

retroreflectivity, removability and adhesiveness. The warranty period shall be no less than 90 days, beginning on the date of installation and shall include all material and labor costs when installed in accordance with the manufacturer's recommendations.

- (3) **Adhesion:** No line shall have walked nor shall it be torn or missing after being installed on the test deck for 90 days.
- c. **All Products (including paint and tape products)**
- (1) **Thickness:** Thickness shall be no greater than 40 mils.
- (2) **Maintained Retroreflectivity and Durability:** Maintained retroreflectivity and durability shall conform to the following requirements after being installed on the test deck for 90 days:
- a) **Maintained Retroreflectivity:** Photometric quantity to be measured is coefficient of retroreflected luminance ( $R_L$ ) in accordance with the requirements of ASTM E 1743 for 15 meter geometry and ASTM E1710 for 30 meter geometry.  $R_L$  shall be expressed in millicandelas per square foot per foot-candle and shall be at least the following values for either 15 meter or 30 meter when measured in the wheel path area.

<b>Coefficient of Retroreflected Luminance (<math>R_L</math>)</b>				
<b>Color</b>	<b>Type F, Class I (15 meter)</b>	<b>Type F, Class I (30 meter)</b>	<b>Type F, Class II (15 meter)</b>	<b>Type F, Class II (30 meter)</b>
White	150	100	290	190
Yellow	100	65	190	125

- b) **Durability:** Marking material shall have a durability rating of at least 4 when determined in the wheel path area.

## SECTION 247—REFLECTIVE SHEETING

### 247.01—Description.

This specification covers reflective sheeting used on traffic control devices to provide a retroreflective surface or message. Color of the reflective sheeting shall be as

specified by contract documents. Reflective sheeting shall be certified in accordance with the requirements of Section 106.06.

### 247.02—Detail Requirements.

Reflective sheeting shall be selected from the Department’s qualified products list. Reflective sheeting products will be included on the qualified products list after the Department determines conformance to the specifications and the manufacturer has supplied written information indicating conformance to the warranty requirements of Section 247.03. Determination of conformance will include, but will not be limited to, the evaluation of test data from AASHTO’s National Transportation Product Evaluation Program (NTPEP) or other Department approved facilities except when otherwise indicated.

Reflective sheeting shall conform to the requirements of ASTM D4956 including supplementary requirement S2 and any exceptions and/or additions included herein.

- (a) Reflective sheeting used on signs (except those specifically indicated otherwise herein), vertical panels (Group 2 channelizing device), and the “STOP” side of sign paddles (hand signaling device) shall conform to the requirements for a Type III material.
- (b) Reflective sheeting used on cones, tubular delineators, drums and permanent sand barrels shall conform to the requirements for a Type III reboundable material and the following supplementary table:

**Minimum Coefficient of Retroreflection  $R_A$   
(Candelas per footcandle per square foot)**

<b>Observation Angle (°)</b>	<b>Entrance Angle (°)</b>	<b>White</b>	<b>Orange</b>
0.2	+50	75	25
0.5	+50	35	10

Minimum daytime luminance factor Y(percent) for the color white shall be 25 for sheeting used on cones and tubular delineators. Reflective sheeting used on cones and tubular delineators is not required to be tested by NTPEP.

- (c) Reflective sheeting used to delineate traffic gates and the trailer’s back frame of portable changeable message signs, arrow boards and portable lights shall be prismatic lens type conforming to the following:

**Color Specification Limits\* (Daytime)**

Color									Daytime Luminance Factor Y (%)	
	1		2		3		4		Min.	Max.
	x	y	x	y	x	y	x	y		
White	0.305	0.305	0.355	0.355	0.335	0.375	0.285	0.325	40	—
Red	0.690	0.310	0.595	0.315	0.569	0.341	0.655	0.345	3	15

\*The four pairs of chromaticity coordinates determine the acceptable color in terms of the CIE 1931 standard colorimetric system measured with standard illuminant D65.

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**Minimum Coefficient of Retroreflection  $R_A$   
(Candelas per footcandle per square foot)  
(0 and 90° Orientation)**

Observation Angle (°)	Entrance Angle (°)	White	Red
0.2	-4	600	120
0.2	+30	300	70
0.2	+45	90	20
0.5	-4	250	50
0.5	+30	120	20
0.5	+45	45	10

Impact resistance shall conform to the requirements of ASTM D4956 with the additional requirement that the material shall also be tested at 32 ± 3 degrees F.

