



INDUSTRIAL TESTING LABORATORY

Report No.

160128-05E

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TEST REPORT

Report Date:

26 May 2016

Project Name:

DaoMing DM7600 Series  
HIP Retroreflective Sheeting (Type IV)

Submitted by:

Daoming Optics & Chemical Co., Ltd  
Yongkang, China 321313

Test Laboratory:

Calcoast - ITL  
San Leandro, CA 94577

Products Tested:

DM7601 White, DM7602 Yellow, DM7605 Green,  
DM7604 Red, DM7606 Blue,  
submitted as six (6) 12" x 12" sheets by DaoMing

SUMMARY

Specification: ASTM D4956-16  
Sheeting Type IV, Class 1 Backing

6.2	Coefficient of Retroreflection .....	Passed
6.3	Daytime Color and Luminance .....	Passed
6.4	Outdoor Weathering (36 months) .....	Not Tested
6.5	Colorfastness [Artificial Accelerated Weathering Based] .....	Passed
6.6	Shrinkage .....	Passed
6.7	Flexibility .....	Passed
6.8	Liner Removal .....	Passed
6.9	Adhesion .....	Passed
6.10	Impact Resistance .....	Passed
6.11	Nighttime Color .....	Passed
	Specular Gloss <sup>†</sup> .....	Passed
S3.	Artificial Accelerated Weathering (2000 hours) .....	Passed

† - Discontinued since -09 version, tested for backward compatibility to previous versions

Written by:

Approved by:

Douglas G. Cummins  
Photometric Engineer

Mark A. Evans  
Laboratory Director

**TEST DATA SHEET**

Project Name: DaoMing DM7600 Series HIP Retroreflective Sheeting (Type IV)

**6.2 Coefficient of Retroreflection**

Requirement: ASTM D4956 Table 5 (Type IV Sheeting)  
 Test Method: ASTM E810 - Test Distance 100 feet (30.5 m)  
 Projector: Hoffman GPS-102 (Illuminant A, 1.0 fc, 30" diameter)  
 Sample Area: 8.0 in. x 8.0 in., 0.444 ft<sup>2</sup> (203 mm x 203 mm, 0.0412 m<sup>2</sup>)

Coefficient of Retroreflection ( $R_A$ ) determined by measuring three (3) 8"x8" samples mounted on 0.040" thick 6061-T6 aluminum panels at two rotation angles ( $\epsilon=0^\circ$  and  $\epsilon=90^\circ$ ) and averaging.  $\epsilon=0^\circ$  arbitrarily defined as orientation parallel to roll direction (see photos).

Tested in accordance to ASTM E810 10.7.1 - since no rotation angle is specified the average of the two orientations ( $\epsilon=0^\circ$  and  $\epsilon=90^\circ$ ) is required to meet minimum requirements.

Unknown if sampling in accordance with D4956 Section 9.1

Units: Candela per footcandle per square foot (Candela per Lux per square meter)

## 0.2° Observation Angle

Entrance Angle:		-4°				+30°			
Sample		0°	90°	Avg( $R_A$ )	Min $R_A$	0°	90°	Avg( $R_A$ )	Min $R_A$
DM7601 White	#1	428.4	345.8	387.1	288	188.4	240.5	214.5	136
	#2	520.8	416.6	468.7	288	155.8	296.0	225.9	136
	#3	487.5	464.3	475.9	288	160.5	266.8	213.7	136
	Average	478.9	408.9	<b>443.9</b>	360	168.2	267.8	<b>218.0</b>	170
DM7602 Yellow	#1	376.7	349.2	363.0	216	238.2	184.6	211.4	108
	#2	392.0	363.3	377.7	216	225.8	190.1	208.0	108
	#3	418.6	359.8	389.2	216	251.4	187.3	219.4	108
	Average	395.8	357.4	<b>376.6</b>	270	238.5	187.3	<b>212.9</b>	135
DM7605 Green	#1	110.5	124.8	117.7	40	69.0	77.6	73.3	20
	#2	114.4	121.1	117.8	40	74.4	79.0	76.7	20
	#3	114.5	123.5	119.0	40	74.0	77.3	75.7	20
	Average	113.1	123.1	<b>118.1</b>	50	72.5	78.0	<b>75.2</b>	25
DM7604 Red	#1	115.2	97.5	106.4	52	61.7	45.8	53.8	24
	#2	120.8	94.1	107.5	52	62.4	42.4	52.4	24
	#3	114.5	81.7	98.1	52	58.8	36.4	47.6	24
	Average	116.8	91.1	<b>104.0</b>	65	61.0	41.5	<b>51.3</b>	30
DM7606 Blue	#1	49.4	38.5	44.0	24	21.3	22.9	22.1	11
	#2	49.4	42.0	45.7	24	19.2	25.4	22.3	11
	#3	49.9	39.0	44.5	24	17.5	18.9	18.2	11
	Average	49.6	39.8	<b>44.7</b>	30	19.3	22.4	<b>20.9</b>	14

