



INDUSTRIAL TESTING LABORATORY

Report No.

141103-01Er1

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TEST REPORT

Report Date: 24 November 2014
Revision Date: 01 May 2015 [added Artificial Accelerated Weathering Data]

Project Name: Huangshan Xingwei XW7200 Series Engineering Grade Retroreflective Sheeting (Type I)

Submitted by: Huangshan Xingwei Reflectorized Material Co., Ltd. Huang Shan City, An Hui Province, China 245200

Test Laboratory: Calcoast - ITL San Leandro, CA 94577

Products Tested: XW7212 White, XW7204 Yellow, XW7208 Green, XW7205 Red, XW7206 Blue

SUMMARY

Specification: ASTM D4956-13 Sheeting Type I, Class 1 Backing

- 6.2 Coefficient of Retroreflection...Passed
6.3 Daytime Color and Luminance...Passed
6.4 Outdoor Weathering...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+...Passed
S1. Fungus Resistance...Not Tested
S3. Artificial Accelerated Weathering...Passed

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

Written by:

Approved by:

[Signature of Douglas G. Cummins]

Douglas G. Cummins
Photometric Engineer

Mark A. Evans
Laboratory Director

TEST DATA SHEET

Project Name: Huangshan Xingwei XW7200 Series Engineering Grade
Retroreflective Sheeting (Type I)

6.2 Coefficient of Retroreflection

Requirement: ASTM D4956 Table 1 (Type I Sheeting)
Test Method: ASTM E810 - Test Distance 100 feet (30.5 m)
Projector: Hoffman GPS-102 (Illuminant A, 1.00 fc, 30" diameter)
Sample Area: 8.0 in. x 8.0 in., 0.444 ft² (204 mm x 204 mm, 0.0416 m²)

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 with lining text upright (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
XW7212 White	#1	98.6	98.5	98.6	56	48.1	47.0	47.6	24
	#2	103.5	103.5	103.5	56	48.9	48.4	48.7	24
	#3	104.7	104.8	104.8	56	47.4	46.7	47.1	24
	Average	102.3	102.3	102.3	70	48.1	47.4	47.8	30
XW7204 Yellow	#1	70.9	70.8	70.9	40	42.0	40.0	41.0	18
	#2	70.6	70.5	70.6	40	41.7	39.8	40.8	18
	#3	71.2	71.0	71.1	40	40.8	39.5	40.2	18
	Average	70.9	70.8	70.8	50	41.5	39.8	40.6	22
XW7208 Green	#1	17.6	17.6	17.6	7.2	8.8	8.4	8.6	2.8
	#2	14.6	14.6	14.6	7.2	7.2	6.9	7.1	2.8
	#3	15.3	15.4	15.4	7.2	7.8	7.5	7.7	2.8
	Average	15.8	15.9	15.9	9.0	7.9	7.6	7.8	3.5
XW7205 Red	#1	16.5	16.5	16.5	11	6.2	5.8	6.0	4.8
	#2	18.2	18.2	18.2	11	7.6	7.1	7.4	4.8
	#3	16.6	16.5	16.6	11	7.1	6.7	6.9	4.8
	Average	17.1	17.1	17.1	14	7.0	6.5	6.8	6.0
XW7206 Blue	#1	6.9	6.9	6.9	3.2	2.9	2.8	2.9	1.4
	#2	6.8	6.8	6.8	3.2	2.9	2.7	2.8	1.4
	#3	6.7	6.8	6.8	3.2	2.8	2.7	2.8	1.4
	Average	6.8	6.8	6.8	4.0	2.9	2.7	2.8	1.7

TEST DATA SHEET

Project Name: Huangshan Xingwei XW7200 Series Engineering Grade
Retroreflective Sheeting (Type I)

