



Designation: **D4956—16 D4956 – 16a**

## Standard Specification for Retroreflective Sheeting for Traffic Control<sup>1</sup>

This standard is issued under the fixed designation D4956; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

*This standard has been approved for use by agencies of the U.S. Department of Defense.*

### 1. Scope

1.1 This specification covers flexible, non-exposed glass bead lens and microprismatic, retroreflective sheeting designed for use on traffic control signs, delineators, barricades, and other devices. This specification covers the performance of retroreflective sheeting materials and does not specifically address inks, overlays, or other imaging methods that may be applied to retroreflective sheeting material to create traffic signs or other devices.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 The following safety hazards caveat pertains only to the test methods portion, Section 7, of this specification. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

### 2. Referenced Documents

#### 2.1 ASTM Standards:<sup>2</sup>

[B209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate](#)

[B209M Specification for Aluminum and Aluminum-Alloy Sheet and Plate \(Metric\)](#)

[B449 Specification for Chromates on Aluminum](#)

[D2794 Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation \(Impact\)](#)

[E284 Terminology of Appearance](#)

[E308 Practice for Computing the Colors of Objects by Using the CIE System](#)

[E808 Practice for Describing Retroreflection](#)

[E810 Test Method for Coefficient of Retroreflection of Retroreflective Sheeting Utilizing the Coplanar Geometry](#)

[E811 Practice for Measuring Colorimetric Characteristics of Retroreflectors Under Nighttime Conditions](#)

[E991 Practice for Color Measurement of Fluorescent Specimens Using the One-Monochromator Method](#)

[E1164 Practice for Obtaining Spectrometric Data for Object-Color Evaluation](#)

[E1247 Practice for Detecting Fluorescence in Object-Color Specimens by Spectrophotometry](#)

[E1347 Test Method for Color and Color-Difference Measurement by Tristimulus Colorimetry](#)

[E1349 Test Method for Reflectance Factor and Color by Spectrophotometry Using Bidirectional \(45°:0° or 0°:45°\) Geometry](#)

[E2152 Practice for Computing the Colors of Fluorescent Objects from Bispectral Photometric Data](#)

[E2153 Practice for Obtaining Bispectral Photometric Data for Evaluation of Fluorescent Color](#)

[E2301 Test Method for Daytime Colorimetric Properties of Fluorescent Retroreflective Sheeting and Marking Materials for High Visibility Traffic Control and Personal Safety Applications Using 45°:Normal Geometry](#)

[G7 Practice for Atmospheric Environmental Exposure Testing of Nonmetallic Materials](#)

[G113 Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials](#)

[G147 Practice for Conditioning and Handling of Nonmetallic Materials for Natural and Artificial Weathering Tests](#)

[G151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources](#)

[G155 Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials](#)

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

## 2.2 Other Standards

ISO 4892-2:2006 Plastics Methods of exposure to laboratory light sources - Part 2: Xenon-arc lamps

ISO 4892-2:2006/Amd.1:2009 Plastics Methods of exposure to laboratory light sources - Part 2: Xenon-arc lamps

EN12899-1:2007 Fixed, vertical road traffic signs - Part 1: Fixed signs

## 3. Terminology

3.1 *Definitions*—Definitions of terms are as described in Terminology E284, Practice E808, and Terminology G113.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *reboundable sheeting, n*—retroreflective material intended to be attached to flexible impact resistant plastic devices, such as traffic drum-like channelizing devices.

## 4. Classification

4.1 Retroreflective sheeting shall consist of a white or colored sheeting having a smooth outer surface and that essentially has the property of a retroreflector over its entire surface. There are nine types and five classes of retroreflective sheeting. Types are determined by conformance to the retroreflectance, color, and durability requirements listed in 6.1 and may be of any construction providing that those requirements are met. Type designation is provided as a means for differentiating functional performance. Typical examples of applications are provided for descriptive information only and are not intended to be limitations or recommendations. Common identifiers for each type are listed in 4.2.