**TEST DATA SHEET**

Project Name: DaoMing DM7600 Series HIP Retroreflective Sheeting (Type IV)

**6.2 Coefficient of Retroreflection (continued)**

0.5° Observation Angle

Entrance Angle:		-4°				+30°			
Sample		0°	90°	Avg ( $R_A$ )	Min $R_A$	0°	90°	Avg ( $R_A$ )	Min $R_A$
DM7601 White	#1	344.2	240.6	292.4	120	176.8	136.9	156.9	58
	#2	316.2	241.5	278.9	120	177.3	161.3	169.3	58
	#3	285.4	254.0	269.7	120	200.8	164.8	182.8	58
	Average	315.3	245.4	<b>280.3</b>	150	185.0	154.3	<b>169.7</b>	72
DM7602 Yellow	#1	248.1	239.8	244.0	88	153.0	129.6	141.3	43
	#2	260.9	252.9	256.9	88	151.5	133.2	142.4	43
	#3	246.2	241.0	243.6	88	152.3	122.7	137.5	43
	Average	251.7	244.6	<b>248.2</b>	110	152.3	128.5	<b>140.4</b>	54
DM7605 Green	#1	90.7	78.6	84.7	17	52.2	51.7	52.0	8.0
	#2	94.0	81.2	87.6	17	58.4	53.3	55.9	8.0
	#3	91.8	78.6	85.2	17	54.6	53.6	54.1	8.0
	Average	92.2	79.5	<b>85.8</b>	21	55.1	52.9	<b>54.0</b>	10
DM7604 Red	#1	57.4	61.6	59.5	22	34.3	28.6	31.5	10
	#2	59.7	67.0	63.4	22	33.6	27.2	30.4	10
	#3	55.8	61.1	58.5	22	32.8	24.0	28.4	10
	Average	57.6	63.2	<b>60.4</b>	27	33.6	26.6	<b>30.1</b>	13
DM7606 Blue	#1	35.0	17.6	26.3	10	17.8	11.8	14.8	4.8
	#2	34.5	19.4	27.0	10	17.8	12.1	15.0	4.8
	#3	34.8	18.1	26.5	10	17.7	12.1	14.9	4.8
	Average	34.8	18.4	<b>26.6</b>	13	17.8	12.0	<b>14.9</b>	6.0

Individual sample's Coefficient of Retroreflection may be 80% of required so long as average of three samples meets minimum requirement.

Products meet Coefficient of Retroreflection requirements for Type IV Sheeting at the 0°, 90°, and the average of 0° and 90° rotations.

**TEST DATA SHEET**

Project Name: DaoMing DM7600 Series HIP Retroreflective Sheeting (Type IV)

**6.3 Daytime Color and Luminance**

Requirement: ASTM D4956 Tables 2 and 11 (Type IV Sheeting)

Test Method: ASTM E308, E1347, E1349, E991, E1164

(Illuminant D65, 2° Observer, Annular 45/0 Geometry)

Average of 8 reads, each read oriented 45° apart

Instrument: Hunterlab Colorflex A60 Spectrocolorimeter (No SCF available)

Product	x	y	Y		
			Measured	Minimum	Maximum
DM7601 White	0.3017	0.3176	50.31	27	-
DM7602 Yellow	0.5469	0.4494	24.39	15	45
DM7605 Green	0.1403	0.4201	8.20	3.0	12
DM7604 Red	0.6700	0.3182	6.23	2.5	15
DM7606 Blue	0.1418	0.1013	4.23	1.0	10

Products meet Daytime Color and Luminance requirements.

