EXHIBIT E

SPECIFICATIONS

2007

FOR: SPECIFICATIONS FOR ROLL MATERIAL, TYPES III&IV, VII AND IX.

Specification No._____ Requisition No._____ Quotation No._____

Make _____ Model _____

Vendor:_____ Bid Prepared By:_____

Address:_____ Phone: _____

Specification Written By: M. Villanueva Approved By:_____ Approved By: R. Scharf

NOTICE: Bidder shall complete right-hand column, indicating specific size and/or make and model of all components when not exactly as specified. State "As Specified" if item is exactly as shown in left column. Return this questionnaire to the Los Angeles County Purchasing Agent.

CONTENTS:

PAGE 49 HAS BEEN DELETED FROM THE SPECIFICATIONS

I SCOPE

These specifications cover sign sundries including nonreflective vinyl film and electronic cuttable film material, ASTM Types III & IV and ASTM Type IX reflective material, and miscellaneous rolled material used in the fabrication of signs required by the County of Los Angeles, Department of Public Works during the contract period, which are to be delivered when and as requested.

II GENERAL

1. Rolled Goods

1. Rolled goods of nonreflective vinyl film, electronic cuttable colored film and premium protective overlay film with pressure sensitive adhesive. Shall be available in widths of 2", 6", 9", 12", 18", 24", 30", 36", 48", and in 50 yards lengths.

2. Rolled goods of ASTM Type III & IV, VII and ASTM Type IX retroreflective sheeting with pressure sensitive adhesive. Shall be available in widths of 2", 6", 9", 12", 18", 24", 30", 36", 48", and in 50 yards lengths.

III REFLECTIVE SHEETING AND NONREFLECTIVE FILM

1. Nonreflective vinyl film shall be durable and glossy. Film shall include a precoated pressure sensitive adhesive with a premask material to stiffen film to aid in application without additional adhesive on either the film or application surface, form a secure bond when applied according to manufacturer's recommendations. Any liner necessary to keep the adhesive clean or from sticking prior to application shall be removable by peeling without soaking in water or solvent.

2. Electronic cuttable film is a durable, transparent, colored film coated with a transparent, pressure sensitive adhesive that is protected by a removable

clear liner. To be used over ASTM Type III & IV, ASTM Type VII, ASTM Type IX, and nonreflective sheeting. The adhesive used to bond the sheeting to the aluminum base shall have no staining effect and shall be mildew resistant. The clear liner, which is necessary to keep the adhesive clean or from sticking prior to application, shall be removable by peeling without the necessity of soaking in water or other solvent. The sheeting surface shall be solvent resistant to gasoline, VM&P naptha, mineral spirits, turpentine and methanol. In addition, to create a graffiti protective coating, the sheeting must have the qualities to embrace a 3M Type 1160, scotch graphic overlay film (film thickness .0015"-.004"); a protective coating similar to Aragon Coating or its equivalent without diminishing appreciatively, the durability and reflectivity features of the sheeting.

3. Premium protective overlay film is a high performance, durable, solvent resistant, transparent, fluoropolymer film coated with a transparent pressure sensitive adhesive. The adhesive is protected by an easy removable, paper liner. The overlay film shall be resistant to spray paints, lipstick, permanent pen, eggs, and stickers. Overlay film shall perform effectively provided that application and maintenance is followed in accordance to the manufacturer's recommendations.

   Premium overlay film is considered unsatisfactory if it has deteriorated due to natural causes to the extent that (1) the sign is ineffective for its intended purpose when viewed from a moving vehicle under normal day and night driving conditions; or (2) the reflective intensity is less than the minimums specified by the retroreflective sheeting grade type. All measurement shall be made after sign cleaning according to the manufacturer's recommendations.

4. ASTM Type III & IV reflective sheeting, see attachment A.

5. ASTM Type VII reflective sheeting:

   1 ASTM Type VII Fluorescent orange, see attachment B.

2. ASTM Type IX Fluorescent yellow and Fluorescent yellow green, see attachment C.

3. ASTM Type IX non fluorescent colors, (white, yellow, red, blue, green), see attachment D.

IV TEST METHODS AND INSPECTION

1. All materials are subject to inspection and release at the place of manufacture, and shall be subject to final inspection at the Department warehouse after delivery. Test panels, 12"x12", representative of any stage of production shall be furnished on request of the Department inspector. These panels shall be processed along with the regular production run and witnessed by the inspector.

   All surfaces exposed to weathering shall be free of blemishes in the coating that may impair the serviceability or detract from the general appearance and color matching of the sign material with any defects or damage that would affect appearance or serviceability will not be acceptable. No repairs shall be made to the face sheet without the approval of the inspector. All material not conforming in all respects to the requirements of these specifications will be rejected.

   The vendor shall present proof that the type of reflective sheeting intended for use in the manufacture of signs has been used on California highway roadway signs for a minimum period of three years. The condition of the sheeting after three years' exposure shall be such as to furnish assurance that the material will provide satisfactory signs in various weathering conditions expected in Los Angeles County for an expected service life of five to ten years. Experimental sign installations involving adequate quantities in various environments and/or the documented satisfactory experience of major user agencies responsible for highway signing in the United States may be used as qualifying experience to fulfill the above-mentioned three-year satisfactory performance requirements.

   Reflective sheetings, processed, applied to approved sign base materials, and cleaned, in accordance with manufacturer's recommendations for their use on

traffic control signs, shall be considered as performing satisfactorily if (1) the sheetings have not deteriorated due to natural causes, (2) the sign is effective for its intended purpose when viewed from a vehicle during daylight and nighttime under low beam headlamp illumination, (3) the diffuse day color conforms to the requirements set forth in ASTM D4956, and (4) the condition of the reflective materials are such as to perform satisfactorily for expected service life.

Qualification: Sheeting shall meet the requirements set forth in the current issue of ASTM D4956 and listed in the current issue of the "Prequalified Product List" issued by the State of California.

To ensure on-going quality, the manufacturer shall have on file with the Department a copy of their current Certificate of Registration, issued by an accredited registrar, confirming compliance of the manufacturer's quality system to the requirements of ISO 9001:2000, ANSI/ASQC Q9001-2000 or an equivalent quality standard. The scope of the registration shall include the material specified herein and the location from which that material is supplied.

V. DELIVERY

1. Delivery shall be within 15 days of receipt of order, except in the case of rush orders which shall be delivered within 3 days of receipt of order. Rush orders shall be limited to standard widths, colors and sizes.

2. Packaging of materials must be in accordance with the manufacturers recommendation .

VI. AWARD OF CONTRACT

To maximize the performance of the sheeting delivered under this contract, the Vendor shall provide all sheetings using matching components recommended, tested, and warranted by the sign sheeting manufacturer. These components include:

1. Surface Treatments (protective overlays & coatings)
2. Imaging Systems (process inks & electro-cut films)
3. Reflective Sheeting (ASTM Type III & IV, ASTM Type VII, and ASTM Type IX)

VII. PATENTS

The Contractor shall assume all costs arising from the use of patented materials, equipment, devices or processes used on or incorporated in the work, and agrees to indemnify and save harmless the County of Los Angeles, Department of Public Works, The Director of Public Works, the Traffic Engineer, and their duly authorized representatives from all suits at law, or action or every nature for, or on account of the use of any patented materials, equipment, devices or processes.