This reflective sheeting is not required to be tested by NTPEP.

- (d) Reflective sheeting used on orange construction and maintenance activity signs, barrier vertical panels installed on concrete traffic barrier service, rear panel of truck mounted attenuators, temporary impact attenuators (except sand barrels) and the "SLOW" side of sign paddles shall be fluorescent prismatic lens type conforming to the following:

**Color specification limits:** Daytime color and maximum spectral radiance factor (peak reflectance) of the sheeting mounted on aluminum test panels shall be determined instrumentally in accordance with the requirements of ASTM E 991. The values shall be determined on a HunterLab Labscan 6000 0/45 Spectrocolorimeter with option CMR 559, or approved equal instrument with circumferential viewing (illumination).

Computations shall be done in accordance with the requirements of ASTM E 308 for the 2 degrees observer. Color shall conform to the following requirements:

**Color Specification Limits\* (Daytime)**

Color	1		2		3		4		Daytime Luminance Factor Y (%)	
	x	y	x	y	x	y	x	y	Min.	Max.
Fluorescent Orange (new)	0.583	0.416	0.523	0.397	0.560	0.360	0.631	0.369	30	–
Fluorescent Orange (weathered)	0.583	0.416	0.523	0.397	0.560	0.360	0.631	0.369	20	45

\*The four pairs of chromaticity coordinates determine the acceptable color in terms of the CIE 1931 standard colorimetric system measured with standard illuminant D65. Maximum spectral radiance factor, new: 110 percent min., weathered: 60 percent min.

**Minimum Coefficient of Retroreflection  $R_A$   
(Candelas per footcandle per square foot)**

Observation Angle (°)	Entrance Angle (°)	Flourescent Orange
0.2	–4	250
0.2	+30	125
0.2	+50	50
0.5	–4	72
0.5	+30	36
0.5	+50	20

Maintained coefficient of retroreflection of the sheeting after 1 year on the test deck shall be at least 50 percent of the minimum coefficient of retroreflection values indicated above.

Impact resistance shall conform to the requirements of ASTM D4956 for reboundable sheeting.

- (e) Reflective sheeting used on temporary sand barrels shall be fluorescent orange prismatic lens reboundable type conforming to the following:

**Color specification limits:** Daytime color and maximum spectral radiance factor (peak reflectance) of the sheeting mounted on aluminum test panels shall be determined instrumentally in accordance with the requirements of ASTM E 991. The values shall be determined on a HunterLab Labscan 6000 0/45 Spectrocolorimeter with option CMR 559, or

approved equal instrument with circumferential viewing (illumination). Computations shall be done in accordance with the requirements of ASTM E 308 for the 2 degrees observer. Color shall conform to the following requirements:

**Color Specification Limits\* (Daytime)**

Color									Daytime Luminance Factor Y (%)	
	1		2		3		4		Min.	Max.
	x	y	x	y	x	y	x	y		
Fluorescent Orange (new)	0.506	0.404	0.562	0.350	0.645	0.355	0.570	0.429	30	–
Fluorescent Orange (weathered)	0.506	0.404	0.562	0.350	0.645	0.355	0.570	0.429	20	45

\*The four pairs of chromaticity coordinates determine the acceptable color in terms of the CIE 1931 standard colorimetric system measured with standard illuminant D65. Maximum spectral radiance factor, new: 110 percent min.

**Minimum Coefficient of Retroreflection  $R_A$   
(Candelas per footcandle per square foot)**

Observation Angle (°)	Entrance Angle (°)	Flourescent Orange
0.2	–4	200
0.2	+30	120
0.2	+50	40
0.5	–4	80
0.5	+30	50
0.5	+50	30

Maintained coefficient of retroreflection of the sheeting after 1 year on the test deck shall be at least 50 percent of the minimum coefficient of retroreflection values indicated above.

Impact resistance shall conform to the requirements of ASTM D4956 for reboundable sheeting.