**6.4 Accelerated Outdoor Weathering**

Requirement: 80% of ASTM D4956 Table 5 (Type IV), 0.2° observation only

Test Method: Exposure: ASTM G7, 36 months, AZ &amp; FL, 45° exposure

Reflex: ASTM E810

Sample Area: 3 in x 6 in, 0.125 ft<sup>2</sup> (75 mm x 150 mm, 0.0113 m<sup>2</sup>)

Not Tested (see S3)

**6.5 Colorfastness**

Requirement: ASTM D4956 Tables 2 and 11 (Type IV Sheeting)

Test Method: Exposure: ASTM D4956 S3, Method I

(ISO 4892-2:2006/Amd.1:2009, Cycle 10) - 2000 hours

Color: ASTM E308, E1347, E1349, E991, E1164

(Illuminant D65, 2° Observer, Annular 45/0 Geometry)

Average of 8 reads, each read oriented 45° apart

Instrument: Hunterlab Colorflex A60 Spectrocolorimeter (No SCF available)

Post 2000 hour Artificial Accelerated Weathering (see S3)

Product	x	y	Y		
			Measured	Minimum	Maximum
DM7601 White	0.3052	0.3225	51.16	27	-
DM7602 Yellow	0.5477	0.4456	24.41	15	45
DM7605 Green	0.1434	0.4155	8.43	3.0	12
DM7604 Red	0.6543	0.3197	6.74	2.5	15
DM7606 Blue	0.1426	0.1085	4.36	1.0	10

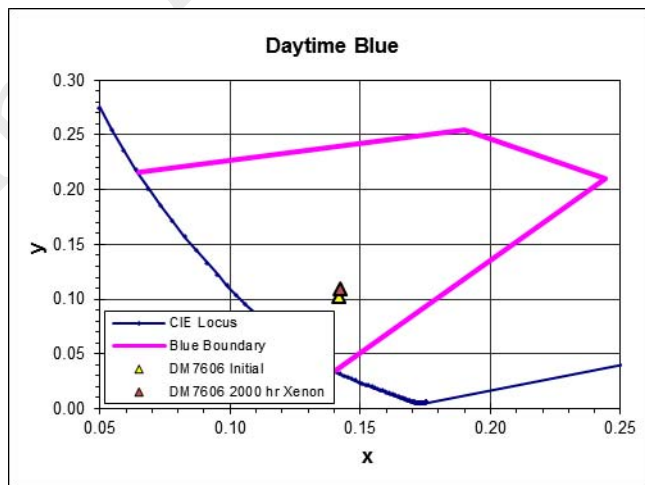
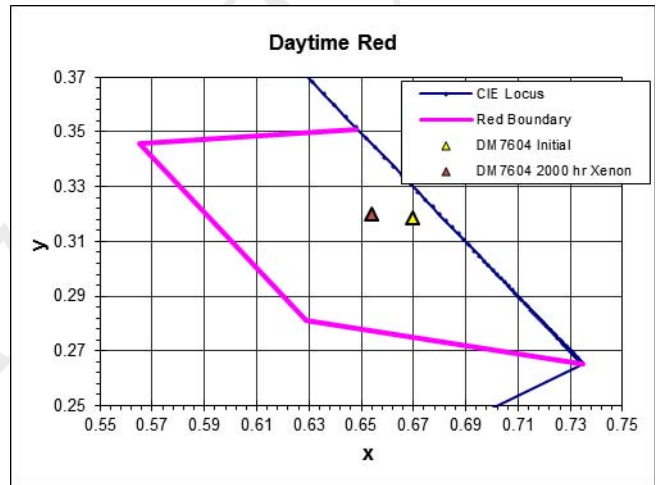
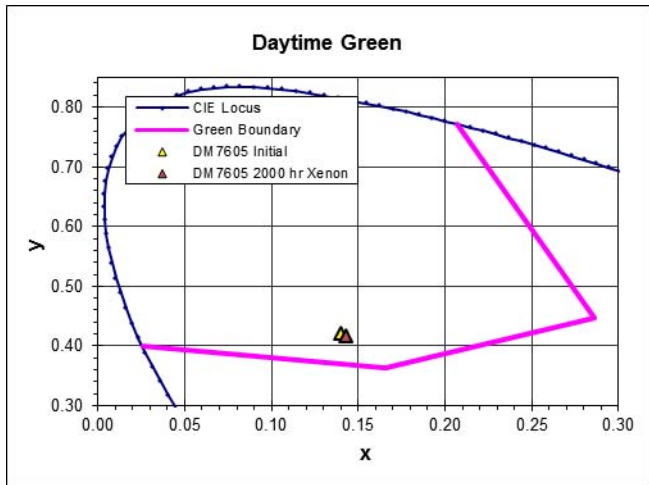
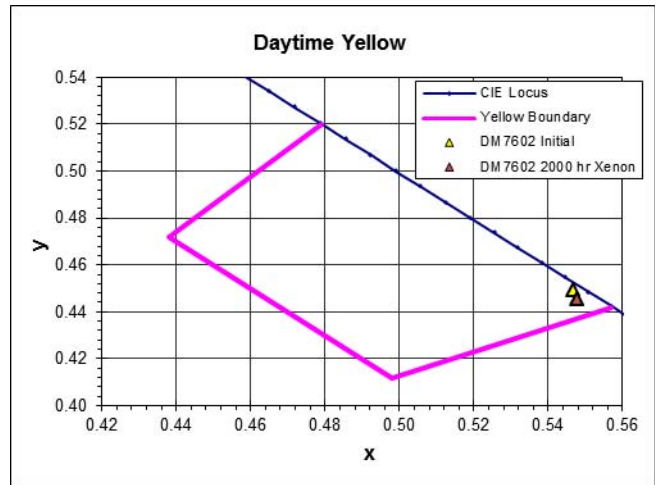
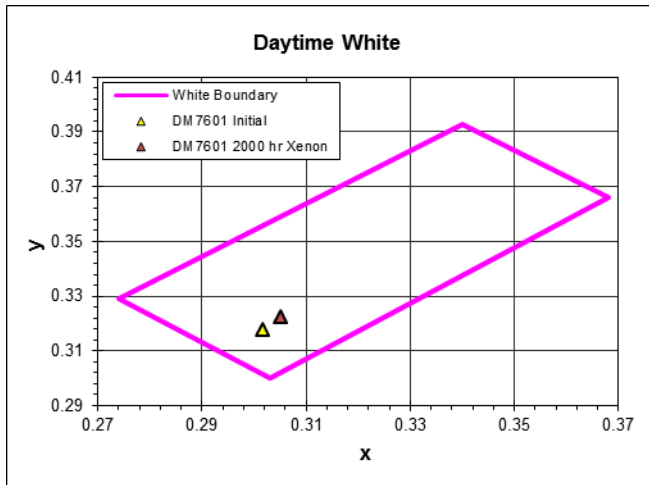
See next page for plots against color boundaries.