VIII. Technical Assistance Requirements

Instruction and Training

The manufacturer supplying the sheeting requirements shall provide the services of a qualified technician for instruction and training at the primary sign manufacturing facility. This instruction shall be available on a quarterly basis at no additional cost, and shall include but not be limited to, training films, material application, equipment operation, silk screening techniques, packaging, storage and other proven sign shop practices as they apply to the reflective sheeting supplied by the manufacturer, and to assure that the resulting signs can comply with the applicable specifications.

Additional on-site technical assistance by the manufacturer supplying the retroreflective sheeting shall be provided at each of the sign shops designated in the bid invitation. This assistance will be provided at least once during each quarter of sign production, if required.

Equipment

The manufacturer supplying the retroreflective sheeting requirements shall provide sheeting application equipment and service for sheeting application equipment of their manufacture, certify that trained personnel will be available on 72 hours notice to render such service, and shall stock authorized parts for their sheeting application equipment. "Service" is understood to mean the capability of calibration and trouble shooting, as well as the training and retraining of personnel as required.

IX. SUBSTITUTION

In the event vendor is unable to furnish brand specified, and an emergency arises, it is understood that vendor will make substitution on equivalent brand. Subject to acceptance by the County Department of Public Works, at no increase in cost to the County of Los Angeles Department of Public Works.

ATTACHMENT A
SPECIFICATION FOR ASTM TYPE III & IV
RETROREFLECTIVE SHEETING

1.0 Scope

This specification covers flexible white or colored, prismatic retroreflective sheeting (hereinafter called sheeting), and related processing materials designed to enhance nighttime visibility of traffic control signs and objects. The sheeting shall consist of cube corner prismatic optics encapsulated by a flexible transparent plastic film that has a smooth outer surface. The sheeting shall have a precoated adhesive protected by an easily removable liner.

The sheeting shall be part of a family of products required for the manufacture and imaging of traffic control signs as described in section 4. Imaged (printed or overlain) areas of signs are covered only by section 2.0, section 6.2, Table 1, section 6.3 and Table 2.

2.0 Prequalification and Performance History

Materials shall be considered for use only when, in the opinion of the agency, sufficient evidence exists to ensure that the materials and services offered can reliably conform to this specification. The sheeting manufacturer shall provide evidence of performance and suitability for use in accordance with the Agency's Qualified Products Procedures

3.0 Classification and Conformance

The sheeting shall meet the performance requirements contained in *all* of the standards and specifications listed below, as modified herein. The sheeting need not conform to any construction or composition limitations included in the reference specifications; and the retroreflectance measurements shall be limited to observation angles less than 2.0°.

AASHTO M 268 Type III and Type IV
AS/NZ 1906.1 Class 1
ASTM D 4956 Type III and Type IV
BS 873 Class 1
CGSB 62-GP-11 Type 1
DIN 67520 Type 2
EN 12899-1 Class 2
FP-03 Type III and Type IV
GB/T 18833 Class 3
JT/T 279 Class 3
NBR 14644 Type II
NTC 4739 Type III and IV
SABS 1519.1 Class III

3.1 The adhesive shall be a pressure-sensitive adhesive of the aggressive tack type requiring no heat, solvent or other preparation for adhesion to smooth, clean surfaces when properly applied at temperatures above 50°F. For application to rough surfaces, a surface primer may be required.

4.0 Imaging Systems

4.1 Process Inks

4.1.1 The manufacturer of the sheeting being offered shall furnish at no additional cost the process inks in standard traffic colors, and thinners recommended for the sheeting to meet the performance requirements of this specification.

4.1.2 The process colors shall be a single line of traffic colors which may be applied before and after the sheeting is applied to a substrate; require no component premixing; and will air dry for packing in 4 hours or less and requires no clear coating.

4.2 Overlay Films: The sheeting manufacturer shall also manufacture colored imaging films and clear protective

overlays, which are compatible with the sheetings, and when used in accordance with the sheeting manufacturer's instructions shall not lessen the warranty term as described in section 7.2.

5.0 Test Panels and Test Conditions

Unless otherwise specified herein, when tests are to be performed using test panels, the specimens shall be applied to smooth aluminum 0.020 in. (0.508 mm), 0.040 in. (1.016 mm) or 0.063 in. (1.600 mm) in thickness cut from Alloy 6061-T6 or 5052-H38. The aluminum shall be degreased and lightly acid etched before the specimens are applied. Unless otherwise specified, all test samples shall be conditioned for 24 hours prior to testing and all tests shall be conducted at a temperature of 73 ± 3°F (23 ± 2°C) and 50 ± 5 % relative humidity.

6.0 Material Requirements

6.1 Color Requirements: Color shall be as specified and shall conform to the requirements for standard highway colors as defined all the standards and specifications listed in section 3.0 above.

6.2 Coefficient of Retroreflection: The coefficients of retroreflection shall be determined in accordance with ASTM E-810, for the minimum requirements of Table 1, as specified.

6.2.1.1 Units: Coefficients of retroreflection shall be specified in units of candelas per lux per square meter. The observation angles shall range from 0.2° to 1.0°. The entrance angles shall range from –4° to 40°.

6.2.1.2 For screen printed transparent colored areas on white sheeting, the coefficients of retroreflection shall not be less than 70% of the values for corresponding color in

the above table. Standard traffic colors not available in integrally colored sheeting may be produced using acrylic overlay films.

6.3 Color Processing: The retroreflective sheeting shall be designed to work in concert with recommended imaging systems. Color processing with compatible transparent and opaque process colors shall be possible in accordance with the sheeting manufacturer's recommendation at temperatures of 66 to 100°F (16 to 38°C) and relative humidity of 20 to 80%. The sheeting shall be heat resistant and permit force curing without staining of applied or unapplied sheeting at temperatures recommended by the sheeting manufacturer.

6.4 Flexibility: The reflective sheeting shall be sufficiently flexible to show no cracking during application to substrates in accordance with the manufacturer's instructions.

6.5 Adhesion: The retroreflective sheeting shall comply with the liner removal and adhesion requirements contained in the standards and specifications listed in section 3.0.

6.6 Impact Resistance: The retroreflective sheeting shall comply with the impact resistance requirements contained in the standards and specifications listed in section 3.0.

6.7 Resistance to Accelerated Weathering: The retroreflective sheeting shall comply with the weathering resistance requirements contained in the standards and specifications listed in section 3.0.

6.8 Resistance to Heat, Cold and Humidity: Three samples of retroreflective sheeting, 3 x 6 inch, applied to test panels in accordance with section 5.0 above, shall be exposed as follows:

6.8.1 Heat: One specimen shall be placed in an oven at 160°F ± 5°F (71° C ± 3° C) for 24 hours, then conditioned as in section 5.0 for 2 hours.

