer's obligation exists.

The sheeting manufacturer shall fulfill all obligations within 120 days after determination of obligations is made. Any obligations not completed within 120 days shall (at the discretion of TxDOT) be performed by TxDOT, and the manufacturer shall be billed for all TxDOT costs in performing the manufacturer's obligation.

When, in the judgment of TxDOT, a deteriorated sign(s) presents a traffic hazard, TxDOT reserves the right to remove the sign(s) from the roadway and place said sign(s) in storage for the manufacturer's inspection. When inspection reveals that the manufacturer is obligated for the sign(s), the manufacturer shall reimburse TxDOT for all costs including labor for removing and replacing the sign(s).

To fulfill obligations to replace or refurbish signs on the roadway, use an independent Contractor.

Terms of the contract shall be according to provisions of contracts used by TxDOT for this type work, be approved by TxDOT, and save harmless TxDOT from any liability that may arise out of the contractor's operations.

TxDOT can provide a sample contract to the sheeting manufacturer upon the sheeting manufacturer's request.

TxDOT reserves the right to place a representative on the job to ensure that signs are replaced or refurbished in accordance with TxDOT standards.

All signs or sign faces used to fulfill the sheeting manufacturer's obligations will be tested by TxDOT to ensure compliance with this specification.

The sheeting manufacturer shall be liable for failures experienced with their sheeting or with the inks or transparent films used as recommended (or as specified in this specification when there is an exception to the manufacturer's recommendations) by the sheeting manufacturer with their sheeting.

### ***TxDOT's Obligation***

TxDOT shall be obligated to:

- ◆ ensure that all signs are dated at the time reflective sheeting is applied to the substrate,
- ◆ date the sign when placed on the roadway by TxDOT personnel, and
- ◆ store and ship all signs according to the manufacturer's recommendations or generally accepted practices for storing and shipping of these materials.

The field-performance obligation-period shall begin with the placement on the roadway or the application to the substrate date, plus four months, whichever is earliest.

### ***Sign Processors' Obligations***

The sign processor shall submit the following with each shipment of signs or sign faces:

- ◆ a TxDOT contract or purchase order number, and
- ◆ a copy of the certification, as required in 'Certification' under the 'Comprehensive Manufacturer's Warranty Requirements' section, showing the lot number of the sheeting from which the completed signs or sign faces were processed.

## Sampling and Testing

Sampling and testing will be in accordance with CST/M&P's *Manual of Testing Procedures*.

Costs of sampling and testing are normally borne by TxDOT; however, the cost of sampling and testing of materials failing to conform to the requirements of this specification shall be borne by the contractor or supplier.

Costs of sampling and testing of failing material shall be \$250 per sample unless otherwise indicated on a purchase order or in the contract plans.

Amounts due TxDOT for conducting such tests will be deducted from monthly or final estimates on contracts or from partial or final payments on direct purchase orders by the State.

## Material Requirements for Reflective Sheeting

### *General Requirements*

This specification covers the general and specific requirements for five (5) types of reflective sheeting materials: Types A, B, C, D, and E. Designation of a sheeting for construction application will be reviewed and pre-approved by CST/M&P.

All types of reflective sheeting materials shall meet all the requirements of ASTM D 4956 specification except when other specific requirements are shown for a particular type of reflective sheeting material or exceptions are indicated in this specification. TxDOT conducts outdoor weathering shall be conducted at TxDOT's test site in Austin, Texas or at other locations as deemed necessary by the Director of CST/M&P.

In addition, all sheeting types shall meet the supplementary requirements specified in ASTM D 4956 supplementary requirement S3, "Artificial Accelerated Weathering." All nonconstruction zone application-types not listed in Table S3.1 will be tested for 2200 hours and shall meet a minimum of 80% of the minimum specified initial retroreflectivity values for that type after accelerated weathering. All construction zone application-types not listed in Table S3.1 will be tested for 500 hours and shall meet a minimum of 60% of the minimum specified initial retroreflectivity values for that type after accelerated weathering.

The manufacturer may fabricate identification marks to denote type of sheeting in or on the face of sheeting. When used, the marking shall be inconspicuously placed on 100 to 300 millimeter (four [4] to 12-inch) centers and visible from a distance of not more than nine (9) meters (30 feet) or in a manner pre-approved by the Director of CST/M&P. The sheeting manufacturer shall furnish identification codes to TxDOT.

- ◆ Type A sheeting shall meet the requirements of ASTM D 4956, Type I.
- ◆ Type B sheeting shall meet the requirements of ASTM D 4956, Type II.
- ◆ Type C sheeting shall meet the requirements of ASTM D 4956, Type III or IV.

- ◆ Type D sheeting shall meet the requirements of ASTM D 4956, Type VII, VIII, or IX.
- ◆ Type E sheeting shall meet the requirements for fluorescent sheeting listed below. If specification requirements are added to the ASTM D 4956 specification for one or more colors and types in a future revision, then that sheeting will be required to meet the revised ASTM D 4956 specification.