Products meet Colorfastness requirements.

TEST DATA SHEET

Project Name: DaoMing DM7600 Series HIP Retroreflective Sheeting (Type IV)

Daytime Color Plots



**TEST DATA SHEET**

Project Name: DaoMing DM7600 Series HIP Retroreflective Sheeting (Type IV)

**6.6 Shrinkage**

Requirement: ASTM D4956 6.6

Test Method: ASTM D4956 7.8

Removed liner from 9" x 9" samples and measured the sample side lengths at t = 0, t = 10 min, and t = 24 hours then determined the length changes.

Product	Side	10 minutes		24 hours	
		Measured	Maximum Allowed	Measured	Maximum Allowed
DM7601 White	1	N/C	1/32"	N/C	1/8"
	2	N/C		N/C	
	3	N/C		N/C	
	4	N/C		N/C	
DM7602 Yellow	1	N/C	1/32"	N/C	1/8"
	2	N/C		N/C	
	3	N/C		N/C	
	4	N/C		N/C	
DM7605 Green	1	N/C	1/32"	N/C	1/8"
	2	N/C		N/C	
	3	N/C		N/C	
	4	N/C		N/C	
DM7604 Red	1	N/C	1/32"	N/C	1/8"
	2	N/C		N/C	
	3	N/C		N/C	
	4	N/C		N/C	
DM7606 Blue	1	N/C	1/32"	N/C	1/8"
	2	N/C		N/C	
	3	N/C		N/C	
	4	N/C		N/C	

N/C indicates no change.

Products meet Shrinkage requirements.

**TEST DATA SHEET**

Project Name: DaoMing DM7600 Series HIP Retroreflective Sheeting (Type IV)

**6.7 Flexibility**

Requirement: ASTM D4956 6.7

Test Method: ASTM D4956 7.9

2¼" x 11" samples prepared by removing protective liner and liberally applying talc on adhesive side. Samples then bent around ½" diameter mandrel by grasping long ends of sample and placing center of sample at the mandrel with adhesive side contacting mandrel, then pulling long ends downward and together within 1 second until material had a 180° bend at its center. Samples tested in three (3) orientations - 0°, 45°, and 90° as defined for coefficient of retroreflection.

Product	Results		
	0°	45°	90°
DM7601 White	No cracking.	No cracking.	No cracking.
DM7602 Yellow	No cracking.	No cracking.	No cracking.
DM7605 Green	No cracking.	No cracking.	No cracking.
DM7604 Red	No cracking.	No cracking.	No cracking.
DM7606 Blue	No cracking.	No cracking.	No cracking.

Products meet Flexibility requirements.