6.8.2 Cold: The second specimen shall be exposed to an air temperature of -70°F ± 5°F (57°C ± 3°C) for 72 hours, then conditioned as in section 5.0 for 2 hours.

6.8.3 Humidity: The final specimen shall be subjected to 100% relative humidity at a temperature of 75° - 78°F (23°-27°C) in accordance with US Federal Test Method Standard 141, method 6201, for 24 hours, then conditioned as in section 5.0 for 24 hours.

Examination of each of the three samples following the exposures shall show no evidence of cracking, peeling, chipping or delamination from the test panel. After heat exposure the sheeting shall retain a minimum of 85% and a maximum of 115% of the original coefficient of retroreflection when measured at room temperature.

Table 1
Minimum Coefficient of Retroreflection
(Candelas per Lux per Square Meter)

White

	-4/5	30	40
0.2	360	175	120
0.5	150	70	55
1.0	20	10	9.0

Green

	-4/5	30	40
0.2	50	30	12
0.5	21	12	8.0
1.0	2.0	2.0	0.8

Yellow

	-4/5	30	40
0.2	270	135	80
0.5	110	60	40
1.0	14	8.5	8.0

Blue

	-4/5	30	40
0.2	30	14	9.0
0.5	13	6.0	4.0
1.0	1.0	0.8	0.5

Red

	-4/5	30	40
0.2	65	35	16
0.5	27	14	10
1.0	3.0	2.0	1.0

Brown

	-4/5	30	40
0.2	18	8.5	5.0
0.5	7.5	3.5	1.5
1.0	1.0	0.2	0.1

Orange

	-4/5	30	40
0.2	145	70	29
0.5	60	28	14
1.0	5.0	3.0	1.0

7.0 Performance Requirements and Obligations

7.1 Certification. The sheeting manufacturer shall submit with each lot or shipment, certification that states that the material supplied will meet all the requirements listed herein.

7.2 Field Performance Requirements

Sheeting processed and applied to sign blank materials in accordance with sheeting manufacturer's recommendations, shall perform effectively for the number of years stated in Table 2 of this specification. The retroreflective sheeting will be considered unsatisfactory if it has deteriorated due to natural causes to the extent that: (1) the sign is ineffective for its intended purpose when viewed from a moving vehicle under normal day and night driving conditions; or (2) the coefficient of retroreflection is less than the minimum specified for that sheeting during that period listed in Table 2. All measurements shall be made after sign cleaning according to sheeting manufacturer's recommendations.

Table 2
Minimum Coefficient of Retroreflection
Candelas per Lux per Sq-Meter
(.2° obs, and -4° entrance)

Sheeting Color	Minimum Coefficient of Retro. (7 years)1	Minimum Coefficient of Retro. (10 years)
White	288	250
Yellow	216	170
Green	40	35
Red	52	45
Blue	24	20
Brown	14	12
Orange	100	

1 When sheeting is used in temporary work zone applications the warranty period shall be limited to 3 years

For screen printed transparent colored areas on white sheeting, the coefficients of retroreflection shall not be less than 70% of the values for the corresponding color in the above table.

7.3 Sheeting Manufacturer's Replacement Obligation

Where it can be shown that retroreflective traffic signs manufactured with sheeting supplied and used according to the sheeting manufacturer's recommendations have not met the performance requirements of Section 7.2 due to internal defects, the sheeting manufacturer shall cover restoration costs as follows for sheetings shown to be unsatisfactory during:

7.3.1 The entire ten years (three years for work zone materials): the sheeting manufacturer will replace the sheeting required to restore the sign surface to its original effectiveness.

7.3.2 In addition, during the first seven years (excluding work zone materials): the sheeting manufacturer will cover the cost of restoring the sign surface to its original effectiveness at no cost to the using Agency for materials and labor.

ATTACHMENT B

Specification for Durable Fluorescent Orange Wide Angle Prismatic Type VII Retroreflective Sheeting for the Work Zone

1.0 Scope. This specification covers flexible, colored, fluorescent wide angle prismatic retroreflective sheeting (hereinafter called sheeting), tape and related processing materials designed to enhance the visibility of traffic control signs and objects under all driving conditions, day and night.

2.0 Classification. The sheeting shall be a visible-activated fluorescent retroreflector providing higher daytime brightness than ordinary colored sheetings of similar chromaticity. The sheeting shall be of the following retroreflective types as specified in the plans or in the invitation to bid.

2.1 Description

The fluorescent orange wide angle prismatic retroreflective sheeting is specifically designed for use on rigid substrate work zone signs to provide high visual impact under nighttime and daytime driving conditions, including low visibility periods such as dawn, dusk, and overcast days. The sheeting shall consist of prismatic lenses formed in a transparent fluorescent orange synthetic resin, sealed, and backed with an aggressive pressure sensitive adhesive protected by a removable liner

3.0 Applicable Documents. The following documents, of the issue in effect on the date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein:

3.1 ASTM Standards.

3.1.1 B-117 Method of salt spray (fog) testing.

3.1.2 B-209 Specification for Aluminum and Aluminum Alloy Sheet and

Plate.

3.1.3 D-523 Standard Method for Test for Specular Gloss.

3.1.4 E-284 Standard Definition of Terms Relating to Appearance of Materials.

3.1.5 E-308 Computing the Colors of Objects by Using the CIE System.

3.1.6 E-810 Standard Test Method for Coefficient of Retroreflection of Retroreflective Sheeting.

3.1.7 E2153 Practice for Obtaining Bispectral Photometric Data for Evaluation of Fluorescent Color.

3.1.8 E2152 Practice for Computing the Colors of Fluorescent Objects from Bispectral Data.

4.0 Test Methods.

4.1 Test Conditions. Unless otherwise specified herein, all applied and unapplied test samples and specimens shall be conditioned at the standard conditions of 23 ± 1°C (73° ± 3°F) and 50 ± 5% relative humidity for 24 hours prior to testing.

4.2 Test Panels. Unless otherwise specified herein, when tests are to be performed using test panels, the specimens of retroreflective material shall be applied to smooth aluminum cut from ASTM B-209 Alloy 5052-H36, 5052-H38, 5154-H38 or 6061-T6 sheets in 0.05 cm (0.020 in.), 0.10 cm (0.040 in.) or 0.16 cm (0.063 in.) thickness. The aluminum shall be degreased and lightly acid etched before the specimens are applied. The specimens shall be applied to the panels in accordance with the recommendations of the retroreflective sheeting manufacturer.