6.2 Coefficient of Retroreflection

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
XW7212 White	#1	43.6	43.4	43.5	24	30.1	29.6	29.9	12
	#2	47.0	47.0	47.0	24	31.4	31.0	31.2	12
	#3	48.7	48.7	48.7	24	30.8	30.3	30.6	12
	Average	46.4	46.4	46.4	30	30.8	30.3	30.5	15
XW7204 Yellow	#1	28.6	28.6	28.6	20	24.1	23.4	23.8	10
	#2	28.1	28.1	28.1	20	24.1	23.5	23.8	10
	#3	28.9	28.9	28.9	20	23.9	23.5	23.7	10
	Average	28.5	28.5	28.5	25	24.0	23.5	23.8	13
XW7208 Green	#1	7.2	7.2	7.2	3.6	5.0	4.9	5.0	1.8
	#2	6.1	6.1	6.1	3.6	4.1	4.0	4.1	1.8
	#3	6.2	6.3	6.3	3.6	4.4	4.2	4.3	1.8
	Average	6.5	6.5	6.5	4.5	4.5	4.4	4.4	2.2
XW7205 Red	#1	9.2	9.3	9.3	6.0	4.4	4.1	4.3	2.4
	#2	9.7	9.7	9.7	6.0	5.2	4.9	5.1	2.4
	#3	9.1	9.1	9.1	6.0	4.9	4.6	4.8	2.4
	Average	9.3	9.4	9.4	7.5	4.8	4.5	4.7	3.0
XW7206 Blue	#1	3.1	3.1	3.1	1.6	1.7	1.6	1.7	0.6
	#2	3.1	3.1	3.1	1.6	1.7	1.6	1.7	0.6
	#3	3.0	3.0	3.0	1.6	1.7	1.6	1.7	0.6
	Average	3.1	3.1	3.1	2.0	1.7	1.6	1.7	0.8

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 I Sheeting.

TEST DATA SHEET

Project Name: Huangshan Xingwei XW7200 Series Engineering Grade
Retroreflective Sheeting (Type I)

6.3 Daytime Color and Luminance

Requirement: ASTM D4956 Tables 2 and 11 (Type III 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
XW7212 White	0.3096	0.3292	45.58	27	-
XW7204 Yellow	0.5049	0.4745	28.43	15	45
XW7208 Green	0.1334	0.4532	9.34	3.0	12
XW7205 Red	0.6334	0.3363	9.16	2.5	15
XW7206 Blue	0.1553	0.1275	2.75	1.0	10

Products meet Daytime Color and Luminance requirements.

Note: See next page for plots against color boundaries.

6.4 Accelerated Outdoor Weathering

Requirement: 50% of ASTM D4956 Table 1 (Type I), 0.2° observation only
Test Method: Exposure: ASTM G7, 24 months, AZ & FL, 45° exposure
Reflex: ASTM E810

Not Tested

6.5 Colorfastness (modified)

Requirement: ASTM D4956 Tables 2 and 11 (Type I Sheeting)
Test Method: Exposure: ASTM D4956 S3, Method I
(ISO 4892-2:2006/Amd.1:2009, Cycle 10) - 1000 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 1000 hour Artificial Accelerated Weathering

Product	x	y	Y		
			Measured	Minimum	Maximum
XW7212 White	0.3112	0.3304	43.44	27	-
XW7204 Yellow	0.4935	0.4789	28.28	15	45
XW7208 Green	0.1357	0.4487	8.96	3.0	12
XW7205 Red	0.6246	0.3346	9.27	2.5	15
XW7206 Blue	0.1536	0.1319	3.02	1.0	10