**6.8 Liner Removal**

Requirement: ASTM D4956 6.8

Test Method: ASTM D4956 7.10

2" x 4" samples exposed to accelerated storage conditions of 71°C at 2.5 psi for 4 hours then cooled to 23°C for 1 hour.

Product	Results
DM7601 White	Liner easily removed without assistance and did not break, tear, or remove adhesive.
DM7602 Yellow	Liner easily removed without assistance and did not break, tear, or remove adhesive.
DM7605 Green	Liner easily removed without assistance and did not break, tear, or remove adhesive.
DM7604 Red	Liner easily removed without assistance and did not break, tear, or remove adhesive.
DM7606 Blue	Liner easily removed without assistance and did not break, tear, or remove adhesive.

Products meet Liner Removal requirements.

**TEST DATA SHEET**

Project Name: DaoMing DM7600 Series HIP Retroreflective Sheeting (Type IV)

**6.9 Adhesion**

Requirement: ASTM D4956 6.9

Test Method: ASTM D4956 7.5

4" each of two (2) 1"x6" sheeting samples were bonded to 0.040" thick degreased and acid-etched 6061-T6 aluminum panels. After conditioning, a 0.79kg weight was hung from the free end of sample 90° to the panel. After 5 minutes, the peel distance was measured.

Product	Peel Distance		Maximum
	1	2	
DM7601 White	0.05"	0.08"	2.0"
DM7602 Yellow	0.05"	0.06"	
DM7605 Green	0.05"	0.05"	
DM7604 Red	0.05"	0.05"	
DM7606 Blue	0.05"	0.05"	

Products meet Adhesion requirements.

**6.10 Impact Resistance**

Requirement: ASTM D4956 6.10

Test Method: ASTM D4956 7.11

3" x 5" samples mounted to 0.040" thick 6061-T6 aluminum and subjected to a 10 in-lb impact from a mass with a steel  $\frac{3}{8}$ " diameter round tip.

Product	Results
DM7601 White	No cracking or delamination outside impact area.
DM7602 Yellow	No cracking or delamination outside impact area.
DM7605 Green	No cracking or delamination outside impact area.
DM7604 Red	No cracking or delamination outside impact area.
DM7606 Blue	No cracking or delamination outside impact area.

Products meet Impact Resistance requirements.



**TEST DATA SHEET**

Project Name: DaoMing DM7600 Series HIP Retroreflective Sheeting (Type IV)

**6.11 Nighttime Color**

Requirement: ASTM D4956 Table 13

Test Method: ASTM E811, E308

(Illuminant A, 2° Observer, +5°/0.33° Geometry at 10 feet)  
Average of 3 reads at  $\varepsilon=0^\circ$  and  $90^\circ$ 

Instrument: Photo Research PR-650 Spectroradiometer

Initial

Product	$\varepsilon=0^\circ$		$\varepsilon=90^\circ$	
	x	y	x	y
DM7601 White	0.4545	0.4124	0.4590	0.4121
DM7602 Yellow	0.5500	0.4455	0.5526	0.4428
DM7605 Green	0.1966	0.5622	0.1974	0.5635
DM7604 Red	0.6781	0.3188	0.6789	0.3181
DM7606 Blue	0.1320	0.2545	0.1328	0.2667

Colorfastness - Post 2000 hr Xenon Weathering (see S3)

Product	$\varepsilon=0^\circ$		$\varepsilon=90^\circ$	
	x	y	x	y
DM7601 White	0.4632	0.4128	0.4672	0.4116
DM7602 Yellow	0.5484	0.4462	0.5506	0.4437
DM7605 Green	0.1974	0.5659	0.1993	0.5647
DM7604 Red	0.6683	0.3269	0.6685	0.3263
DM7606 Blue	0.1354	0.2712	0.1373	0.2829

Products meet Nighttime Color requirements.