5.0 Physical Requirements.

5.1 Daytime Color Requirements.

5.1.1 Daytime Color Test. Conformance to daytime color requirements of Table I shall be determined instrumentally on sheeting applied to aluminum test panels, using a 2-monochromator spectrophotometer employing annular 45/0 illuminating and viewing geometry. The bispectral radiance factor matrix (Donaldson matrix) shall be obtained in accordance with ASTM E2153 "Practice for Obtaining Bispectral Photometric Data for Evaluation of Fluorescent Color. The total chromaticity coordinates and total luminance factor shall be computed from the Donaldson matrix in accordance with ASTM E2152 "Practice for Computing the Colors of Fluorescent Objects from Bispectral Data" for CIE illuminant D65 and the CIE 1931 (2°) standard colorimetric observer. The measurements shall be made on a Labsphere BFC-450 Bispectral Fluorescence Colorimeter or equivalent.

Table I
CIE Daytime Chromaticity Coordinate Limits* and Total Luminance Factor Minimum

Color	Chromaticity Coordinate 1		Chromaticity Coordinate 2		Chromaticity Coordinate 3		Chromaticity Coordinate 4		Total Luminance Factor Y (%) min.	
	x	y	x	y	x	y	x	y	min.	max.
Fluorescent Orange	.583	.416	.535	.400	.595	.351	.645	.355	25	----

* The four pairs of chromaticity coordinates determine the acceptable color in terms of the CIE 1931 Standard Colorimetric System computed for CIE illuminant D65.

5.2 Fluorescence Requirements

5.2.1 Fluorescence Test. Conformance to fluorescence luminance factor requirements in Table II, shall be determined instrumentally, on sheeting applied to aluminum test panels, using a 2-monochromator spectrophotometer employing annular 45/0 illuminating and viewing geometry. The fluorescence luminance factor shall be calculated from bispectral fluorescence radiance factor matrix (the fluorescent component of the Donaldson matrix) in accordance with ASTM E2152 "Practice for Computing the Colors of Fluorescent Objects from Bispectral Data" for CIE illuminant D65 and the CIE 1931 (2°) standard colorimetric observer. The measurements shall be made on a Labsphere BFC-450 Bispectral Fluorescence Colorimeter or equivalent.

Table II
Fluorescence Luminance Factor Minimum Y_F Min. (%)

Fluorescent Orange	New Sheeting 20	In-service 15

5.3 Coefficient of Retroreflection, R_A. The coefficients of retroreflection shall not be less than the minimum values specified in Tables III. Testing shall be in accordance with ASTM E-810 and the values of 0° rotation and 90° rotation will be averaged to determine the R_A.

5.3.1 Units. Coefficients of retroreflection R_A shall be specified in units of candelas per lux per square meter.

5.3.2 The sheeting is positioned at the 90° rotation angle when the flat sides of the diamond seal pattern are running vertically. The sheeting is positioned at the 0° rotation angle when the flat sides of the diamond seal pattern are running horizontally (parallel to the entrance plane).

Table III
Minimum Coefficient of Retroreflection R_A For New Sheeting
(Candelas per lux per square meter)

Observation Angle	Entrance Angle		
	-4°	30°	
0.2°	230	130	
0.5°	72	41	

5.4 Resistance to Accelerated Weathering

The retroreflective surface of the sheeting shall be weather resistant and show no appreciable cracking, blistering, crazing, or dimensional change after 1 year's unprotected outdoor exposure facing the equator, and inclined 45° from the vertical. Following exposure, , panels shall be washed in a 5% HCL solution for 45 seconds, rinsed thoroughly with clean water, blotted with a soft clean cloth and brought to equilibrium at standard conditions. After cleaning the sample shall:

5.4.1 Show no appreciable evidence of cracking, scaling, pitting, blistering, edge

lifting or curling or more than 1/32 inch (0.08 cm) shrinkage or expansion.

5.4.2 Retain not less than 50% of the coefficient of retroreflection values listed in Table III at 0.2 degrees observation, -4 degrees entrance (measured in accordance with ASTM E810).

5.4.3 Be within the values listed in Table I and in-service values in Table II.

5.5 Optical Stability

The retroreflective sheeting, applied to a test panel as in 4.2, above, and conditioned for 24 hours, at 73° F ±3° F and 50% ±5% relative humidity shall be measured at 0.2° observation and -4° entrance angles, and exposed to 160 ± 5° F (71 ± 3° C) for 24 hours in an air circulating oven. After heat exposure the sheeting shall retain between 80% and 120% of the original tested value at 0.2° observation and -4 entrance angles.

5.6 Gloss. The retroreflective sheeting shall have an 85° specular gloss of not less than 50 when tested in accordance with ASTM D-523.

5.7 Color Processing. The retroreflective sheeting shall permit color processing with compatible process colors in accordance with the sheeting manufacturer's recommendations at temperatures of 15° to 38°C (59 to 100°F) and relative humidities of 20% to 80%. The sheeting shall be heat resistant and permit force curing without staining of applied or unapplied sheeting at temperatures recommended by the sheeting manufacturer.

5.8 Shrinkage. A 9" by 9" adhesive side up with liner removed specimen shall be conditioned a minimum of one hour at 72° F and 50% relative humidity. Remove liner and place specimen on a flat surface with adhesive side up. Ten minutes later and again after 24 hours, the specimen shall be measured to determine the amount of dimensional change. The reflective sheeting

shall not shrink in dimension more than 1/32" in 10 minutes nor more than 1/8" in 24 hours.

6.0 Sheeting Manufacturer's Warranty

6.1 Certification. The sheeting manufacturer shall, upon request, submit with each lot or shipment, a certification which states that the material supplied will meet all of the requirements listed herein.

6.2 Field Performance

Retroreflective sheeting processed and applied in accordance with the sheeting manufacturer's recommendations, is expected to perform effectively for a minimum of 3 years. The retroreflective sheeting will be considered unsatisfactory if it has deteriorated due to natural causes to the extent that: (1) the sign is ineffective for its intended purpose or (2) does not meet the requirements as stated in Section 5.5.

6.2.1 All measurements shall be made after sign cleaning according to the sheeting manufacturer's recommendations.

6.2.2 Natural causes include effects of exposure to weather. Natural causes exclude (without limitation) damage from exposure to chemicals, abrasion and other mechanical damage (such as from fasteners used to mount the sign, collisions or mishandling), vandalism, or malicious mischief.

6.3 Sheeting Manufacturer's Replacement Obligation

6.3.1 Where it can be shown that the retroreflective sheeting fails to conform to the performance requirements of Section 6.2, the sheeting manufacturer's sole responsibility and purchaser's and user's exclusive remedy shall be:

6.3.1.1 Replacement sheeting shall carry the unexpired warranty of the sheeting it replaces.

6.4 Process Inks. The manufacturer of the sheeting shall furnish at no additional cost the process inks, clears and thinners recommended for the sheeting to meet the performance requirements of this specification, and shall further be responsible for technical assistance in the use of these inks in accordance with section 7.

7.0 Technical Assistance Requirements.

7.1 Instruction and Training.

7.1.1 The manufacturer supplying the sheeting requirements shall provide the services of a qualified technician for instruction and training at the primary sign manufacturing facility. This instruction shall be available on a quarterly basis at no additional cost, and shall include but not be limited to, training films, material application, equipment operation, silk screening techniques, packaging, storage and other proven sign shop practices as they apply to the reflective sheeting supplied by the manufacturer, and to assure that the resulting signs can comply with the applicable specifications.

