



INDUSTRIAL TESTING LABORATORY

Report No.

141103-02Er1

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TEST REPORT

Report Date: 24 November 2014

Revision Date: 09 February 2015 [revised photometry & color]

Project Name: Huangshan Xingwei XW1800 Series Hi Intensity Grade Retroreflective Sheeting (Type III)

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: XW1812 White, XW1804 Yellow, XW1808 Green, XW1805 Red, XW1806 Blue samples submitted 03 Nov 2014 and 15 Jan 2015

SUMMARY

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

- 6.2 Coefficient of RetroreflectionPassed
- 6.3 Daytime Color and LuminancePassed
- 6.4 Outdoor WeatheringNot Tested
- 6.5 ColorfastnessNot Tested
- 6.6 ShrinkagePassed
- 6.7 FlexibilityPassed
- 6.8 Liner RemovalPassed
- 6.9 AdhesionPassed
- 6.10 Impact ResistancePassed
- 6.11 Nighttime ColorPassed
- Specular Gloss[†]Passed
- S1. Fungus ResistanceNot Tested
- S3. Artificial Accelerated WeatheringNot Tested

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

Written by:

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Douglas G. Cummins
Photometric Engineer

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Laboratory Director

TEST DATA SHEET

Project Name: Huangshan Xingwei XW1800 Series Hi Intensity Grade
Retroreflective Sheeting (Type III)

6.2 Coefficient of Retroreflection

Requirement: ASTM D4956 Table 4 (Type III 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
XW1812 White	#1	267.5	267.5	267.5	200	251.5	255.5	253.5	120
	#2	267.7	267.2	267.5	200	256.9	264.5	260.7	120
	#3	269.5	270.6	270.1	200	252.2	262.0	257.1	120
	Average	268.2	268.4	268.3	250	253.5	260.7	257.1	150
XW1804 Yellow	#1	211.7	213.2	212.5	136	191.0	202.5	196.8	80
	#2	214.0	214.9	214.5	136	200.3	206.2	203.3	80
	#3	204.8	206.0	205.4	136	191.8	194.4	193.1	80
	Average	210.2	211.4	210.8	170	194.4	201.0	197.7	100
XW1808 Green	#1	65.8	66.6	66.2	36	60.6	61.3	61.0	20
	#2	65.9	66.6	66.3	36	60.8	61.5	61.2	20
	#3	66.4	66.9	66.7	36	61.2	61.6	61.4	20
	Average	66.0	66.7	66.4	45	60.9	61.5	61.2	25
XW1805 Red	#1	46.5	46.6	46.6	36	42.7	43.7	43.2	20
	#2	45.7	46.0	45.9	36	42.2	42.9	42.6	20
	#3	46.7	46.9	46.8	36	43.2	44.0	43.6	20
	Average	46.3	46.5	46.4	45	42.7	43.5	43.1	25
XW1806 Blue	#1	26.1	28.1	27.1	16	22.1	24.9	23.5	8.8
	#2	26.2	28.2	27.2	16	22.0	25.0	23.5	8.8
	#3	26.3	28.3	27.3	16	22.3	25.1	23.7	8.8
	Average	26.2	28.2	27.2	20	22.1	25.0	23.6	11

TEST DATA SHEET

Project Name: Huangshan Xingwei XW1800 Series Hi Intensity Grade
Retroreflective Sheeting (Type III)