### ***Film Characteristics***

- ◆ Tensile Strength and Elongation (Type A and B only)
  - The tensile strength shall not be less than 25 Newtons (five [5]-pounds-force) per 25.4 millimeters (one [1] inch) of width.
  - The elongation shall be greater than 5%.
  - Tensile strength and elongation shall be tested according to ASTM D 882.
- ◆ Workability
  - The integrity of the film shall be such that when the sheeting or a completed sign face is trimmed (in the normal manner) to match the sign substrate, the film shall not crack, flake, nor chip on the sign panel or sign face side of the trim line.
- ◆ Temperature Stability
  - At any combination of temperatures from 10 to 38°C (50 to 100°F) and relative humidity from 20% to 90%, the sheeting shall permit cutting, application, and color processing.
  - Unapplied sheeting shall permit heat curing of process inks at temperatures up to 93 °C (200 °F), unless otherwise recommended by the sheeting manufacturer and so stated in their technical literature.
- ◆ Chemical Resistance
  - The surface of the sheeting or the face of a completed sign shall be chemically resistant to the extent that there will be no surface change when wiped with a soft, clean cloth dampened with mild detergents or cleaners supplied by or recommended by the sheeting manufacturer.

### ***Adhesive***

Precoat the backside of the reflective sheeting with either a heat-activated or a pressure-sensitive adhesive. No additional coats of adhesive shall be required to affix the reflective sheeting to the sign blank. The adhesive and liner when used shall meet the requirements of ASTM D 4956.

Suppliers of reflective sheeting, using a porous, textured backing paper to protect the adhesive layer which is not suitable for use as a slip-sheet for packaging of completed signs, sign panels, or both, shall supply rolls of slip sheet paper in the various widths of reflective sheeting supplied. The area of slip-sheet paper, supplied in the various widths, shall be the same as the area of reflective sheeting supplied in the various widths. Slip-sheet paper

supplied shall be considered as subsidiary to the reflective sheeting and any costs, direct or indirect, shall be included in the bid price for reflective sheeting on state purchases.

- ◆ Stain Resistance
  - The adhesive shall have no staining effect on the reflective sheeting.

### ***Color***

- ◆ Reflected Night Color
  - The reflected night color shall be identifiable as the same color as the day color when observed at 15 meters (50 feet).
  - The reflected night color shall be uniform and free of streaks, mars, and other imperfections.

### ***Optical Performance***

- ◆ Coefficient of Retroreflection
  - Before exposure, sheeting reverse screened with transparent ink, shall have the minimum values specified in ASTM D 4956.
- ◆ Tests
  - Coefficient of retroreflection will be determined according to Test Method "Tex-842-B, Measuring Retroreflectivity."

### ***Material Identification***

Each container, carton, or box containing reflective sheeting shall be marked with the information listed in ASTM D 4956.

The identification number(s) shall also appear on the inside of the sheeting roll core.

The number(s) on the box's outside and on the core's inside shall match. The mismatch of these numbers can and may be cause for rejection.

### ***Fluorescent Sheeting***

Type E fluorescent sheeting shall meet the minimum coefficient of retroreflection values listed in Table I. Each color shall meet the International Committee on Illumination (CIE) color specification limits listed in Table II when measured in the same manner as indicated in ASTM 4956 for nonfluorescent sheeting. Each color shall also meet the values indicated below for Fluorescent Test I or Fluorescent Test II.

- ◆ Table I

<b>Type E Fluorescent Sheeting Minimum Coefficient of Retroreflection: cd/(lx m<sup>2</sup>)</b>			
<b>Observation / Entrance Angle/(Degrees)</b>	<b>Orange</b>	<b>Yellow</b>	<b>Yellow/Green</b>
0.2 / -4	180	220	360
0.2 / 30	85	125	205

0.5 / -4	60	145	235
0.5 / 30	30	75	110

## ◆ Table II

Initial Daytime Fluorescent Color Specification Limits and Minimum Luminance Factors (Y min)										
Color	1		2		3		4		Luminance Y min	
	x	y	x	y	x	y	x	y		
Orange	0.583	0.418	0.516	0.397	0.560	0.341	0.655	0.345	20	
Yellow	0.498	0.412	0.557	0.442	0.479	0.520	0.438	0.472	40	
Yellow / Green	0.387	0.610	0.460	0.540	0.421	0.486	0.368	0.539	60	

## Fluorescent Test I

The fluorescent sheeting shall be measured instrumentally using a bispectral (2-monochromator) spectrophotometer employing annular 45/0 (or equivalent 0/45) illuminating and viewing geometry. The fluorescence luminance factor ( $Y_f$ ) shall be calculated from the fluorescence spectral radiance factors computed for CIE illuminant D 65 in accordance with ASTM E 308, ASTM E 2152, and ASTM E 2153. The sheeting shall meet the following values for the life of the sheeting:

- ◆ Color:  $Y_f$  (%) (minimum)
- ◆ Orange: 17
- ◆ Yellow: 25
- ◆ Yellow/Green: 35

## Fluorescent Test II

The fluorescence sheeting shall be measured to determine the Total Luminance Factor ( $Y\%$ ) and the color chromaticity coordinates ( $x$ ,  $y$ ). The MacAdam limit luminance factor ( $Y_m$ ) shall be computed using the equations described below. Color measurements will be made using Illuminant D 65 and in accordance with ASTM D 4956. The Luminance Factor shall be greater than 70% of the MacAdam limit for the life of the sheeting.