4.1.1 The typical applications for the retroreflective sheeting addressed in this specification are:

| Type | Typical Application  |
|------|--|
| I    | Highway signing, construction-zone devices, and delineators                  |
| II   | Highway signing, construction-zone devices, and delineators                  |
| III  | Highway signing, construction-zone devices, and delineators                  |
| IV   | Highway signing, construction-zone devices, and delineators                  |
| V    | Delineators  |
| VI   | Temporary roll-up signs, warning signs, traffic cone collars, and post bands |
| VII  | This type designation has been replaced with Type VIII                       |
| VIII | Highway signing, construction-zone devices, and delineators                  |
| IX   | Highway signing, construction-zone devices, and delineators                  |
| X    | This type designation has been replaced with Type VIII                       |
| XI   | Highway signing, construction-zone devices, and delineators                  |

4.2 Retroreflective sheeting shall be classified as follows (the type sequence is not indicative of performance level):

4.2.1 *Type I*—A retroreflective sheeting referred to as “engineering grade” that is typically an enclosed lens glass-bead sheeting. Applications for this material include permanent highway signing, construction zone devices, and delineators.

4.2.2 *Type II*—A retroreflective sheeting referred to as “super engineer grade” that is typically an enclosed lens glass-bead sheeting. Applications for this material include permanent highway signing, construction zone devices, and delineators.

4.2.3 *Type III*—A retroreflective sheeting referred to as “high-intensity” that is typically manufactured as an encapsulated glass-bead retroreflective material or as an unmetalized microprismatic retroreflective element material. Applications for this material include permanent highway signing, construction zone devices, and delineators.

4.2.4 *Type IV*—A retroreflective sheeting referred to as “high-intensity” that is typically an unmetalized microprismatic retroreflective element material. Applications for this material include permanent highway signing, construction zone devices, and delineators.

4.2.5 *Type V*—A retroreflective sheeting referred to as “super high-intensity” that is typically a metalized microprismatic retroreflective element material. This sheeting is typically used for delineators.

4.2.6 *Type VI*—An elastomeric retroreflective sheeting without adhesive. This sheeting is typically a vinyl microprismatic retroreflective material. Applications include orange temporary roll-up warning signs, traffic cone collars, and post bands.

4.2.7 *Type VII*—Retroreflective sheeting materials previously classified as Type VII have been reclassified as Type VIII. The use of a designation as Type VII has been discontinued.

4.2.8 *Type VIII*—A retroreflective sheeting typically manufactured as an unmetalized cube corner microprismatic retroreflective element material. Applications for this material include permanent highway signing, construction zone devices, and delineators.

4.2.9 *Type IX*—A retroreflective sheeting typically manufactured as an unmetalized cube corner microprismatic retroreflective element material. Applications for this material include permanent highway signing, construction zone devices, and delineators.

4.2.10 *Type X*—Retroreflective sheeting materials previously classified as Type X have been reclassified as Type VIII. The use of a designation as Type X has been discontinued.

4.2.11 *Type XI*—A retroreflective sheeting typically manufactured as an unmetalized cube corner microprismatic retroreflective element material. Applications for this material include permanent highway signing, construction zone devices, and delineators.

NOTE 1—All retroreflective sheetings, but especially microprismatic sheetings, may have unique performance characteristics outside of the range of the standard geometries presented in the tables that define the types. Certain applications may require the use of a particular product within a particular type in order to achieve a desired level of retroreflectivity in a given situation. In these cases, information concerning additional performance characteristics must be obtained.

4.3 *Backing Classes*—The backing required for retroreflective sheeting shall be classified as follows:

4.3.1 *Class 1*—The adhesive backing shall be pressure-sensitive, require no heat, solvent, or other preparation for adhesion to smooth, clean surfaces.

4.3.2 *Class 2*—The adhesive backing shall have an adhesive that shall be activated by applying heat and pressure to the material. The temperature necessary to form a durable permanent bond shall be a minimum of 150°F (66°C).