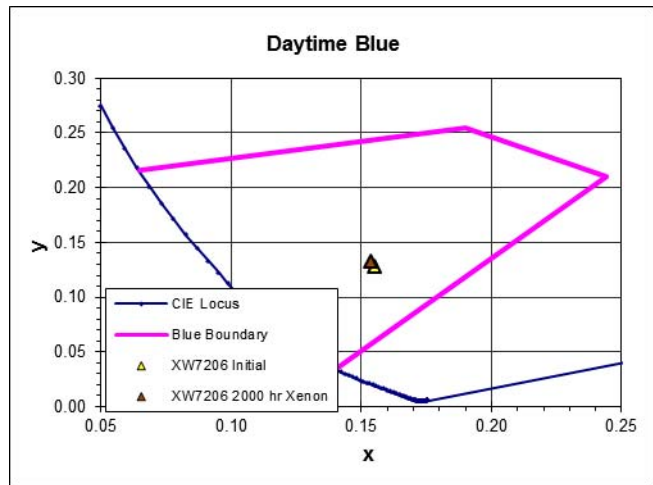
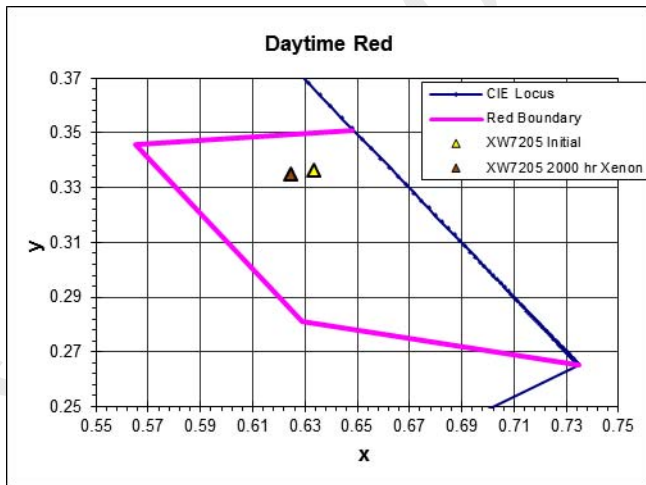
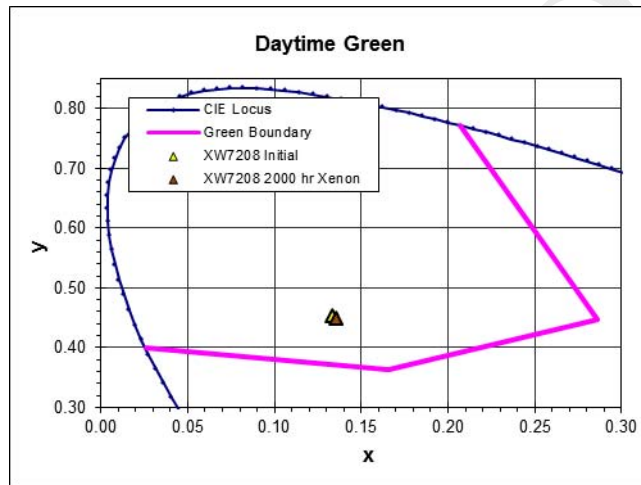
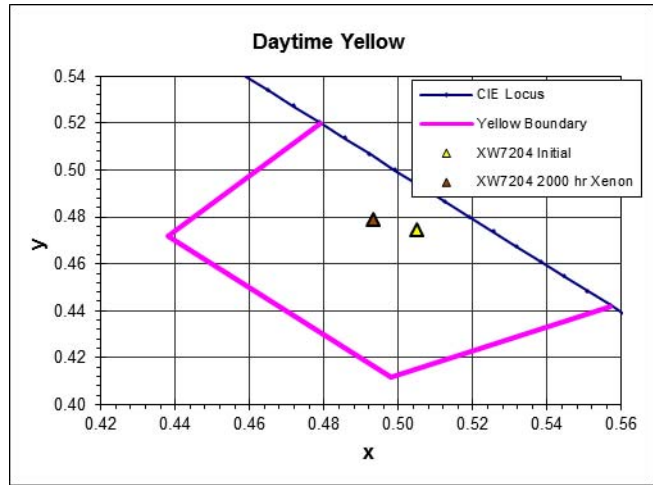
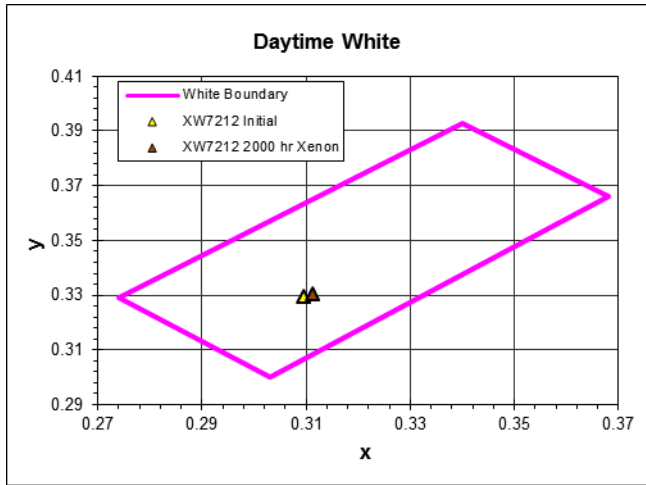
Products meet Colorfastness requirements.

Note: See next page for plots against color boundaries.