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
XW1812 White	#1	100.9	100.6	100.8	76	97.2	96.2	96.7	52
	#2	97.3	97.4	97.4	76	95.6	95.1	95.4	52
	#3	97.0	97.3	97.2	76	94.3	93.9	94.1	52
	Average	98.4	98.4	98.4	95	95.7	95.1	95.4	65
XW1804 Yellow	#1	76.9	77.0	77.0	50	73.5	73.7	73.6	36
	#2	77.3	77.2	77.3	50	74.8	74.4	74.6	36
	#3	78.1	77.9	78.0	50	74.8	74.1	74.5	36
	Average	77.4	77.4	77.4	62	74.4	74.1	74.2	45
XW1808 Green	#1	22.2	22.4	22.3	12	20.8	20.6	20.7	8.0
	#2	22.2	22.5	22.4	12	20.8	20.7	20.8	8.0
	#3	22.4	22.6	22.5	12	20.9	20.8	20.9	8.0
	Average	22.3	22.5	22.4	15	20.8	20.7	20.8	10
XW1805 Red	#1	18.3	18.2	18.3	12	17.3	17.2	17.3	8.0
	#2	18.4	18.4	18.4	12	17.5	17.3	17.4	8.0
	#3	18.3	18.3	18.3	12	17.4	17.3	17.4	8.0
	Average	18.3	18.3	18.3	15	17.4	17.3	17.3	10
XW1806 Blue	#1	8.9	9.7	9.3	6.0	7.7	8.6	8.2	4.0
	#2	8.9	9.7	9.3	6.0	7.7	8.6	8.2	4.0
	#3	9.0	9.8	9.4	6.0	7.7	8.7	8.2	4.0
	Average	8.9	9.7	9.3	7.5	7.7	8.6	8.2	5.0

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 III Sheeting.

TEST DATA SHEET

Project Name: Huangshan Xingwei XW1800 Series Hi Intensity Grade
Retroreflective Sheeting (Type III)

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
XW1812 White	0.3055	0.3242	31.47	27	-
XW1804 Yellow	0.5177	0.4756	19.74	15	45
XW1808 Green	0.1486	0.4410	8.65	3.0	12
XW1805 Red	0.6586	0.3239	4.79	2.5	15
XW1806 Blue	0.1448	0.1384	4.65	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: 80% of ASTM D4956 Table 4 (Type III), 0.2° observation only
Test Method: Exposure: ASTM G7, 36 months, AZ & FL, 45° exposure
Reflex: ASTM E810