For fluorescent yellow chromaticities:

$$Y_m = 110 - 223x + 155y$$

$$Y\% > 0.70 \times Y_m$$

For fluorescent yellow-green chromaticities:

$$\text{When } y < 0.53 \quad Y_m = 133 - 99x + 4y$$

$$\text{When } y \geq 0.53 \quad Y_m = 308 - 99x - 326y$$

$$Y\% > 0.70 \times Ym$$

For fluorescent orange chromaticities:

$$Ym = 70 - 164x + 175y$$

$$Y\% > 0.70 \times Ym$$

## **Material Requirements for Screen Inks**

### ***General Requirements***

Screen inks shall be a material specifically formulated for use as screen ink for screening sign faces and/or legends on the various types of reflective sheeting, as specified elsewhere in this specification.

### ***Color***

Screen inks, when screened onto any approved white reflective sheeting, shall produce a color within the color requirements specified for the various colors of reflective sheeting in ASTM D 4956.

The screen inks shall be used as supplied or thinned according to the manufacturer's recommendations.

The screen used shall be of the type recommended by the manufacturer.

Color will be determined by using ink from sealed, unopened containers as received from the manufacturer.

### ***Transparency***

Black screen ink, when applied on white sheeting, shall be completely opaque. All other colors, when screened onto white sheeting according to the manufacturer's recommendation, shall meet the contrast ratio requirements as specified in the 'Sign Faces and Completed Signs' section.

### ***Durability***

Screen inks, recommended by the ink manufacturer for use on the various types of reflective sheeting, shall exhibit the same durability as specified for that type of reflective sheeting.

When tested according to Federal Test Method 6301, "Adhesion (Wet) Tape Test," no process inks shall be removed after processing a minimum of 96 hours or exposure of the various sheeting types of sheeting to durability and weathering tests specified.

## **Material Requirements, Colored, Transparent Films**

### ***General Requirements***

Colored, transparent films shall consist of durable, electronically cuttable films coated with a transparent, pressure-sensitive adhesive protected by a removable liner.

The films are designed to be cut on knife-over-roll (sprocket-fed or friction-fed) and flat bed electronic cutting machines. The films shall be:

- ◆ available in standard traffic colors,
- ◆ dimensionally stable, and
- ◆ designed optimally to cut, weed, lift, and transfer.

The use of colored, transparent films shall not require the release of any volatile, organic compounds.

### ***Color***

When applied to retroreflective sheeting, the resulting color shall fall within the color requirements specified for the various colors of reflective sheeting in ASTM D 4956.

### ***Coefficient of Retroreflection***

When applied to retroreflective sheeting, the resulting coefficient of retroreflection reading shall have the minimum values as shown in ASTM D 4956.

Coefficient of retroreflection will be determined according to Test Method "Tex-842-B, Measuring Retroreflectivity."

### ***Adhesion***

Adhesion shall meet the requirements and test described in ASTM D 4956.

### ***Durability***

Colored, transparent films, when applied to the various types of reflective sheeting, shall meet the same durability requirements as specified for that type of reflective sheeting.

## **Sign Faces and Completed Signs**

For all sign faces and completed signs using transparent screen inks or transparent films, the "Contrast Ratio" is the quotient obtained when the coefficient of retroreflection of the white is divided by the coefficient of retroreflection of the other color.

The contrast ratio will be determined at an observation angle of 0.2 degree and an entrance angle of -4 degrees.

For all signs which use reflectorized white and red, the contrast ratio shall not be less than 4.0 nor greater than 15.0.

For all other signs, sign panels, sign faces, and traffic control devices the contrast ratio shall not be less than 2.0.

### **Packaging**

The materials shall be packaged in containers that will permit normal shipping and storage without the material sustaining damage or becoming difficult to apply.

Roll material shall contain no more than three (3) splices per 46 meters (50 yards). The length of the roll core shall not be less than the width of the material.

- ◆ Pressure-Sensitive Material
  - The ends of the material shall be cut square with an overlap splice of  $9.5 \pm 3.2$  millimeters ( $3/8 \pm 1/8$  inch in width).
  - Edges of the overlap splice are to be straight and square.
- ◆ Heat-Activated Material
  - The ends of the material shall be cut square but jointed closely together and held securely in place with a removable tape.

### **Archived Versions**

Archived versions of “DMS-8300, Flat Surface Reflective Sheeting” are available through the following links:

- ◆ Click on [8300-898](#) for the specification effective August 1998 through December 2001.
- ◆ Click on [8300-0102](#) for the specification effective January 2002 through January 2003.