4.3.2.1 The Class 2 material shall be repositionable under normal shop conditions and at substrate temperatures up to 100°F (38°C) and without damage to the material. The Class 2 material may be perforated to facilitate removal of air in heat-vacuum laminators, but the perforations must be of a size and frequency such that they do not cause objectionable blemishes when the sheeting is printed.

4.3.3 *Class 3*—The adhesive backing shall have a positionable low-tack pressure-sensitive adhesive that requires no heat, solvent, or other preparation for adhesion to smooth, clean surfaces. It shall be repositionable up to a temperature of 100°F (38°C) without damage to the material.

4.3.4 *Class 4*—The adhesive backing shall have a low-temperature pressure-sensitive adhesive that permits sheeting applications at temperatures down to +20°F (-7°C) without the aid of heat, solvent, or other preparation for adhesion to smooth, dry, clean surfaces.

4.3.5 *Class 5*—This shall be a nonadhesive backing made of material commercially used for self-supporting products such as traffic cone collars, temporary roll-up warning signs, and post bands.

## 5. Ordering Information

5.1 The purchaser using this specification shall include the following information:

5.1.1 ASTM designation (D4956),

5.1.2 Classification type (see Section 4),

5.1.3 Adhesive class (see 4.3),

5.1.4 Daytime color (see 6.3),

5.1.5 Length and width of sheets (see 8.1),

5.1.6 Length and width of rolls (see 8.2),

5.1.7 Supplementary information, if required by the purchaser, including:

5.1.7.1 Compliance with the minimum coefficient of retroreflection for 0.1° observation angle is a supplementary requirement which shall apply only when specified. An observation angle of 0.1° may be specified where the long distance performance of a sheeting is to be a requirement,

5.1.7.2 Fungus-resistance testing requirements (see Supplementary Requirement S1), and

5.1.7.3 Reboundable sheeting requirements (see Supplementary Requirement S2),

5.1.8 Indication that the sheeting is intended for work zone use, if applicable, to determine which weathering requirements apply, and

5.1.9 Any additional information.

## 6. Performance Requirements

6.1 This is a summary of the minimum performance requirements for each type of retroreflective sheeting.

6.1.1 *Type I*—Minimum Coefficient of Retroreflection—**Table 1**; Outdoor Weathering—24 months, see 6.4; Daytime Luminance Factor—**Table 2**; Other requirements: When sheeting is specified for construction work zone applications, the outdoor weathering shall be 12 months.

6.1.2 *Type II*—Minimum Coefficient of Retroreflection—**Table 3**; Outdoor Weathering—36 months, see 6.4; Daytime Luminance Factor—**Table 2**; Other requirements: When sheeting is specified for construction work zone applications, the outdoor weathering shall be 12 months.

6.1.3 *Type III*—Minimum Coefficient of Retroreflection—**Table 4**; Outdoor Weathering—36 months, see 6.4; Daytime Luminance Factor—**Table 2**; Other requirements: When sheeting is specified for construction work zone applications, the outdoor weathering shall be 12 months.

6.1.4 *Type IV*—Minimum Coefficient of Retroreflection—**Table 5**; Outdoor Weathering—36 months, see 6.4; Daytime Luminance Factor—**Table 2**; Other requirements: When sheeting is specified for construction work zone applications, the outdoor weathering shall be 12 months.

**TABLE 1 Type I Sheeting<sup>A</sup>**

| Observation Angle | Entrance Angle | White | Yellow | Orange | Green | Red | Blue | Brown |
|-------------------|----------------|-------|--------|--------|-------|-----|------|-------|
| 0.2°              | -4°            | 70    | 50     | 25     | 9.0   | 14  | 4.0  | 1.0   |
| 0.2°              | +30°           | 30    | 22     | 7.0    | 3.5   | 6.0 | 1.7  | 0.3   |
| 0.5°              | -4°            | 30    | 25     | 13     | 4.5   | 7.5 | 2.0  | 0.3   |
| 0.5°              | +30°           | 15    | 13     | 4.0    | 2.2   | 3.0 | 0.8  | 0.2   |

<sup>A</sup> Minimum Coefficient of Retroreflection ( $R_A$ ) cd/ft<sup>2</sup> (cd·lx<sup>-1</sup>·m<sup>-2</sup>).