TEST DATA SHEET

Project Name: Huangshan Xingwei XW7200 Series Engineering Grade Retroreflective Sheeting (Type I)

Daytime Color Plots



TEST DATA SHEET

Project Name: Huangshan Xingwei XW7200 Series Engineering Grade
Retroreflective Sheeting (Type I)

6.6 Shrinkage

Requirement: ASTM D4956 6.6

Test Method: ASTM D4956 7.8

Product	Side	10 minutes		24 hours	
		Measured	Maximum Allowed	Measured	Maximum Allowed
XW7212 White	1	N/C	1/32"	-1/32"	1/8"
	2	N/C		-1/64"	
	3	N/C		-1/64"	
	4	N/C		-1/32"	
XW7204 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	
XW7208 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	
XW7205 Red	1	N/C	1/32"	-1/64"	1/8"
	2	N/C		N/C	
	3	N/C		-1/64"	
	4	N/C		N/C	
XW7206 Blue	1	N/C	1/32"	N/C	1/8"
	2	N/C		-1/64"	
	3	N/C		-1/64"	
	4	N/C		-1/64"	

N/C indicates no change.

Products meet Shrinkage requirements.

TEST DATA SHEET

Project Name: Huangshan Xingwei XW7200 Series Engineering Grade
Retroreflective Sheeting (Type I)

6.7 Flexibility

Requirement: ASTM D4956 6.7

Test Method: ASTM D4956 7.9

Samples prepared by removing protective liner and liberally applying talc on adhesive side. Samples then bent around $\frac{1}{8}$ " 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°
XW7212 White	No cracking.	No cracking.	No cracking.
XW7204 Yellow	No cracking.	No cracking.	No cracking.
XW7208 Green	No cracking.	No cracking.	No cracking.
XW7205 Red	No cracking.	No cracking.	No cracking.
XW7206 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

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
XW7212 White	Liner easily removed without assistance and did not break, tear, or remove adhesive.
XW7204 Yellow	Liner easily removed without assistance and did not break, tear, or remove adhesive.
XW7208 Green	Liner easily removed without assistance and did not break, tear, or remove adhesive.
XW7205 Red	Liner easily removed without assistance and did not break, tear, or remove adhesive.
XW7206 Blue	Liner easily removed without assistance and did not break, tear, or remove adhesive.

Products meet Liner Removal requirements.

TEST DATA SHEET

Project Name: Huangshan Xingwei XW7200 Series Engineering Grade
Retroreflective Sheeting (Type I)

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	
XW7212 White	0.05"	0.05"	2.0"
XW7204 Yellow	0.05"	0.10"	
XW7208 Green	0.05"	0	
XW7205 Red	0.06"	0.05"	
XW7206 Blue	0	0.10"	

Products meet Adhesion requirements.

6.10 Impact Resistance

Requirement: ASTM D4956 6.10

Test Method: ASTM D4956 7.11

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

Product	Results
XW7212 White	No cracking or delamination outside impact area.
XW7204 Yellow	No cracking or delamination outside impact area.
XW7208 Green	No cracking or delamination outside impact area.
XW7205 Red	No cracking or delamination outside impact area.
XW7206 Blue	No cracking or delamination outside impact area.

Products meet Impact Resistance requirements.

TEST DATA SHEET

Project Name: Huangshan Xingwei XW7200 Series Engineering Grade
Retroreflective Sheeting (Type I)

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°

Instrument: Photo Research PR-650 Spectroradiometer

Initial

Product	$\varepsilon=0^\circ$		$\varepsilon=90^\circ$	
	x	y	x	y
XW7212 White	0.4463	0.4192	0.4472	0.4192
XW7204 Yellow	0.5466	0.4470	0.5450	0.4485
XW7208 Green	0.1979	0.6346	0.1980	0.6335
XW7205 Red	0.6695	0.3247	0.6696	0.3245
XW7206 Blue	0.1334	0.3039	0.1336	0.3005

Post 1000 hour Weathering

Product	$\varepsilon=0^\circ$		$\varepsilon=90^\circ$	
	x	y	x	y
XW7212 White	0.4410	0.4181	0.4374	0.4165
XW7204 Yellow	0.5224	0.4605	0.5223	0.4606
XW7208 Green	0.2045	0.6357	0.2045	0.6355
XW7205 Red	0.6635	0.3289	0.6631	0.3289
XW7206 Blue	0.1350	0.3198	0.1352	0.3191

Products meet Nighttime Color requirements.