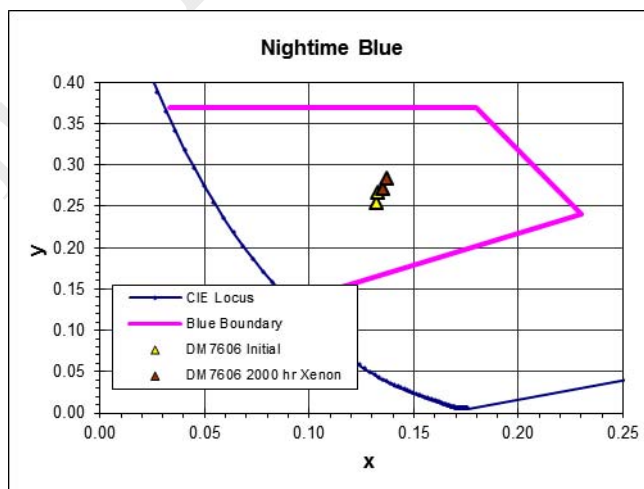
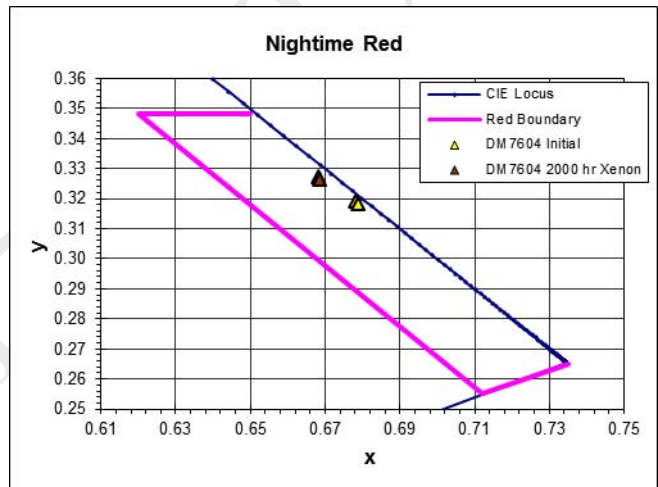
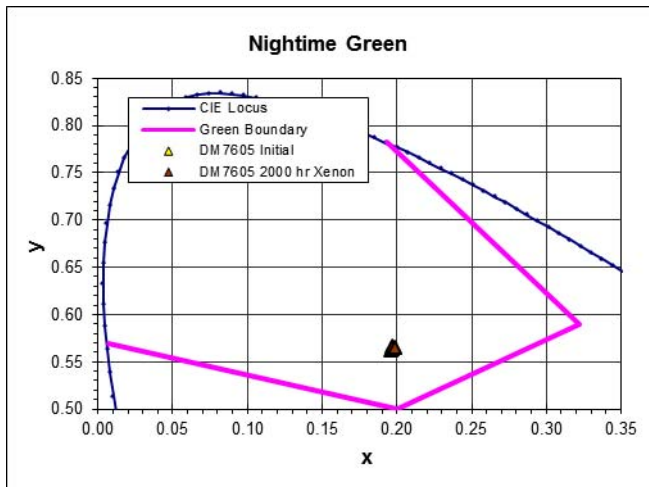
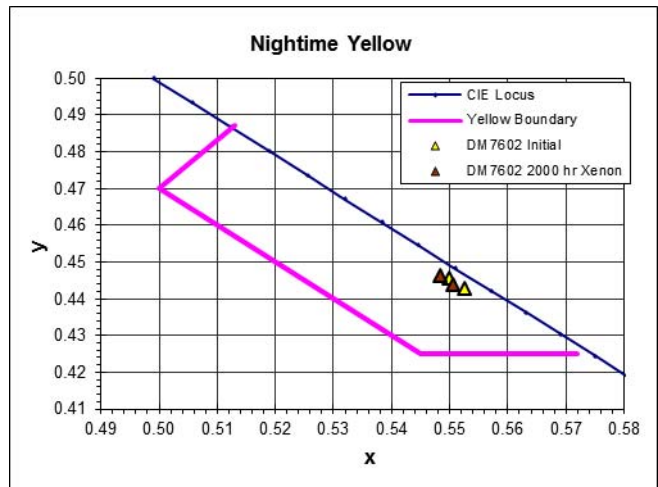
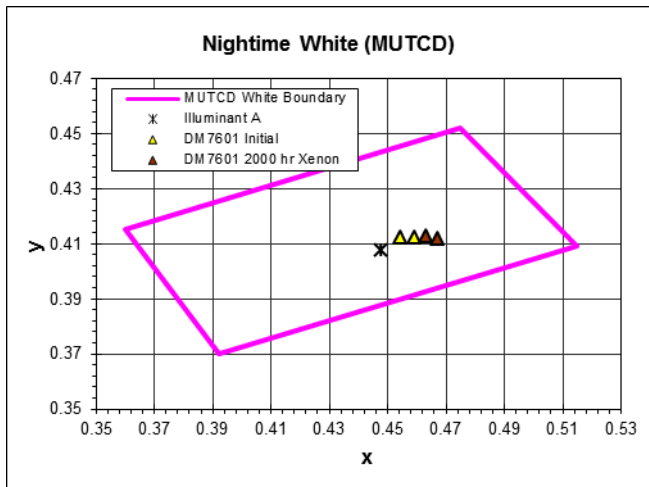
Note: D4956 has no White requirements; using MUTCD White requirements.  
All other color requirements identical to MUTCD requirements.