7.1.2 Additional on-site technical assistance by the manufacturer supplying the retroreflective sheeting shall be provided at each of the sign shops designated in the bid invitation. This assistance will be provided at least once during each quarter of sign production, if required.

7.2 Compliance. Failure to comply with the requirements and schedules of 7.1 shall be cause for cancellation of contract.

8.0 Government Using Agency Obligation. The using agency shall be responsible for requiring the dating of all signs at the time of fabrication with the fabrication date so that the start of the warranty period can be determined. In the event of claims made under the warranty the agency shall notify the sheeting

manufacturer of the failure within a reasonable time of the failure, provide reasonable information requested by the sheeting manufacturer and permit the manufacturer to verify the cause of the failure.

ATTACHMENT C

SPECIFICATION FOR TYPE IX FLUORESCENT YELLOW AND FLUORESCENT YELLOW GREEN REFLECTIVE SHEETING

1.0 Scope

This specification covers flexible fluorescent colored, wide angle retroreflective sheeting (hereinafter called sheeting), tape and related processing materials designed to enhance nighttime visibility of traffic control signs and objects. The sheeting shall consist of prismatic lens elements with a distinctive interlocking diamond seal pattern and datum orientation marks visible from the face of a smooth surface. The sheeting shall have a precoated adhesive protected by an easily removable liner.

The sheeting shall be part of a family of matched component products required for the manufacture and imaging of permanent traffic control signs as described in section 4. Only section 2.0, section 6.4 and section 7.2.1 cover printed colored areas of signs.

2.0 Classification and Conformance

The sheeting shall conform to the physical requirements of FP-96 and AASHTO M 268 and ASTM D 4956. Adhesive shall conform to Class 1. The sheeting shall further be required by the plans or in the invitation to bid to conform to the requirements contained herein. The sheeting is intended for shop production of new stationary traffic control signs or objects, exclusive of those used for construction and maintenance work zones. Periodic random sampling shall be taken to verify conformance.

2.1 For determining conformance to requirements for Coefficients of Retroreflection of material supplied and used in widths of 24 inches/60cm and greater, 9 samples are taken from 1 square yard/1 square meter of material.

2.1.1 The samples should be taken across the roll or sheet (left, center, right) and

spaced evenly down the roll or sheet.

2.1.2 Coefficients of Retroreflection are determined on each sample in accordance with 5.2.

2.1.4 To conform to this specification, all 9 samples shall meet the limits given in Table III.

2.1.5 For determining conformance to requirements for accelerated weathering, 2 replicate samples shall be tested.

2.1.6 For all other tests, single replicates shall be tested.

3.0 Items to be Included in Bids

3.1 Process Colors

3.1.1 The manufacturer of the sheeting shall manufacture and offer process colors in standard traffic colors, clears and thinners recommended for the sheeting to meet the performance requirements of this specification. The sheeting manufacturer shall further be responsible for technical assistance in the use of these colors in accordance with Section 7.

3.1.2 The process colors shall be a single line of traffic colors which: may be applied before and after sheeting is applied to a substrate; require no component premixing; and will air dry for packing in 3 hours or less and requires no clear coating.

3.1.3 The sheeting manufacturer shall, upon request, provide custom color match formulas from the color series.

3.2 Slip Sheet

Slip sheet paper recommended by the sheeting manufacturer for use in packaging, storing, or shipping shall be available from the

manufacturer

Slip sheet paper shall be supplied in rolls by the manufacturer, in at least equal square footage and in the same widths as the sheeting supplied.

3.3 Washers

Washers are recommended by the sheeting manufacturer to protect the sign surface from damage by bolts or other fasteners shall be available from the manufacturer.

3.4 Overlay Films

The sheeting manufacturer shall also manufacture colored acrylic imaging films and clear protective overlays, which are compatible with the sheetings, and when used in accordance with the sheeting manufacturer's instructions, shall not lessen the warranty term as described in section 6.2.

4.0 Test Panels and Test Conditions

Unless otherwise specified herein, sheeting shall be applied to test panels in accordance with ASTM D 4956-01, section 6.2 and test conditions shall conform to ASTM D 4956 section 7.1.

5.0 Requirements

5.0 Color Requirements

5.1.1 Fluorescent Daytime Color

Conformance to daytime color requirements of Table I shall be determined instrumentally on sheeting applied to aluminum test panels, using a 2-monochromator spectrophotometer employing annular 45/0 illuminating and viewing geometry. The bispectral radiance factor matrix (Donaldson matrix) shall be obtained in accordance with ASTM E 2153 "Practice for Obtaining Bispectral Photometric Data for Evaluation of Fluorescent Color". The

total chromaticity coordinates and total luminance factor shall be computed from the Donaldson matrix in accordance with ASTM E2152 "Practice for Computing the Colors of Fluorescent Objects from Bispectral Data" for CIE illuminant D65 and the CIE 1931 (2°) standard colorimetric observer. The measurements shall be made on a Labsphere BFC-450 Bispectral Fluorescence Colorimeter or equivalent.

Table I
CIE Daytime Chromaticity Coordinate Limits* and
Total Luminance Factor Minimum

Color	Chromaticity Coordinate 1		Chromaticity Coordinate 2		Chromaticity Coordinate 3		Chromaticity Coordinate 4		Total Luminance Factor Y (%) Min.
	x	y	x	Y	x	y	x	y	
Fluorescent Yellow	0.521	0.424	0.557	0.442	0.479	0.520	0.454	0.491	45%
Fluorescent Yellow Green	0.390	0.610	0.460	0.540	0.421	0.486	0.368	0.539	60%

*The four pairs of chromaticity coordinates determine the acceptable color in terms of the CIE 1931 Standard Colorimetric System computed for CIE illuminant D 65.

5.1.2 Fluorescence Test

Conformance to fluorescence luminance factor requirements in Tables II and IV, shall be determined instrumentally, on sheeting applied to aluminum test panels, using a 2-monochromator spectrophotometer employing annular 45/0 (or equivalent 0/45) illuminating and viewing geometry.2 3 The fluorescence luminance factor shall be calculated from the fluorescence spectral radiance factors computed for CIE illuminant D65 in accordance with ASTM E 308 "Practice for Computing the Colors of Objects by Using the CIE System" for the CIE 1931 (2°) standard colorimetric observer. The measurements shall be made on a Labsphere BFC-450 Bispectral Fluorescence Colorimeter or equivalent.

Table II
Minimum Fluorescence Luminance Factor - New Sheeting

Sheeting Type	Fluorescence Luminance Factor Limit, Y_F Min.
Fluorescent Yellow	25%
Fluorescent Yellow Green	35%

5.2 Coefficient of Retroreflection

The coefficients of retroreflection shall be determined in accordance with ASTM E-810, for the minimum requirements of Table III. This table contains measurement geometry found in ASTM D 4956, as well as values at 1.0° observation and 40° entrance to fully characterize sheeting performance throughout its expected range of use.