Not Tested

6.5 Colorfastness

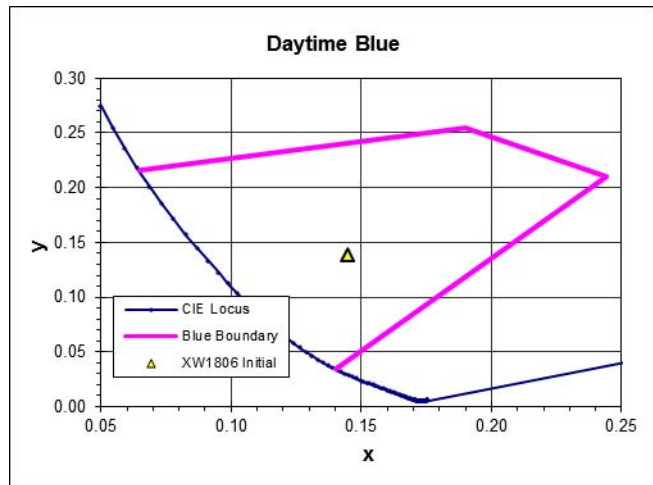
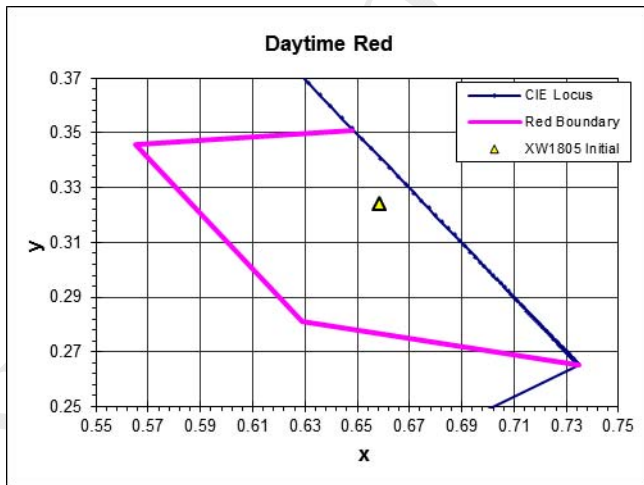
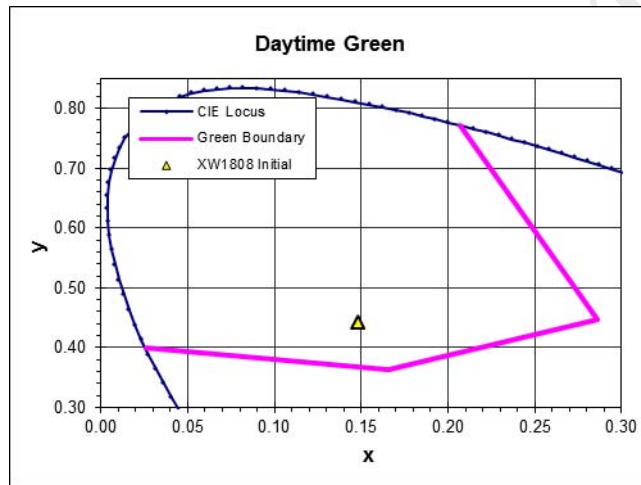
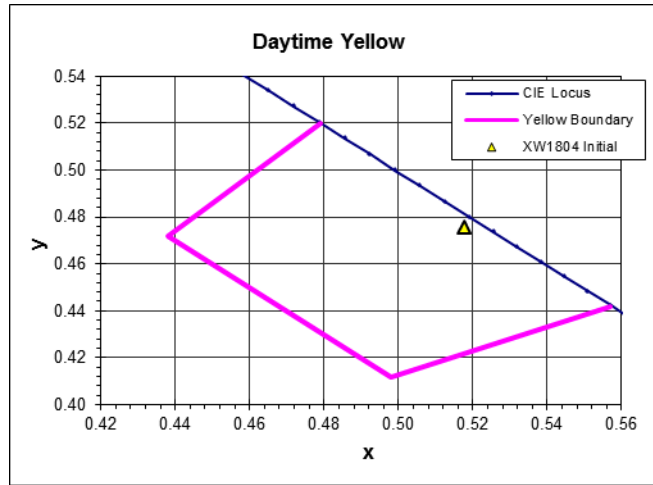
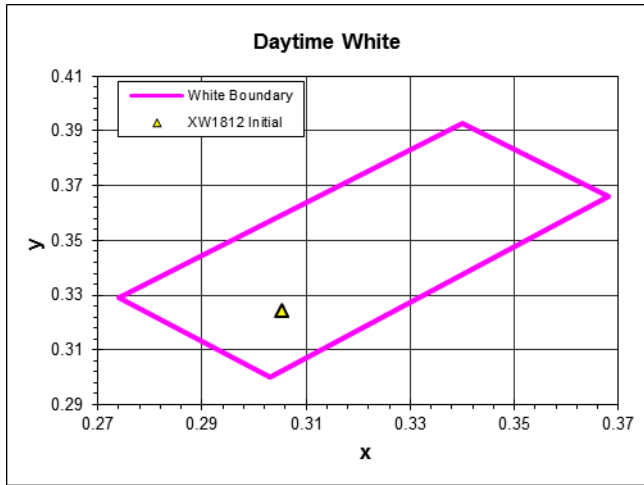
Requirement: ASTM D4956 Tables 2 and 11 (Type III Sheeting)
Test Method: Exposure: ASTM G7, 36 months, AZ & FL, 45° exposure
Color: ASTM E308, E1347, E1349, E991, E1164
(Illuminant D65, 2° Observer, Annular 45/0 Geometry)
Average of 8 reads, each read oriented 45° apart
Instrument: Hunterlab Colorflex A60 Spectrocolorimeter (No SCF available)

Not Tested

TEST DATA SHEET

Project Name: Huangshan Xingwei XW1800 Series Hi Intensity Grade Retroreflective Sheeting (Type III)

Daytime Color Plots



TEST DATA SHEET

Project Name: Huangshan Xingwei XW1800 Series Hi Intensity Grade
Retroreflective Sheeting (Type III)

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
XW1812 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	
XW1804 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	
XW1808 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	
XW1805 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	
XW1806 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: Huangshan Xingwei XW1800 Series Hi Intensity Grade
Retroreflective Sheeting (Type III)

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°
XW1812 White	No cracking.	No cracking.	No cracking.
XW1804 Yellow	No cracking.	No cracking.	No cracking.
XW1808 Green	No cracking.	No cracking.	No cracking.
XW1805 Red	No cracking.	No cracking.	No cracking.
XW1806 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
XW1812 White	Liner easily removed without assistance and did not break, tear, or remove adhesive.
XW1804 Yellow	Liner easily removed without assistance and did not break, tear, or remove adhesive.
XW1808 Green	Liner easily removed without assistance and did not break, tear, or remove adhesive.
XW1805 Red	Liner easily removed without assistance and did not break, tear, or remove adhesive.
XW1806 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 XW1800 Series Hi Intensity Grade
Retroreflective Sheeting (Type III)

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	
XW1812 White	0.05"	0	2.0"
XW1804 Yellow	0.08"	0.10"	
XW1808 Green	0.10"	0.15"	
XW1805 Red	0	0.05"	
XW1806 Blue	0	0.05"	

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
XW1812 White	No cracking or delamination outside impact area.
XW1804 Yellow	No cracking or delamination outside impact area.
XW1808 Green	No cracking or delamination outside impact area.
XW1805 Red	No cracking or delamination outside impact area.
XW1806 Blue	No cracking or delamination outside impact area.

Products meet Impact Resistance requirements.

TEST DATA SHEET

Project Name: Huangshan Xingwei XW1800 Series Hi Intensity Grade
Retroreflective Sheeting (Type III)

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

Product	$\varepsilon=0^\circ$		$\varepsilon=90^\circ$	
	x	y	x	y
XW1812 White	0.4915	0.4205	0.4913	0.4205
XW1804 Yellow	0.5659	0.4302	0.5662	0.4297
XW1808 Green	0.2048	0.6133	0.2050	0.6134
XW1805 Red	0.6859	0.3114	0.6857	0.3114
XW1806 Blue	0.1290	0.3356	0.1294	0.3385

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.

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 ($\varepsilon=0^\circ$, 45° , and 90°) and averaged.

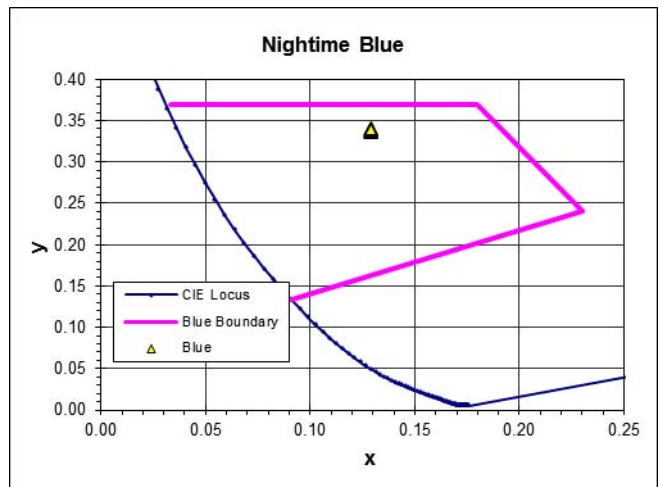
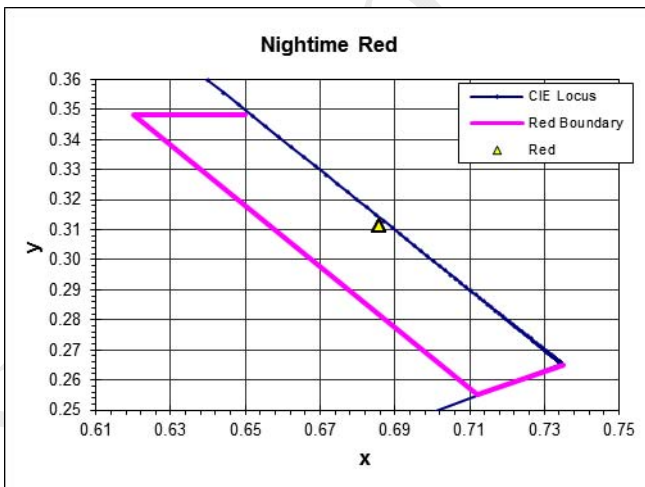
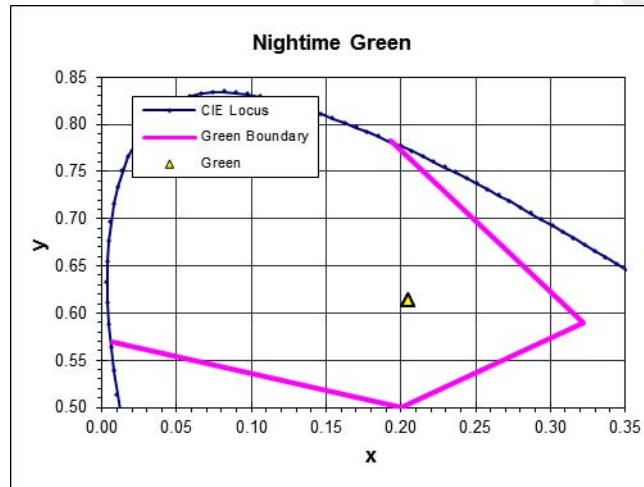
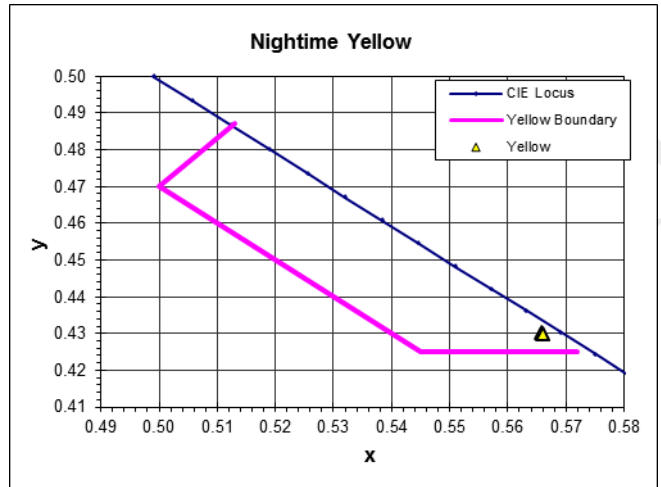
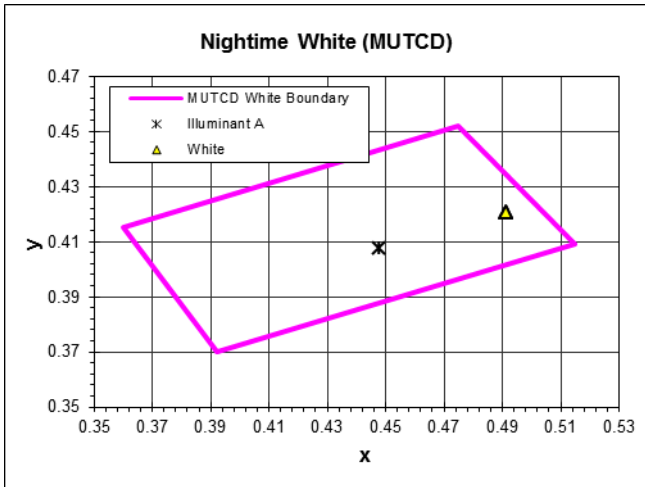
Product	Measured				Minimum
	0°	45°	90°	Avg	
XW1812 White	66.6	65.6	65.3	65.8	40
XW1804 Yellow	93.4	93.7	92.9	93.3	
XW1808 Green	82.2	85.9	89.3	85.8	
XW1805 Red	70.3	69.8	64.3	68.1	
XW1806 Blue	68.3	68.9	64.4	67.2	

Products meet Specular Gloss requirements.

TEST DATA SHEET

Project Name: Huangshan Xingwei XW1800 Series Hi Intensity Grade
Retroreflective Sheeting (Type III)

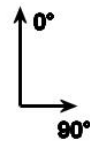
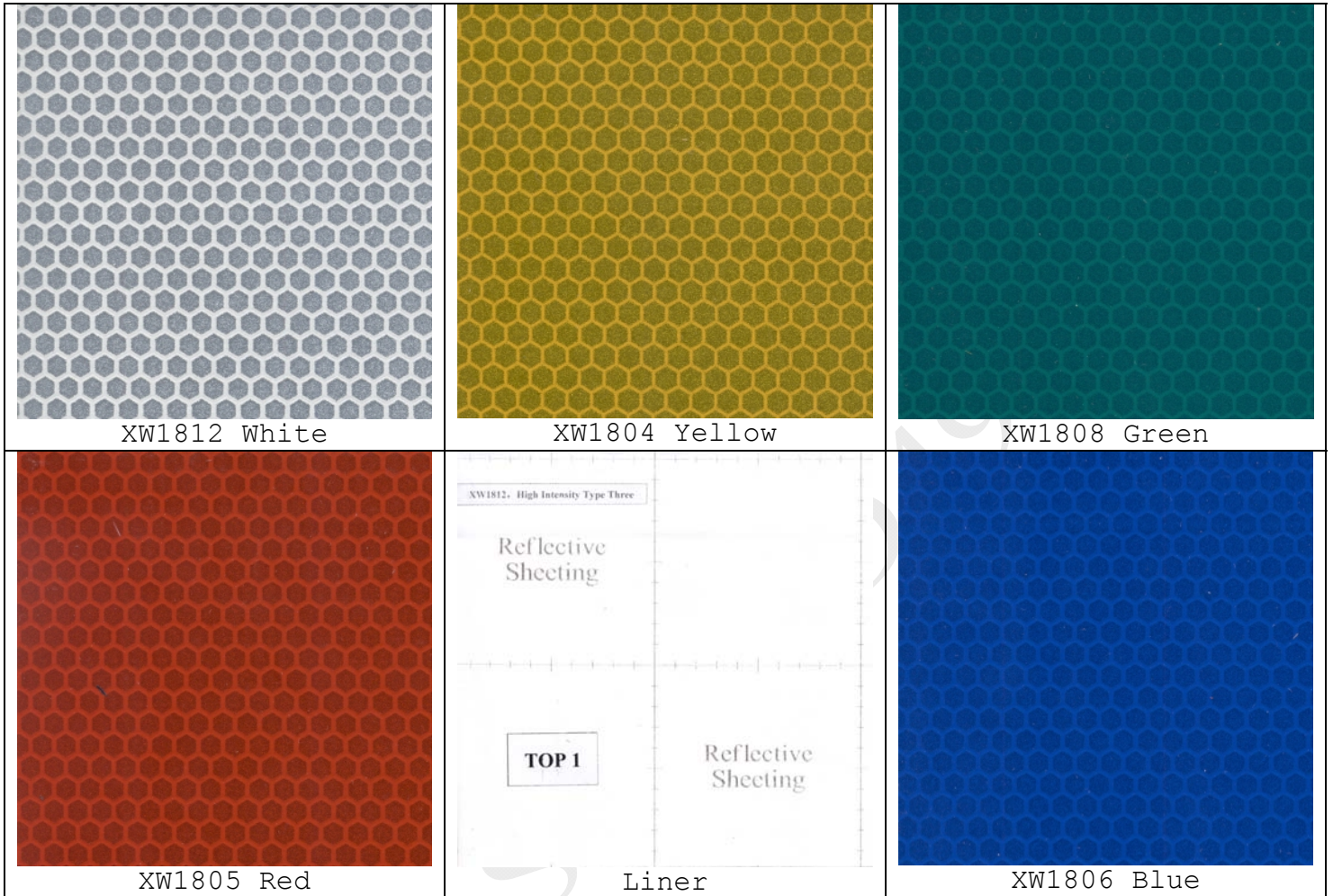
Nighttime Color Plots



TEST DATA SHEET

Project Name: Huangshan Xingwei XW1800 Series Hi Intensity Grade
Retroreflective Sheeting (Type III)

Photographs



Sheeting Orientation