Colorfastness of Nighttime Color is not explicitly required for ASTM D4956.

**TEST DATA SHEET**

Project Name: DaoMing DM7600 Series HIP Retroreflective Sheet (Type IV)

**Nighttime Color Plots**



**TEST DATA SHEET**

Project Name: DaoMing DM7600 Series HIP Retroreflective Sheeting (Type IV)

**Specular Gloss (85°)**Requirement: ASTM D4956-07<sup>e1</sup> 6.11*Note: Specular Gloss discontinued since ASTM D4956-09  
Test included for backward compatibility*

Test Method: ASTM D523 (85°)

Instrument: Gardco 85° Glossmeter

Gloss was measured across three (3) orientations ( $\epsilon=0^\circ$ ,  $45^\circ$ , and  $90^\circ$ ) and averaged.

Product	Measured				Minimum
	0°	45°	90°	Avg	
DM7601 White	94.9	90.9	91.7	92.5	40
DM7602 Yellow	93.4	93.8	94.8	94.0	
DM7605 Green	98.0	96.2	94.1	96.1	
DM7604 Red	92.9	88.4	85.8	89.0	
DM7606 Blue	94.9	90.5	90.1	91.8	

Products meet Specular Gloss requirements.

**TEST DATA SHEET**

Project Name: DaoMing DM7600 Series HIP Retroreflective Sheeting (Type IV)

**S3. Artificial Accelerated Weathering**

Requirement: 80% of ASTM D4956 Table 5 (Type IV), 0.2° observation only  
 Test Method: Exposure: ASTM D4956 S3, Method I  
 (ISO 4892-2:2006/Amd.1:2009, Cycle 10) - 2000 hours;  
 New Jersey Industrial Controls report #: TRN 2016-688  
 Reflex: ASTM E810

Three (3) 3"x6" samples were mounted on 0.040" thick 6061-T6 aluminum panels and exposed for 2000 hours of Xenon Accelerated Weathering per ISO 4892-2:2006/Amd.1:2009 Cycle 10). Samples were washed in a mild detergent solution and dried after exposure.

Samples held in place on the two ends of the panel during exposure and thus some areas of the panel were not exposed. A 2" x 5" mask centered over the sample was used to cover unexposed areas. Samples' Coefficient of Retroreflection was measured at two rotation angles ( $\varepsilon=0^\circ$  and  $\varepsilon=90^\circ$ ) and averaged.

Units: Candela per footcandle per square foot (Candela per Lux per square meter)

Entrance Angle:		-4°				+30°			
Sample		0°	90°	Avg( $R_A$ )	Min $R_A$	0°	90°	Avg( $R_A$ )	Min $R_A$
DM7601 White	#1	473.2	528.7	501.0	-	131.3	203.5	167.4	-
	#2	564.1	518.6	541.4	-	194.1	348.2	271.2	-
	#3	382.2	395.6	388.9	-	203.5	278.7	241.1	-
	Average	473.2	481.0	<b>477.1</b>	288	176.3	276.8	<b>226.6</b>	136
DM7602 Yellow	#1	390.9	390.6	390.8	-	247.3	227.7	237.5	-
	#2	397.9	385.0	391.5	-	224.2	210.0	217.1	-
	#3	418.9	407.6	413.3	-	262.9	244.8	253.9	-
	Average	402.6	394.4	<b>398.5</b>	216	244.8	227.5	<b>236.2</b>	108
DM7605 Green	#1	106.7	125.1	115.9	-	62.8	79.4	71.1	-
	#2	123.7	133.4	128.6	-	76.9	80.4	78.7	-
	#3	99.9	111.6	105.8	-	65.8	76.1	71.0	-
	Average	110.1	123.4	<b>116.7</b>	40	68.5	78.6	<b>73.6</b>	20
DM7604 Red	#1	123.2	108.2	115.7	-	60.9	56.6	58.8	-
	#2	128.1	122.2	125.2	-	73.1	66.2	69.7	-
	#3	130.6	118.9	124.8	-	68.8	57.7	63.3	-
	Average	127.3	116.4	<b>121.9</b>	52	67.6	60.2	<b>63.9</b>	24
DM7606 Blue	#1	61.9	42.9	52.4	-	20.3	26.7	23.5	-
	#2	58.0	42.4	50.2	-	23.1	25.4	24.3	-
	#3	61.7	52.1	56.9	-	25.5	24.3	24.9	-
	Average	60.5	45.8	<b>53.2</b>	24	23.0	25.5	<b>24.2</b>	11