2 "Design and testing of a two-monochromator reference spectrofluorimeter for high-accuracy total radiance factor measurements" by Joanne C. Zwinkels, D.S. Gignac, M. Nevins, I. Powell, and A. Bewsher, Applied Optics, Vol. 36 no. 4, pp. 892-902 (1997).

3 "Principles of Bispectral Fluorescence Colorimetry" by Jim Leland, N. Johnson, and A. Arecchi, Proceedings of SPIE - The International Society for Optical Engineering: Vol. 3140, pp. 76-87 (1997).

5.2.1 Units

Coefficients of retroreflection shall be specified in units of candelas per lux per square meter.

5.2.2 The observation angles shall be 0.2°, 0.5°, and 1.0°.

5.2.3 The entrance angles shall be -4°, 30° and 40°.

5.3 Specular Gloss

The retroreflective sheeting shall have an 85° specular gloss of not less than 40 when tested in accordance with ASTM D 523.

Table III
Minimum Coefficient of Retroreflection
(cd/lux/m^2)

Y	-4.0	30.0	40.0
.2	240	150	55
.5	165	75	15
0	45	24	6

FYG	-4.0	30.0	40.0
0.2	325	200	75
0.5	236	105	23
1.0	65	35	8

5.4 Color Processing

The retroreflective sheeting shall be designed to work in concert with recommended imaging systems. Color processing with compatible transparent and opaque process colors shall be possible in accordance with the sheeting manufacturer's recommendation at temperatures of 60° to 100°F (16° to 38°C) and relative humidity of 20% to 80%. The sheeting shall be heat resistant and permit force curing without staining of applied or unapplied sheeting at temperatures recommended by the sheeting manufacturer.

5.5 Shrinkage

The retroreflective sheeting shall comply with the shrinkage requirements contained in ASTM D 4956 section 7.8.

5.6 Adhesive

The retroreflective sheeting shall comply with the liner removal and adhesion requirements contained in ASTM D 4956 sections 7.10 and 7.5 respectively.

5.7 Resistance to Accelerated Weathering

5.7.1 The retroreflective surface of the sheeting shall be weather resistant and show no appreciable cracking, blistering, crazing or dimensional change after three years unprotected outdoor exposure conducted according to ASTM G7 and inclined at 45° from the horizontal facing the equator. After cleaning, the coefficient of retroreflection shall not be less than 80% of the values in Table III and the colors shall conform to 6.1 and Table IV.

5.7.2 After weathering, the samples shall:

5.7.2.1 Show no appreciable evidence of cracking, scaling, pitting, blistering, edge lifting or curling or more than 1/32 inch (0.08 cm) shrinkage or expansion.

5.7.2.2 Retain not less than 80% of the coefficient of retroreflection values specified in Table III.

Retroreflective performance measurements after weather exposure shall be made at all observation and entrance angles. Sheeting shall be measured using the average values at 0° & 90° rotation. Where more than one panel of a color is measured, the

coefficient of retroreflection shall be the average of all the determinations.

5.7.2.3 Not to be removable from the aluminum panels without damage.

Table IV
Minimum Fluorescence Luminance Factor
(All measurements shall be made after cleaning according to manufacturer's recommendations)

Color	Warranty Period	Minimum Fluorescence Luminance Factor Y_F %	Minimum Total Luminance Factor Y_T %
Fluorescent Yellow	10 Years*	20%	45%
Fluorescent Yellow Green	10 Years*	20%	60%

*Due to climatic conditions, the warranty in the following states will be a seven year warranty: Alabama, Arizona, Florida, Georgia, Hawaii, Louisiana, Mississippi, New Mexico, South Carolina, Texas

5.8 Optical Stability

Three samples of retroreflective sheeting applied to test panels and conditioned as in Section 4.0 shall each first have their photometric properties characterized by measuring the coefficients of retroreflection according to the provisions in Section 6.2 at all test geometries shown in Table III. These panels shall then be exposed in an air circulating oven at 170 ± 5°F (77± 3°C) for a period of 24 hours. After exposure the panels shall be allowed to condition according to the provisions of Section 4.0. These panels will again be characterized for photometric properties by measuring the coefficients of retroreflection according to the provisions of Section 5.2 at all test geometries measured before exposure.

The coefficients of retroreflection measured after exposure shall be between 85% and 115% of the values measured before exposure for each of the three samples.

5.9 Fungus resistance

The retroreflective sheeting shall comply with the supplementary requirements contained in section S1 of ASTM D 4956.

5.10 Resistance to Corrosion

The retroreflective sheeting applied to a test panel and conditioned as in 5.0, shall show no loss of adhesion, appreciable discoloration or corrosion and after cleaning shall retain a minimum of 80% of the original coefficient of retroreflection when measured at 0.2° observation angle, -4° entrance angle, and 0° rotation angles after 1000 hours exposure to a 5% concentration salt spray at 35°C (95°F) when tested in accordance with ASTM B 117.

5.11 General Characteristics and Packaging

The retroreflective sheeting as supplied shall be of good appearance, free from ragged edges, cracks and extraneous materials and shall be furnished in either rolls or sheets.

When furnished in continuous rolls, the number of splices shall not be more than two per 50 yards (45.7 m) of material, with a maximum of three pieces in any 50-yard (45.7 m) length. Splices shall be butted or overlapped and shall be suitable for continuous application as furnished.

The sheeting shall be packaged in accordance with commercially accepted standards. Each carton shall clearly stipulate the brand, quantity, size, lot or run number, color and type adhesive. Stored under normal conditions the retroreflective sheeting as furnished shall be suitable for use for a minimum period of one year.

6.0 Performance Requirements and Obligations

6.1 Certification

The sheeting manufacturer shall submit with each lot or shipment, a certification that states the material supplied will meet all the requirements listed herein.

6.2 Field Performance Requirements

6.2.1 Sheeting processed and applied to sign blank materials in accordance with sheeting manufacturer's recommendations, shall perform effectively for the number of years stated in this specification. The retroreflective sheeting will be considered unsatisfactory if it has deteriorated due to natural causes to the extent that: (1) the sign is ineffective for its intended purpose when viewed from a moving vehicle under normal day and night driving conditions; or (2) the coefficient of retroreflection is less than the minimum specified for that sheeting during that period listed.

80% of values listed in Table III up to 7 years* and 70% of values listed in Table III up to 10* years.

Failure of process colors or overlay films provided and/or sold for use on recommended sheeting shall constitute a failure of entire sign and shall be replaced under manufacturer's replacement obligations (7.3).

All measurements shall be made after sign cleaning according to sheeting manufacturer's recommendations.

* 5 years in states listed in Table IV
* 7 years in states listed in Table IV

6.3 Sheeting Manufacturer's Replacement Obligation

6.3.1

For fluorescent colors where it can be shown that retroreflective signs, supplied and used according to the sheeting manufacturer's recommendations, have not met the performance requirements of Section 7.2, the sheeting manufacturer shall cover restoration costs as follows for sheetings shown to be unsatisfactory during:

6.3.1.1

For those states with a 10 year warranty, if the failure occurs within the first 7 years from the date of fabrication, the sheeting manufacturer shall, at its expense, restore the sign surface to its original effectiveness.