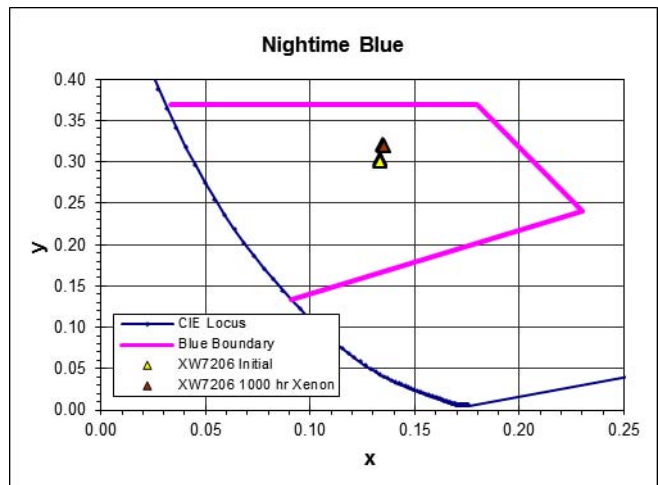
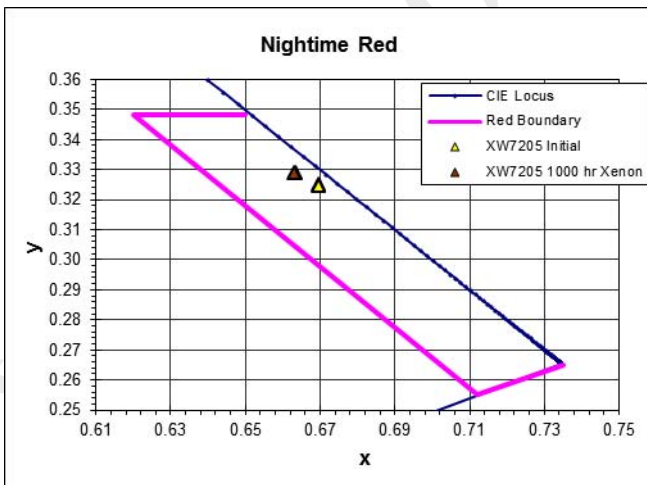
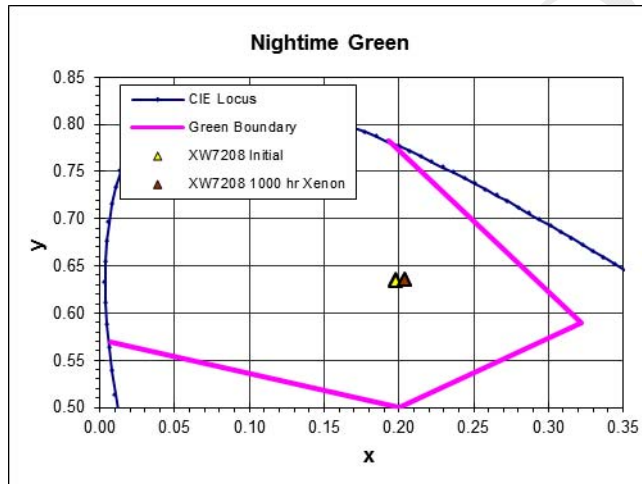
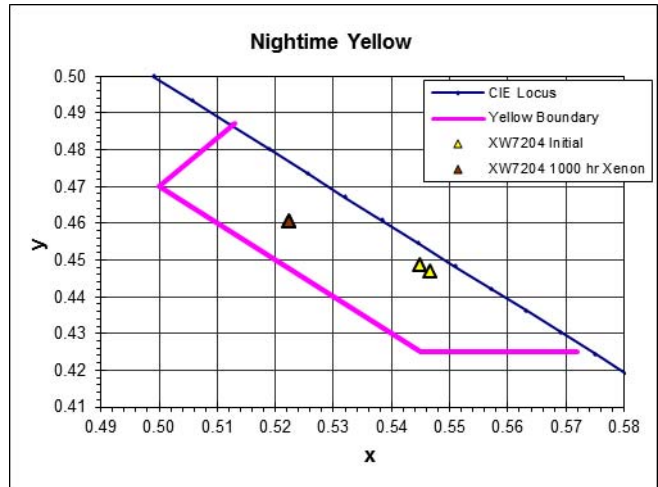
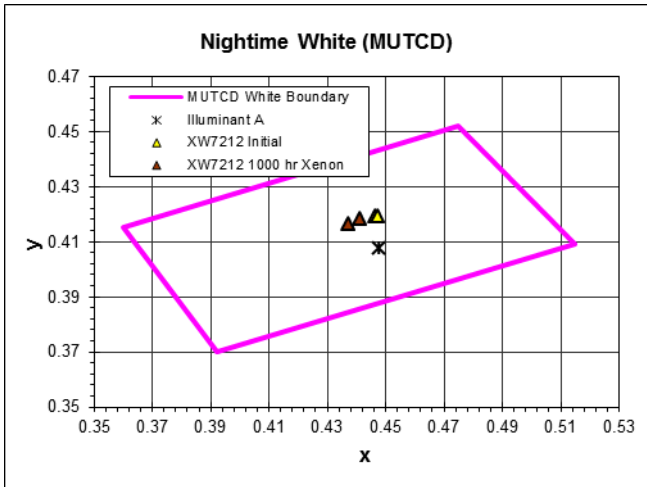
Note: D4956 has no White requirements; using MUTCD White requirements.
All other color requirements identical to MUTCD requirements.
See next page for plots against color boundaries.

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

TEST DATA SHEET

Project Name: Huangshan Xingwei XW7200 Series Engineering Grade Retroreflective Sheeting (Type I)

Nighttime Color Plots



TEST DATA SHEET

Project Name: Huangshan Xingwei XW7200 Series Engineering Grade
Retroreflective Sheeting (Type I)

Specular Gloss (85°)

Requirement: ASTM D4956-07^{e1} 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° , and 90°) and averaged.

Product	Measured				Minimum
	0°	45°	90°	Avg	
XW7212 White	85.1	85.4	84.6	85.0	40
XW7204 Yellow	83.1	84.0	83.6	83.6	
XW7208 Green	92.4	91.0	90.5	91.3	
XW7205 Red	77.8	77.2	76.8	77.3	
XW7206 Blue	73.6	72.8	71.4	72.6	

Products meet Specular Gloss requirements.

TEST DATA SHEET

Project Name: Huangshan Xingwei XW7200 Series Engineering Grade
Retroreflective Sheeting (Type I)

S3. Artificial Accelerated Weathering

Requirement: 50% of ASTM D4956 Table 1 (Type I), 0.2° observation only
Test Method: Exposure: ASTM D4956 S3, Method I
(ISO 4892-2:2006/Amd.1:2009, Cycle 1) - 1000 hours;
ARDL report PN121079
Reflex: ASTM E810

Three (3) 3"x6" samples were mounted on 0.040" thick 6061-T6 aluminum panels and exposed for 1000 hours of Xenon Accelerated Weathering per ISO 4892-2:2006/Amd.1:2009 Cycle 1 at ARDL.

After washing in a mild detergent solution and dried, samples' Coefficient of Retroreflection was measured at two rotation angles ($\epsilon=0^\circ$ and $\epsilon=90^\circ$) 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
XW7212 White	#1	84.8	86.9	85.9	35	46.4	50.7	48.6	15
	#2	86.2	85.9	86.1		44.1	47.7	45.9	
	#3	86.7	86.8	86.8		40.8	47.2	44.0	
	Average	85.9	86.5	86.2		43.8	48.5	46.2	
XW7204 Yellow	#1	75.0	75.1	75.1	25	44.4	46.1	45.3	11
	#2	70.1	69.9	70.0		42.2	43.2	42.7	
	#3	69.9	69.7	69.8		41.2	44.8	43.0	
	Average	71.7	71.6	71.6		42.6	44.7	43.7	
XW7208 Green	#1	14.9	14.9	14.9	4.5	6.9	7.0	7.0	1.8
	#2	17.4	17.5	17.5		8.2	8.8	8.5	
	#3	17.6	17.8	17.7		7.7	8.8	8.3	
	Average	16.6	16.7	16.7		7.6	8.2	7.9	
XW7205 Red	#1	19.8	20.1	20.0	7.0	7.4	8.2	7.8	3.0
	#2	21.8	21.9	21.9		9.9	11.2	10.6	
	#3	21.8	22.0	21.9		9.2	10.2	9.7	
	Average	21.1	21.3	21.2		8.8	9.9	9.4	
XW7206 Blue	#1	7.8	8.0	7.9	2.0	3.0	3.3	3.2	0.9
	#2	8.4	8.6	8.5		3.2	3.5	3.4	
	#3	8.3	8.5	8.4		3.0	3.4	3.2	
	Average	8.2	8.4	8.3		3.1	3.4	3.2	

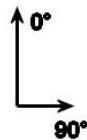
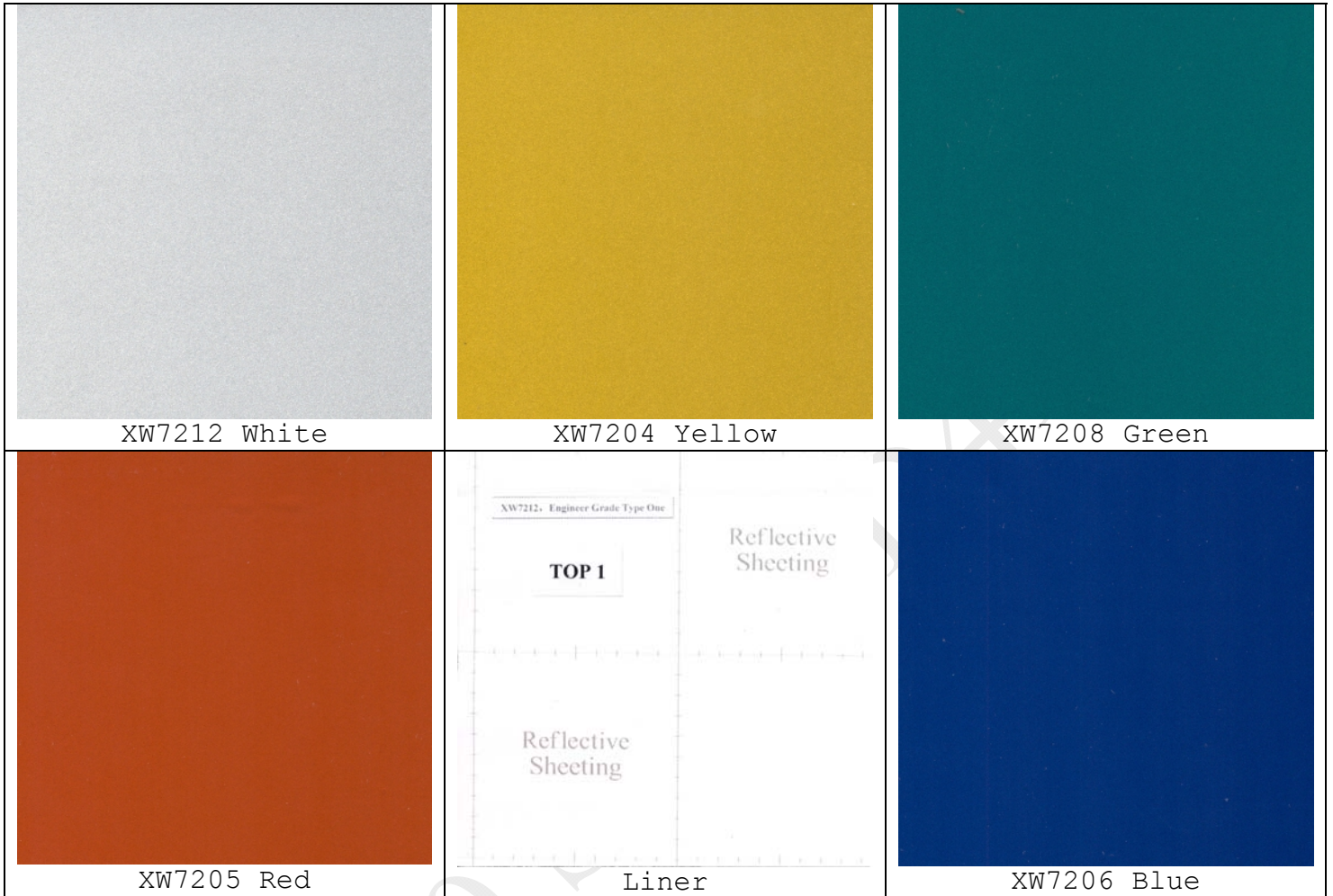
Samples show no appreciable cracking, scaling, pitting, blistering, edge lifting, or curling, or more than $1/32$ " shrinkage or expansion.

Products meet Artificial Accelerated Weathering requirements.

TEST DATA SHEET

Project Name: Huangshan Xingwei XW7200 Series Engineering Grade
Retroreflective Sheeting (Type I)

Photographs



Sheeting Orientation

XW7200