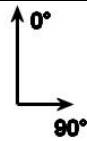
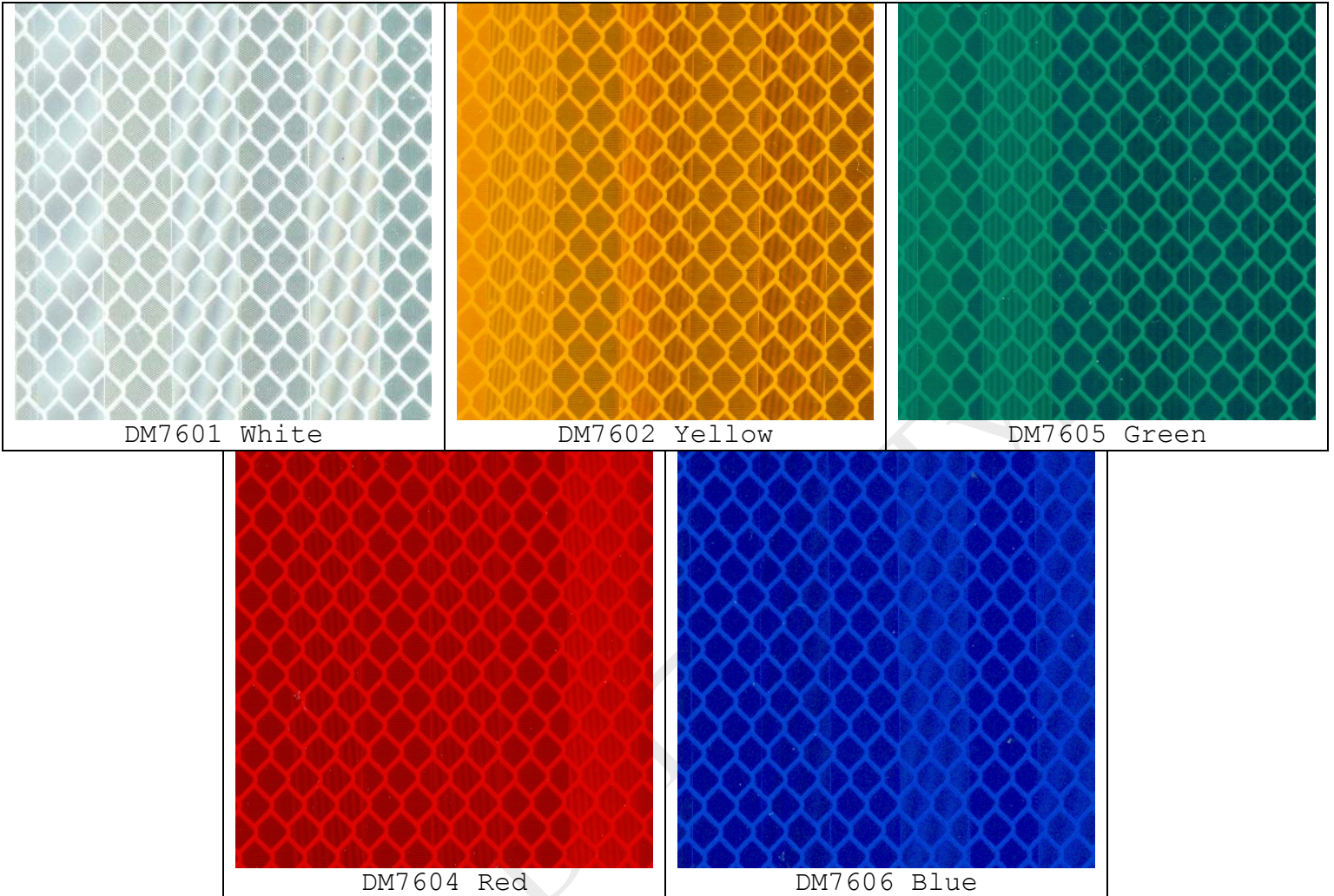
Samples show no appreciable cracking, scaling, pitting, blistering, edge lifting, or curling, or more than  $1/32$ " shrinkage or expansion.

Products meet Artificial Accelerated Weathering requirements at the 0°, 90°, and the average of 0° and 90° rotations.

**TEST DATA SHEET**

Project Name: DaoMing DM7600 Series HIP Retroreflective Sheeting (Type IV)

**Photographs**



Sheeting Orientation



HIP Grade DM7600 Series  
PMMA Type, Printable, Tearable  
[Http://www.chinadaoming.com](http://www.chinadaoming.com)

Label on sample liners