6.3.1.2

If the failure occurs in the 8th through the 10th year from the date of fabrication, the sheeting manufacturer will furnish the necessary amount of sheeting to restore the sign surface to its original effectiveness.

6.3.1.3

Replacement sheeting shall carry the unexpired warranty of the sheeting it replaces.

6.3.1.4
For those states with a 7 year warranty, if the failure occurs within the first 5 years from the date of fabrication, the manufacturer will, at its expense, restore the sign surface to its original effectiveness.

6.3.1.5
If the failure occurs within the 6th or 7th year from the date of fabrication, the manufacturer will furnish the necessary amount of sheeting necessary to restore the sign surface to its original effectiveness.

6.3.1.6
Replacement sheeting shall carry the unexpired warranty of the sheeting it replaces.

9.0 Applicable Documents

The following documents, of the issues in effect on the date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

9.1 ASTM Standards

9.1.1 B 209 Specification for Aluminum and Aluminum Alloy Sheet and Plate.

9.1.2 D 523 Standard Method for Test for Specular Gloss.

9.1.3 D 4956 Standard Specification for Retroreflective Sheeting for Traffic Control.

9.1.4 E 284 Standard Definition of terms Relating to Appearance of Materials.

9.1.5 E 308 Standard Method for computing the colors of objects by using the CIE system.

9.1.6 E 810 Standard Test Method for Coefficient of Retroreflection of Retroflective Sheeting.

9.1.7 E 1164 Standard Practice for obtaining spectrophotometric data for object color evaluation.

9.1.8 E 2153 Practice for Obtaining Bispectral Photometric Data for Evaluation of Fluorescent Color.

9.1.9 E 2152 Practice for Computing the Colors of Fluorescent Objects from Bispectral Data.

9.2 Other Standards

9.2.1 AASHTO M 268 Standard Specification for Retroreflective Sheeting for Traffic Control

9.2.2 FHWA FP-96 Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects

ATTACHMENT D

SPECIFICATION FOR TYPE IX NON-FLUORESCENT RETROREFLECTIVE SHEETING

1.0 Scope

This specification covers flexible white or colored, wide angle retroreflective sheeting (hereinafter called sheeting), tape and related processing materials designed to enhance nighttime visibility of traffic control signs and objects. The sheeting shall consist of prismatic lens elements with a distinctive interlocking diamond seal pattern and datum orientation marks visible from the face of a smooth surface. The sheeting shall have a precoated adhesive protected by an easily removable liner.

The sheeting shall be part of a family of matched component products required for the manufacture and imaging of permanent traffic control signs as described in section 4. Only section 2.0, section 6.2.4, section 6.4 and section 7.2.1 cover printed colored areas of signs.

3.0 Classification and Conformance

The sheeting shall conform to the physical requirements of FP-96 and AASHTO M 268 and the physical and photometric requirements in ASTM D 4956, Type IX Adhesive shall conform to Class 1. The sheeting shall further be required by the plans or in the invitation to bid to conform to the requirements contained herein. The sheeting is intended for shop production of new stationary traffic control signs or objects, exclusive of those used for construction and maintenance work zones. Periodic random sampling shall be taken to verify conformance.

3.1 For determining conformance to requirements for Coefficients of Retroreflection of material supplied and used in widths of 24 inches/60cm and greater, 9 samples are taken from 1 square yard/1 square meter of material.

3.1.1 The samples should be taken across the roll or sheet (left, center, right) and

spaced evenly down the roll or sheet.

3.1.2 Coefficients of Retroreflection are determined on each sample in accordance with 6.2.

3.1.3 To conform to this specification, all 9 sample shall meet the limits given in Table I.

3.1.4 For determining conformance to requirements for accelerated weathering, 2 replicate samples shall be tested.

3.1.5 For all other tests, single replicates shall be tested.

4.0 Items to be Included in Bids

4.1 Process Colors

4.1.1 The manufacturer of the sheeting shall manufacture and offer process colors in standard traffic colors, clears and thinners recommended for the sheeting to meet the performance requirements of this specification. The sheeting manufacturer shall further be responsible for technical assistance in the use of these colors in accordance with Section 8.

4.1.2 The process colors shall be a single line of traffic colors which: may be applied before and after sheeting is applied to a substrate; require no component premixing; and will air dry for packing in 3 hours or less and requires no clear coating.

4.1.3 The sheeting manufacturer shall, upon request, provide custom color match formulas from the color series.

4.2 Slip Sheet

Slip sheet paper recommended by the sheeting manufacturer for use in packaging, storing or shipping shall be available from the

manufacturer. Slip sheet paper shall be supplied in rolls by the manufacturer, in at least equal square footage and in the same widths as the sheeting supplied.

4.3 Washers

Washers recommended by the sheeting manufacturer to protect the sign surface from damage by bolts or other fasteners shall be available from the manufacturer.

4.4 Overlay Films

The sheeting manufacturer shall also manufacture colored acrylic imaging films and clear protective overlays, which are compatible with the sheetings, and when used in accordance with the sheeting manufacturer's instructions, shall not lessen the warranty term as described in section 7.2.

5.0 Test Panels and Test Conditions

Unless otherwise specified herein, sheeting shall be applied to test panels in accordance with ASTM D 4956-01, section 7.2 and test conditions shall conform to ASTM D 4956 section 7.1.

6.0 Requirements

6.0 Color Requirements

6.1.1 Ordinary Colors

Color shall be as specified and shall conform to the requirements of ASTM D 4956-01, Table 13. Luminance factors shall conform to ASTM D 4956-01, Table 9.

6.1 Coefficient of Retroreflection

The coefficients of retroreflection shall be

determined in accordance with ASTM E-810, for the minimum requirements of Table I. This table contains values found in ASTM D 4956, as well as values at 0.1° and 1.0° observation and 45° entrance to fully characterize sheeting performance throughout its expected range of use.

6.2.1 Units

Coefficients of retroreflection shall be specified in units of candelas per lux per square meter.

6.2.2 The observation angles shall be 0.1°, 0.2°, 0.5°, and 1.0°.

6.2.3 The entrance angles shall be -4°, 30° and 45°.

6.2.4 For screen printed transparent colored areas or transparent colored overlay films on white sheeting, the coefficients of retroreflection shall not be less than 70% of the values for corresponding color in Table I.

6.3 Specular Gloss

The retroreflective sheeting shall have an 85° specular gloss of not less than 40 when tested in accordance with ASTM D 523.