- (f) Reflective sheeting used on object markers, nose of guardrails, permanent impact attenuators (except sand barrels), standard road edge delineators, special road edge delineators, barrier delineators, guardrail delineators, interstate road edge delineators, chevron panels, bridge end panel signs (VW-13) and railroad advance warning signs (including any supplemental plates) shall be high observation angle prismatic lens type conforming to the following:

**Color Specification Limits\* (Daytime)**

Color	1		2		3		4		Daytime Luminance Factor Y (%)	
	x	y	x	y	x	y	x	y	Min.	Max.
	White	0.305	0.305	0.355	0.355	0.335	0.375	0.285	0.325	40
Yellow	0.487	0.423	0.545	0.454	0.465	0.534	0.427	0.483	24	45

\*The four pairs of chromaticity coordinates determine the acceptable color in terms of the CIE 1931 standard colorimetric system measured with standard illuminant D65.

**Minimum Coefficient of Retroreflection R<sub>A</sub>  
(Candelas per footcandle per square foot)**

Observation Angle (°)	Entrance Angle (°)	White	Yellow
0.2	-4	370	300
0.2	+30	225	180
0.5	-4	275	220
0.5	+30	125	100
1.0	-4	75	58
1.0	+30	42	35

Maintained coefficient of retroreflection of the sheeting after 3 years on the test deck shall be at least 50 percent of the minimum coefficient of retroreflection values indicated above.

Impact resistance shall conform to the requirements of ASTM D4956.

- (g) Reflective sheeting used on Type III barricades shall be prismatic lens type conforming to the following:

**Color Specification Limits\* (Daytime)**

Color	1		2		3		4		Daytime Luminance Factor Y (%)	
	x	y	x	y	x	y	x	y	Min.	Max.
	White	0.305	0.305	0.355	0.355	0.335	0.375	0.285	0.325	40
Orange	0.550	0.360	0.630	0.370	0.581	0.418	0.516	0.394	7	27

\*The four pairs of chromaticity coordinates determine the acceptable color in terms of the CIE 1931 standard colorimetric system measured with standard illuminant D65.

**Minimum Coefficient of Retroreflection  $R_A$**   
**(Candelas per footcandle per square foot)**

Observation Angle (°)	Entrance Angle (°)		
		White	Orange
0.2	-4	600	200
0.2	+30	270	120
0.2	+50	80	20
0.5	-4	220	80
0.5	+30	105	50
0.5	+50	40	18

Maintained coefficient of retroreflection of the sheeting after 1 year on the test deck shall be at least 50 percent of the minimum coefficient of retroreflection values indicated above.

Impact resistance shall conform to the requirements of ASTM D4956 for reboundable sheeting.

- (h) Reflective sheeting used on pedestrian, bicycle and school crossing signs including advance signing, school portion of school speed limit signs, school bus stop ahead signs, and “Share The Road” signs when used with bicycle signs shall be fluorescent yellow-green high observation angle prismatic lens type conforming to the following:

**Color specification limits:** Daytime color and maximum spectral radiance factor (peak reflectance) of the sheeting mounted on aluminum test panels shall be determined instrumentally in accordance with the requirements of ASTM E 991. The values shall be determined on a HunterLab Labskan 6000 0/45 Spectrocolorimeter with option CMR 559, or approved equal instrument with circumferential viewing (illumination). Computations shall be done in accordance with the requirements of ASTM E 308 for the 2 degrees observer. Color shall conform to the following requirements:

**Color Specification Limits\* (Daytime)**

Color									Daytime Luminance Factor Y (%)	
	1		2		3		4		Min.	Max.
	x	y	x	y	x	y	x	y		
Fluorescent Yellow-Green (new and weathered)	0.387	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 measured with standard illuminant D65. Maximum spectral radiance factor, new: 130 percent min., weathered: 84% min.

**Minimum Coefficient of Retroreflection  $R_A$**   
**(Candelas per footcandle per square foot)**

<b>Observation Angle (°)</b>	<b>Entrance Angle (°)</b>	<b>Flourescent Yellow-Green</b>
0.2	-4	325
0.2	+30	203
0.5	-4	238
0.5	+30	108
1.0	-4	63
1.0	+30	35

Maintained coefficient of retroreflection of the sheeting after 3 years on the test deck shall be at least 50 percent of the minimum coefficient of retroreflection values indicated above.

Impact resistance shall conform to the requirements of ASTM D4956 for reboundable sheeting.

- (i) Reflective sheeting used on retroreflective rollup signs shall conform to the requirements for a Type VI material except fluourescent orange signs shall conform to the following color specification limits (except Reflectance Limits Y), and beginning January 1, 2003, all rollup signs shall conform to the following:

**Color specification limits:** Daytime color and maximum spectral radiance factor (peak reflectance) of the fluourescent orange sheeting mounted on aluminum test panels shall be determined instrumentally in accordance with the requirements of ASTM E 991. The values shall be determined on a HunterLab Labscan 6000 0/45 Spectrocolorimeter with option CMR 559, or approved equal instrument with circumferential viewing (illumination). Computations shall be done in accordance with the requirements of ASTM E 308 for the 2 degrees observer. Color shall conform to the following requirements:

**Color Specification Limits\* (Daytime)**

<b>Color</b>									<b>Daytime Luminance Factor Y (%)</b>	
	<b>1</b>		<b>2</b>		<b>3</b>		<b>4</b>		<b>Min.</b>	<b>Max.</b>
	<b>x</b>	<b>y</b>	<b>x</b>	<b>y</b>	<b>x</b>	<b>y</b>	<b>x</b>	<b>y</b>		
Fluorescent Orange (new)	0.581	0.418	0.516	0.394	0.569	0.341	0.655	0.345	30	—
Fluorescent Orange (weathered- warranty values)	0.581	0.418	0.516	0.394	0.569	0.341	0.655	0.345	20	45

continued

**Color Specification Limits\* (Daytime)**

Color									Daytime Luminance Factor Y (%)	
	1		2		3		4		Min.	Max.
	x	y	x	y	x	y	x	y		
White	0.305	0.305	0.355	0.355	0.335	0.375	0.285	0.325	40	—

\*The four pairs of chromaticity coordinates determine the acceptable color in terms of the CIE 1931 standard colorimetric system measured with standard illuminant D65. Maximum spectral radiance factor, new: 110 percent min., weathered: 60 percent min.

**Minimum Coefficient of Retroreflection  $R_A$   
(Candelas per footcandle per square foot)**

Observation Angle (°)	Entrance Angle (°)	White	Flourescent Orange
0.2	-4	300	200
0.2	+30	180	125
0.2	+50	90	50
0.5	-4	200	72
0.5	+30	75	36
0.5	+50	45	20

This reflective sheeting is not required to be tested by NTPEP.

**247.03—Warranty Requirements.**

**The reflective sheeting manufacturer** shall provide the following warranties to the Department on their products:

- (a) **Type III Sheeting (Permanent Use)** – 12 year warranty with 10 years being 100 percent full replacement covering all material and labor costs associated with fabrication and installation of the sign or device, and the final 2 years being 100 percent sheeting replacement cost.
- (b) **Prismatic and High Observation Angle Prismatic Sheeting (Permanent Use)** – 10 year warranty with 7 years being 100 percent full replacement covering all material and labor costs associated with fabrication and installation of the sign or device, and the final 3 years being 100 percent sheeting replacement cost.
- (c) **Type III, Prismatic and Rollup Sign Sheeting (Workzone Use)** – 3 year full replacement warranty covering all material and labor costs associated with fabrication of the sign or device.

The warranty shall cover the loss of retroreflectivity, loss of colorfastness, cracking and any other conditions inherent to the sheeting including inks and overlay film that causes it to be ineffective in providing the direction to the motorists as intended.

Minimum values of retroreflectivity maintained during the warranty period shall be the same as those required for the maintained coefficient of retroreflection values as indicated herein, or ASTM D4956 if they do not exist herein. For reflective sheeting indicated in Section 247.02(c), and for reflective sheeting indicated in Section 247.02(i) to be used beginning January 1, 2003, the minimum values of retroreflectivity maintained during the warranty period shall be no less than 50 percent of the minimum coefficient of retroreflection values indicated herein.

Loss of colorfastness is considered to have occurred if the color of the sheeting is not within the color specification limits indicated herein or ASTM D4956, as applicable during the warranty period.