**TABLE 2 Daytime Luminance Factor (Y%)<sup>A</sup>**

| Color                    | All except Type V |         | Type V  |         |
|--------------------------|-------------------|---------|---------|---------|
|                          | Minimum           | Maximum | Minimum | Maximum |
| White                    | 27                | ...     | 15      |         |
| Yellow                   | 15                | 45      | 12      | 30      |
| Orange                   | 10                | 30      | 7.0     | 25      |
| Green                    | 3.0               | 12      | 2.5     | 11      |
| Red                      | 2.5               | 15      | 2.5     | 11      |
| Blue                     | 1.0               | 10      | 1.0     | 10      |
| Purple                   | 2.0               | 10      | 2.0     | 10      |
| Brown                    | 1.0               | 9.0     | 1.0     | 9.0     |
| Fluorescent Yellow-Green | 60                |         |         |         |
| Fluorescent Yellow       | 40                |         |         |         |
| Fluorescent Orange       | 20                |         |         |         |
| Fluorescent Pink         | 25                | ...     |         |         |

<sup>A</sup> The luminance factors shown for fluorescent colors consist of the sum of a reflectance luminance factor and fluorescence luminance factor. The luminance factor may be determined using a good approximation to Illuminant D65, requiring an instrument with an appropriately filtered light source, or by using a bispectral photometer conforming to Test Method G147.

**TABLE 3 Type II Sheeting<sup>A</sup>**

| Observation Angle | Entrance Angle | White | Yellow | Orange | Green | Red | Blue | Brown |
|-------------------|----------------|-------|--------|--------|-------|-----|------|-------|
| 0.2°              | -4°            | 140   | 100    | 60     | 30    | 30  | 10   | 5.0   |
| 0.2°              | +30°           | 60    | 36     | 22     | 10    | 12  | 4.0  | 2.0   |
| 0.5°              | -4°            | 50    | 33     | 20     | 9.0   | 10  | 3.0  | 2.0   |
| 0.5°              | +30°           | 28    | 20     | 12     | 6.0   | 6.0 | 2.0  | 1.0   |

<sup>A</sup> Minimum Coefficient of Retroreflection ( $R_A$ ) cd/ft<sup>2</sup> (cd·lx<sup>-1</sup>·m<sup>-2</sup>).

**TABLE 4 Type III Sheeting<sup>A</sup>**

| Observation Angle | Entrance Angle | White | Yellow | Orange | Green | Red | Blue | Brown |
|-------------------|----------------|-------|--------|--------|-------|-----|------|-------|
| 0.1° <sup>B</sup> | -4°            | 300   | 200    | 120    | 54    | 54  | 24   | 14    |
| 0.1° <sup>B</sup> | +30°           | 180   | 120    | 72     | 32    | 32  | 14   | 10    |
| 0.2°              | -4°            | 250   | 170    | 100    | 45    | 45  | 20   | 12    |
| 0.2°              | +30°           | 150   | 100    | 60     | 25    | 25  | 11   | 8.5   |
| 0.5°              | -4°            | 95    | 62     | 30     | 15    | 15  | 7.5  | 5.0   |
| 0.5°              | +30°           | 65    | 45     | 25     | 10    | 10  | 5.0  | 3.5   |

<sup>A</sup> Minimum Coefficient of Retroreflection ( $R_A$ ) cd/ft<sup>2</sup> (cd·lx<sup>-1</sup>·m<sup>-2</sup>).

<sup>B</sup> Values for 0.1° observation angle are supplementary requirements that shall apply only when specified by the purchaser in the contract or order.

6.1.5 *Type V*—Minimum Coefficient of Retroreflection—Table 6; Outdoor Weathering—36 months, see 6.4; Daytime Luminance Factor—Table 2; Other requirements: When sheeting is specified for construction work zone applications, the outdoor weathering shall be 12 months.

6.1.6 *Type VI*—Minimum Coefficient of Retroreflection—Table 7; Outdoor Weathering—6 months, see 6.4; Daytime Luminance Factor—Table 2.

6.1.7 *Type VII*—Retroreflective sheeting materials previously classified as Type VII have been reclassified as Type VIII.

6.1.8 *Type VIII*—Minimum Coefficient of Retroreflection—Table 8; Outdoor Weathering—36 months, see 6.4; Daytime Luminance Factor—Table 2; Other requirements: When sheeting is specified for construction work zone applications, the outdoor weathering shall be 12 months.

6.1.9 *Type IX*—Minimum Coefficient of Retroreflection—Table 9; Outdoor Weathering—36 months, see 6.4; Daytime Luminance Factor—Table 2; Other requirements: When sheeting is specified for construction work zone applications, the outdoor weathering shall be 12 months.

6.1.10 *Type X*—Retroreflective sheeting materials previously classified as Type X have been reclassified as Type VIII.

6.1.11 *Type XI*—Minimum Coefficient of Retroreflection—Table 10; Outdoor Weathering—36 months, see 6.4; Daytime Luminance Factor—Table 2; Other requirements: When sheeting is specified for construction work zone applications, the outdoor weathering shall be 12 months.

6.2 *Coefficient of Retroreflection*—The coefficient of retroreflection shall meet or exceed the minimum requirements for the appropriate type of sheeting (see Table 1 and Tables 3-10) as specified in 7.3.

**TABLE 5 Type IV Sheeting<sup>A</sup>**

| Observation Angle  | Entrance Angle | White | Yellow | Orange | Green | Red | Blue | Purple | Brown | Fluorescent Yellow-Green | Fluorescent Yellow | Fluorescent Orange |
|--------------------|----------------|-------|--------|--------|-------|-----|------|--------|-------|--------------------------|--------------------|--------------------|
| 0.10 <sup>°B</sup> | −4°            | 500   | 380    | 200    | 70    | 90  | 42   | 20     | 25    | 400                      | 300                | 150                |
| 0.10 <sup>°B</sup> | +30°           | 240   | 175    | 94     | 32    | 42  | 20   | 10     | 12    | 185                      | 140                | 70                 |
| 0.20°              | −4°            | 360   | 270    | 145    | 50    | 65  | 30   | 14     | 18    | 290                      | 220                | 105                |
| 0.20°              | +30°           | 170   | 135    | 68     | 25    | 30  | 14   | 6.8    | 8.5   | 135                      | 100                | 50                 |
| 0.50°              | −4°            | 150   | 110    | 60     | 21    | 27  | 13   | 6.0    | 7.5   | 120                      | 90                 | 45                 |
| 0.50°              | +30°           | 72    | 54     | 28     | 10    | 13  | 6    | 2.9    | 3.5   | 55                       | 40                 | 22                 |

<sup>A</sup> Minimum Coefficient of Retroreflection ( $R_A$ ) cd/ft<sup>2</sup> (cd·lx<sup>-1</sup>·m<sup>-2</sup>).

<sup>B</sup> Values for 0.1° observation angle are supplementary requirements that shall apply only when specified by the purchaser in the contract or order.

**TABLE 6 Type V Sheeting<sup>A</sup>**

| Observation Angle  | Entrance Angle | White | Yellow | Orange | Green | Red | Blue | Purple |
|--------------------|----------------|-------|--------|--------|-------|-----|------|--------|
| 0.10 <sup>°B</sup> | −4°            | 2000  | 1300   | 800    | 360   | 360 | 160  | 80     |
| 0.10 <sup>°B</sup> | +30°           | 1100  | 740    | 440    | 200   | 200 | 88   | 45     |
| 0.20°              | −4°            | 700   | 470    | 280    | 120   | 120 | 56   | 28     |
| 0.20°              | +30°           | 400   | 270    | 160    | 72    | 72  | 32   | 16     |
| 0.50°              | −4°            | 160   | 110    | 64     | 28    | 28  | 13   | 6.4    |
| 0.50°              | +30°           | 75    | 51     | 30     | 13    | 13  | 6.0  | 3.0    |

<sup>A</sup> Minimum Coefficient of Retroreflection ( $R_A$ ) cd/ft<sup>2</sup> (cd·lx<sup>-1</sup>·m<sup>-2</sup>).

<sup>B</sup> Values for 0.1° observation angle are supplementary requirements that shall apply only when specified by the purchaser in the contract or order.

6.3 *Daytime Color*—The color of the sheeting shall conform to requirements of **Table 2** and **Table 11** when tested in accordance with **7.4**. Daytime color requirements were developed for a limited set of retroreflective sheetings and a limited set of measurement devices. Measurement techniques appropriate for a wider range of optical technologies and instruments are under development. Some sheeting may require visual assessment to determine the acceptability of daytime appearance.

6.4 *Accelerated Outdoor Weathering Requirements*—The retroreflective sheeting shall be weather resistant and show no appreciable cracking, scaling, pitting, blistering, edge lifting, or curling, or more than 1/32-in. (0.8-mm) shrinkage or expansion when tested in accordance with **7.6**. Conduct retroreflectivity measurements after outdoor weathering at 0.2° observation and −4° and +30° entrance angles. The minimum coefficient of retroreflection ( $R_A$ ) after weathering is specified in **Table 12**.

NOTE 2—Supplementary Requirement S3 describes a method for artificial accelerated weathering, which users of this specification may employ for preliminary judgment until outdoor weathering results are available.

6.5 *Colorfastness*—After the specified outdoor weathering, the specimen shall conform to the requirements of **Table 2** and **Table 11** when tested in accordance with **7.4** and **7.7**.

6.6 *Shrinkage*—The retroreflective sheeting shall not shrink in any dimension more than 1/32 in. (0.8 mm) in 10 min or more than 1/8 in. (3.2 mm) in 24 h when tested in accordance with **7.8**.

6.7 *Flexibility*—The sheeting shall be sufficiently flexible to show no cracking when tested in accordance with **7.9**.

6.8 *Liner Removal*—The liner, when provided, shall be easily removed without soaking in water or other solutions, and shall not break, tear, or remove adhesive from the sheeting. (See **7.10**.)

6.9 *Adhesion*—When tested in accordance with **7.5**, the adhesive backing of the retroreflective sheeting shall produce a bond that will support a 1 3/4-lb (0.79-kg) weight for adhesive classes 1, 2, and 3 or a 1-lb (0.45-kg) weight for adhesive class 4 for 5 min, without the bond peeling for a distance of more than 2 in. (51 mm).

6.10 *Impact Resistance*—Retroreflective sheeting shall show no cracking or delamination outside of the actual area of impact when subjected to the impact test in accordance with **7.11**.

6.11 *Nighttime Color*—The nighttime color of the sheeting shall conform to the requirements of **Table 13**, when tested in accordance with **7.12**.

## 7. Test Methods

7.1 *Test Conditions*—Unless otherwise specified in this specification, condition all adhesively bonded and unbonded test samples and specimens at a temperature of 73 ± 3°F (23 ± 2°C) and 50 ± 5 % relative humidity for 24 h prior to testing.

7.2 *Panel Preparations*—Unless otherwise specified in this specification, when tests are to be performed using test panels, apply the specimens of retroreflective material to smooth aluminum cut from Alloy 6061-T6 or 5052-H38, in accordance with Specification **B209** or **B209M**. The sheets shall be 0.020 in. (0.508 mm), 0.040 in. (1.016 mm), or 0.063 in. (1.600 mm) in thickness, and a minimum of 8 by 8 in. (200 by 200 mm). Prepare the aluminum in accordance with Specification **B449**, Class

**TABLE 7 Type VI Sheeting<sup>A</sup>**

| Observation Angle  | Entrance Angle | White | Yellow | Orange | Green | Red | Blue | Purple | Fluorescent Yellow-Green | Fluorescent Yellow | Fluorescent Orange | Fluorescent Pink |
|--------------------|----------------|-------|--------|--------|-------|-----|------|--------|--------------------------|--------------------|--------------------|------------------|
| 0.10° <sup>B</sup> | -4°            | 750   | 525    | 190    | 90    | 105 | 68   | 30     | 600                      | 450                | 300                | 225              |
| 0.10° <sup>B</sup> | +30°           | 300   | 210    | 75     | 36    | 42  | 27   | 12     | 240                      | 180                | 120                | 90               |
| 0.20°              | -4°            | 500   | 350    | 125    | 60    | 70  | 45   | 20     | 400                      | 300                | 200                | 150              |
| 0.20°              | +30°           | 200   | 140    | 50     | 24    | 28  | 18   | 8.0    | 160                      | 120                | 80                 | 60               |
| 0.50°              | -4°            | 225   | 160    | 56     | 27    | 32  | 20   | 9.0    | 180                      | 135                | 90                 | 65               |
| 0.50°              | +30°           | 85    | 60     | 21     | 10    | 12  | 7.7  | 3.4    | 68                       | 51                 | 34                 | 25               |

<sup>A</sup> Minimum Coefficient of Retroreflection ( $R_A$ ) cd/ft<sup>2</sup> (cd·lx<sup>-1</sup>·m<sup>-2</sup>).

<sup>B</sup> Values for 0.1° observation angle are supplementary requirements that shall apply only when specified by the purchaser in the contract or order.

**TABLE 8 Type VIII Sheeting<sup>A</sup>**

| Observation Angle  | Entrance Angle | White | Yellow | Orange | Green | Red | Blue | Purple | Brown | Fluorescent Yellow-Green | Fluorescent Yellow | Fluorescent Orange |
|--------------------|----------------|-------|--------|--------|-------|-----|------|--------|-------|--------------------------|--------------------|--------------------|
| 0.10° <sup>B</sup> | -4°            | 1000  | 750    | 375    | 100   | 150 | 45   | 40     | 30    | 800                      | 600                | 300                |
| 0.10° <sup>B</sup> | +30°           | 460   | 345    | 175    | 46    | 69  | 21   | 18     | 14    | 370                      | 280                | 135                |
| 0.20°              | -4°            | 700   | 525    | 265    | 70    | 105 | 32   | 28     | 21    | 560                      | 420                | 210                |
| 0.20°              | +30°           | 325   | 245    | 120    | 33    | 49  | 15   | 13     | 10    | 260                      | 200                | 95                 |
| 0.50°              | -4°            | 250   | 190    | 94     | 25    | 38  | 11   | 10     | 7.5   | 200                      | 150                | 75                 |
| 0.50°              | +30°           | 115   | 86     | 43     | 12    | 17  | 5.0  | 4.6    | 3.5   | 92                       | 69                 | 35                 |

<sup>A</sup> Minimum Coefficient of Retroreflection ( $R_A$ ) cd/ft<sup>2</sup> (cd·lx<sup>-1</sup>·m<sup>-2</sup>).

<sup>B</sup> Values for 0.1° observation angle are supplementary requirements that shall apply only when specified by the purchaser in the contract or order.

**TABLE 9 Type IX Sheeting<sup>A</sup>**

| Observation Angle  | Entrance Angle | White | Yellow | Orange | Green | Red | Blue | Purple | Fluorescent Yellow-Green | Fluorescent Yellow | Fluorescent Orange |
|--------------------|----------------|-------|--------|--------|-------|-----|------|--------|--------------------------|--------------------|--------------------|
| 0.10° <sup>B</sup> | -4°            | 660   | 500    | 250    | 66    | 130 | 30   | 26     | 530                      | 400                | 200                |
| 0.10° <sup>B</sup> | +30°           | 370   | 280    | 140    | 37    | 74  | 17   | 15     | 300                      | 220                | 110                |
| 0.20°              | -4°            | 380   | 285    | 145    | 38    | 76  | 17   | 15     | 300                      | 230                | 115                |
| 0.20°              | +30°           | 215   | 162    | 82     | 22    | 43  | 10   | 8.6    | 170                      | 130                | 65                 |
| 0.50°              | -4°            | 240   | 180    | 90     | 24    | 48  | 11   | 10     | 190                      | 145                | 72                 |
| 0.50°              | +30°           | 135   | 100    | 50     | 14    | 27  | 6.0  | 5.4    | 110                      | 81                 | 41                 |
| 1.00°              | -4°            | 80    | 60     | 30     | 8.0   | 16  | 3.6  | 3.2    | 64                       | 48                 | 24                 |
| 1.00°              | +30°           | 45    | 34     | 17     | 4.5   | 9.0 | 2.0  | 1.8    | 36                       | 27                 | 14                 |

<sup>A</sup> Minimum Coefficient of Retroreflection ( $R_A$ ) cd/ft<sup>2</sup> (cd·lx<sup>-1</sup>·m<sup>-2</sup>).

<sup>B</sup> Values for 0.1° observation angles are supplementary requirements that shall apply only when specified by the purchaser in the contract or order.

**TABLE 10 Type XI Sheeting<sup>A</sup>**

| Observation Angle  | Entrance Angle | White | Yellow | Orange | Green | Red | Blue | Purple | Brown | Fluorescent Yellow-Green | Fluorescent Yellow | Fluorescent Orange |
|--------------------|----------------|-------|--------|--------|-------|-----|------|--------|-------|--------------------------|--------------------|--------------------|
| 0.10° <sup>B</sup> | -4°            | 830   | 620    | 290    | 83    | 125 | 37   | 33     | 25    | 660                      | 500                | 250                |
| 0.10° <sup>B</sup> | +30°           | 325   | 245    | 115    | 33    | 50  | 15   | 13     | 10    | 260                      | 200                | 100                |
| 0.20°              | -4°            | 580   | 435    | 200    | 58    | 87  | 26   | 23     | 17    | 460                      | 350                | 175                |
| 0.20°              | +30°           | 220   | 165    | 77     | 22    | 33  | 10   | 8.8    | 7.0   | 180                      | 130                | 66                 |
| 0.50°              | -4°            | 420   | 315    | 150    | 42    | 63  | 19   | 17     | 13    | 340                      | 250                | 125                |
| 0.50°              | +30°           | 150   | 110    | 53     | 15    | 23  | 7.0  | 6.0    | 5.0   | 120                      | 90                 | 45                 |
| 1.00°              | -4°            | 120   | 90     | 42     | 12    | 18  | 5.0  | 4.8    | 4.0   | 96                       | 72                 | 36                 |
| 1.00°              | +30°           | 45    | 34     | 16     | 5.0   | 7.0 | 2.0  | 1.8    | 1.0   | 36                       | 27                 | 14                 |

<sup>A</sup> Minimum Coefficient of Retroreflection ( $R_A$ ) cd/ft<sup>2</sup> (cd·lx<sup>-1</sup>·m<sup>-2</sup>).

<sup>B</sup> Values for 0.1° observation angle are supplementary requirements that shall only apply when specified by the purchaser in the contract or order.

2, or degrease and lightly acid etch before the specimens are applied. Apply the specimens to the panels in accordance with the recommendations of the retroreflective sheeting manufacturer.

### 7.3 Coefficient of Retroreflection:

7.3.1 For lots, rolls, or sheets of retroreflective sheeting at least 1 yd long in new (unexposed) condition, take 3 samples in accordance with Section 9.1. Determine the coefficients of retroreflection in accordance with Test Method E810.

7.3.1.1 To conform to this specification, the average of the 3 coefficients of retroreflection shall meet the minimum limits given in Section 6.2 and none of the coefficients of retroreflection obtained on any of the samples shall be less than 80 % of the values required in Section 6.2.