Table I
Minimum Coefficient of Retroreflection
(cd/lux/m^2)

White	-4.0	30.0	45.0
0.1	660	430	120
0.2	380	225	90
0.5	275	135	35
1.0	80	45	10

Green	-4.0	30.0	45.0
0.1	80	45	12.5
0.2	45	28	9.8
0.5	32	16	3.5
1.0	9	6	1.6

Yellow	-4.0	30.0	45.0
0.1	565	315	90
0.2	300	180	70

Blue	-4.0	30.0	45.0
0.1	42	22	6
0.2	22	14	4.5

0.5	220	100	27
1.0	60	35	8.8

0.5	17	8	1.5
1.0	4.5	3	.8

Red	-4.0	30.0	45.0
0.1	165	110	24
0.2	98	65	26
0.5	70	32	10
1.0	20	11	3

6.4 Color Processing

The retroreflective sheeting shall be designed to work in concert with recommended imaging systems. Color processing with compatible transparent and opaque process colors shall be possible in accordance with the sheeting manufacturer's recommendation at temperatures of 60° to 100°F (16° to 38°C) and relative humidity of 20% to 80%. The sheeting shall be heat resistant and permit force curing without staining of applied or unapplied sheeting at temperatures recommended by the sheeting manufacturer.

6.5 Shrinkage

The retroreflective sheeting shall comply with the shrinkage requirements contained in ASTM D 4956 section 7.8.

6.6 Adhesive

The retroreflective sheeting shall comply with the liner removal and adhesion requirements contained in ASTM D 4956 sections 7.10 and 7.5 respectively.

6.7 Resistance to Accelerated Weathering

6.7.1 The retroreflective surface of the sheeting shall be weather resistant and show no appreciable cracking, blistering, crazing or dimensional change after three years unprotected outdoor exposure conducted according to ASTM G7 and inclined at 45° from the horizontal facing the

equator. After cleaning, the coefficient of retroreflection shall not be less than 80% of the values in Table I and the colors shall conform to 6.1.

6.7.2 After weathering, the samples shall:

6.7.2.1 Show no appreciable evidence of cracking, scaling, pitting, blistering, edge lifting or curling or more than 1/32 inch (0.08 cm) shrinkage or expansion.

6.7.2.2 Retain not less than 80% of the coefficient of retroreflection values specified in Table I.

Retroreflective performance measurements after weather exposure shall be made at all observation and entrance angles. Sheeting shall be measured using the average values at 0° & 90° rotation. Where more than one panel of a color is measured, the coefficient of retroreflection shall be the average of all the determinations.

6.7.2.3 Not be removable from the aluminum panels without damage.

6.8 Optical Stability

Three samples of retroreflective sheeting applied to test panels and conditioned as in Section 5.0 shall each first have their photometric properties characterized by measuring the coefficients of retroreflection according to the provisions in Section 6.2 at all test geometries shown in Table I. These panels shall then be exposed in an air circulating oven at 170 ± 5°F (77± 3°C) for a period of 24 hours. After exposure the panels shall be allowed to condition according to the provisions of Section 5.0. These panels will again be characterized for photometric properties by

measuring the coefficients of retroreflection according to the provisions of Section 6.2 at all test geometries measured before exposure.

The coefficients of retroreflection measured after exposure shall be between 85% and 115% of the values measured before exposure for each of the three samples.

6.9 Fungus resistance

The retroreflective sheeting shall comply with the supplementary requirements contained in section S1 of ASTM D 4956.

6.10 Resistance to Corrosion

The retroreflective sheeting applied to a test panel and conditioned as in 5.0, shall show no loss of adhesion, appreciable discoloration or corrosion and after cleaning shall retain a minimum of 80% of the original coefficient of retroreflection when measured at 0.2° observation angle, -4° entrance angle, and 0° rotation angles after 1000 hours exposure to a 5% concentration salt spray at 35°C (95°F) when tested in accordance with ASTM B 117.

6.11 General Characteristics and Packaging

The retroreflective sheeting as supplied shall be of good appearance, free from ragged edges, cracks and extraneous materials and shall be furnished in either rolls or sheets. When furnished in continuous rolls, the number of splices shall not be more than two per 50 yards (45.7 m) of material, with a maximum of three pieces in any 50-yard (45.7 m) length. Splices shall be butted or overlapped and shall be suitable for continuous application as furnished. The sheeting shall be packaged in accordance with commercially accepted standards. Each carton shall clearly stipulate the brand, quantity, size, lot or run number, color and type adhesive. Stored under normal conditions the retroreflective sheeting as furnished shall be suitable for use for a minimum period of one year.

7.0 Performance Requirements and Obligations

7.1 Certification

The sheeting manufacturer shall submit with each lot or shipment, a certification that states the material supplied will meet all the requirements listed herein.

7.2 Field Performance Requirements

7.2.1 Sheeting processed and applied to sign blank materials in accordance with sheeting manufacturer's recommendations, shall perform effectively for at least 12 years. The retroreflective sheeting will be considered unsatisfactory if it has deteriorated due to natural causes to the extent that: (1) the sign is ineffective for its intended purpose when viewed from a moving vehicle under normal day and night driving conditions; or (2) the coefficient of retroreflection is less than the minimum specified for that sheeting during that period listed.

80% of values listed in Table I up to 7 years and 70% of values listed in Table I up to 12 years.

Failure of process colors or overlay films provided and/or sold for use on recommended sheeting shall constitute a failure of entire sign and shall be replaced under manufacturer's replacement obligations (7.3).

For screen printed transparent colored areas or transparent colored overlay films on white sheeting, the coefficients of retroreflection shall not be less than 70% of the values for the corresponding integral color.

All measurements shall be made after sign cleaning according to sheeting manufacturer's recommendations.

7.3 Sheeting Manufacturer's Replacement

Obligation

7.3.1 For standard colors where it can be shown that retroreflective signs, supplied and used according to the sheeting manufacturer's recommendations, have not met the performance requirements of Section 7.2, the sheeting manufacturer shall cover restoration costs as follows for sheetings shown to be unsatisfactory during:

7.3.1.1 The entire 12 years: the sheeting manufacturer will replace the sheeting required to restore the sign surface to its original effectiveness.

7.3.1.2 In addition, during the first 7 years the sheeting manufacturer will cover the cost of restoring the sign surface to its original effectiveness at no cost to County of Los Angeles for materials and labor.

9.0 Applicable Documents

The following documents, of the issues in effect on the date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

9.1 ASTM Standards

9.1.1 B 209 Specification for Aluminum and Aluminum Alloy Sheet and Plate.

9.1.2 D 523 Standard Method for Test for Specular Gloss.

9.1.3 D 4956 Standard Specification for Retroreflective Sheeting for Traffic Control.

9.1.4 E 284 Standard Definition of terms Relating to Appearance of Materials.

9.1.5 E 308 Standard Method for computing the colors of objects by using the CIE system.

9.1.6 E 810 Standard Test Method for Coefficient of Retroreflection of Retroflective Sheeting.

9.1.10 E 1164 Standard Practice for obtaining spectrophotometric data for object color evaluation.

9.2 Other Standards

9.2.1 AASHTO M 268 Standard Specification for Retroreflective Sheeting for Traffic Control

9.2.2 FHWA FP-96 Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects