



INDUSTRIAL TESTING LABORATORY

Report No. 180618-01B

Page 1 of 9

TEST REPORT

Report Date: 07 September 2018

Project Name: XW 8200 Series Retroreflective License Plate Sheeting

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

Test Laboratory: Calcoast - ITL
San Leandro, CA 94577

Samples Submitted: XW 8212 White, XW 8204 Yellow
One (1) each: legend of "G5 743236847"
Seven (7) each: legend of "G23"
One (1) each: no legend or embossing
112 mm x 520 mm finished license plates

SUMMARY

Specification: ISO 7591-1982: Road Vehicles - Retro-reflective registration plates for motor vehicles and trailers

- 6.1 Coefficient of Retroreflection ...Passed
Simulated Rainfall ...Passed
6.2 Uniformity of retro-reflection ...Passed
7.1 Daytime Color and Luminance ...Passed
7.2 Nighttime Color ...Passed
8 Temperature Resistance ...Passed
9 Adhesion to Substrate ...Passed
10 Impact Resistance ...Passed
11 Bending Resistance ...Passed
12 Water Resistance ...Passed
13 Cleanability ...Passed
14 Resistance to Fuel ...Passed
15 Resistance to Saline Mist ...Passed
16 Durability ...Passed

Written by:

Approved by:

[Signature of Douglas G. Cummins]

[Signature of Mark A. Evans]

Douglas G. Cummins
Photometric Engineer

Mark A. Evans
Laboratory Director

**TEST DATA SHEET**

Project Name: XW 8200 Series Retroreflective License Plate Sheeting

**DESCRIPTION**

Samples were received as finished license plates and designated as per ISO 7591 Annex A.1 with the exception that sample No. 9 (completely finished plate but without legend) was used for initial photometric and colorimetric characteristics.

Sample	Test Clause
9	6, 7
2A	8
2B	9
3	10, 11
4	12
5	13, 14
6	15
7	16
1, 8	-not used-

Sample No. 2 was divided into two equal parts for testing clauses 8 and 9. Sample No. 7 was cut into two equal parts (7A, 7B) to better fit the samples into the weathering chamber.

**PHOTOGRAPHS**

Top: Sample #8 (completely finished plates)  
Middle: Samples #s 1 - 7 (partial legends)  
Bottom: Sample #9 (no legends)

**TEST DATA SHEET**

Project Name: XW 8200 Series Retroreflective License Plate Sheeting

**6.1 Coefficient of Retroreflection**

Requirement: Table 1  
 Test Method: ASTM E810 - Test Distance 30.5 m  
 Projector: Hoffman GPS-102 (Illuminant A, 10 Lux, 75 cm diameter)  
 Sample Area: 110 mm x 520 mm (0.057 m<sup>2</sup>)

## 0.20° (0° 12') Observation Angle

Entrance Angle:	R <sub>A</sub> (Cd / Lx / m <sup>2</sup> )						Max.
	+5°		+30°		+40°		
	Meas.	Min.	Meas.	Min.	Meas.	Min.	
Sample							
XW 8212 White #9	97.7	45	52.0	18	21.7	8	250
XW 8204 Yellow #9	32.9	30	15.0	12	6.9	5	250

## 0.33° (0° 20') Observation Angle

Entrance Angle:	R <sub>A</sub> (Cd / Lx / m <sup>2</sup> )						Max.
	+5°		+30°		+40°		
	Meas.	Min.	Meas.	Min.	Meas.	Min.	
Sample							
XW 8212 White #9	80.4	30	47.6	12	20.6	6	250
XW 8204 Yellow #9	23.9	20	13.1	8	6.4	4	250

## 1.5° (1° 30') Observation Angle

Entrance Angle:	R <sub>A</sub> (Cd / Lx / m <sup>2</sup> )						Max.
	+5°		+30°		+40°		
	Meas.	Min.	Meas.	Min.	Meas.	Min.	
Sample							
XW 8212 White #9	17.2	3.5	13.3	2.0	9.1	0.7	250
XW 8204 Yellow #9	5.8	2.3	5.7	0.8	3.5	0.4	250

Simulated Rainfall

Requirement: 90% of Table 1 (tested only at +5° Entrance Angle)  
 Test Method: ASTM E810 - Test Distance 30.5 m  
 EN 471 Rainfall Chamber,  
 measured after 2 min at 284 mm/hour flowrate  
 Projector: Hoffman GPS-102 (Illuminant A, 10 Lux, 75 cm diameter)  
 Sample Area: Sample masked except for center 110 mm x 200 mm (0.022 m<sup>2</sup>)

## +5° Entrance Angle

Observation Angle:	R <sub>A</sub> (Cd / Lx / m <sup>2</sup> )						Max.
	0.20° (0°12')		0.33° (0°20')		1.5° (1°30')		
	Meas.	Min.	Meas.	Min.	Meas.	Min.	
Sample							
XW 8212 White #9	84.5	41	70.1	27	14.8	3.2	250
XW 8204 Yellow #9	27.2	27	20.4	18	5.2	2.1	250

Samples meet Coefficient of Retroreflection requirements.

**TEST DATA SHEET**

Project Name: XW 8200 Series Retroreflective License Plate Sheeting

**6.2 Uniformity of Retroreflection**

Requirement: Ratio of highest to lowest shall not exceed 2  
 Test Method: ASTM E810 - Test Distance 30.5 m  
 0.33° (0°20') observation angle; +5° entrance angle  
 Projector: Hoffman GPS-102 (Illuminant A, 10 Lux, 75 cm diameter)  
 Measured Area: 50 mm x 50 mm (0.0025 m<sup>2</sup>)

Samples were masked using black cloth and a paper with a 50 mm x 50 mm square viewing area hole cut out. Samples were divided into 5 equal parts and retroreflection measurements performed with the viewing area placed at the center of each part.

Sample	R <sub>A</sub> (Cd / Lx / m <sup>2</sup> )					Ratio	
	1	2	3	4	5	Calc	Max.
XW 8212 White #9	76.9	80.7	81.4	79.6	79.1	1.06	2
XW 8204 Yellow #9	24.5	23.7	23.9	23.7	24.4	1.03	2

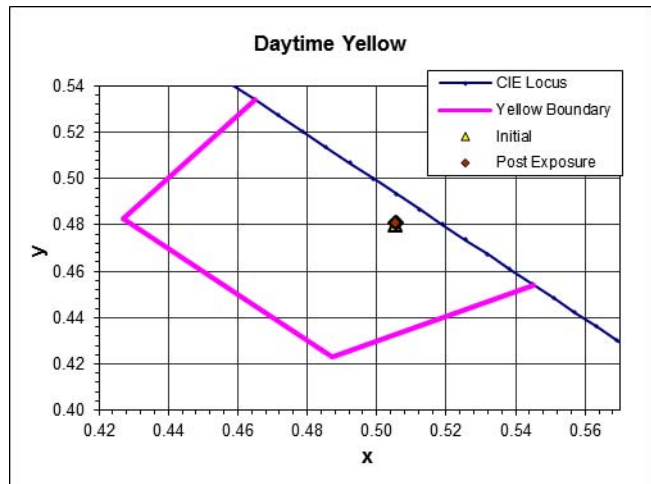
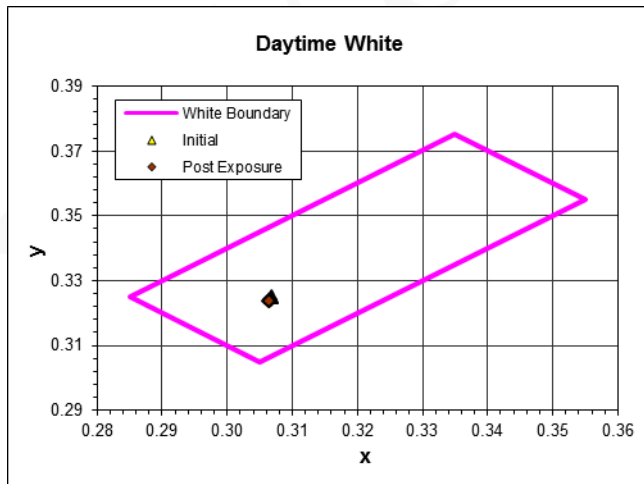
Samples meet Uniformity of Retroreflection requirements.

**7.1 Daytime Color and Luminance**

Requirement: Table 2  
 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 Spectrocolorimeter (No SCF available)

Sample	x	y	Y	
			Measured	Minimum
XW 8212 White #9	0.3069	0.3249	35.51	35
XW 8204 Yellow #9	0.5053	0.4797	32.54	27

Samples meet Daytime Color and Luminance requirements.



**TEST DATA SHEET**

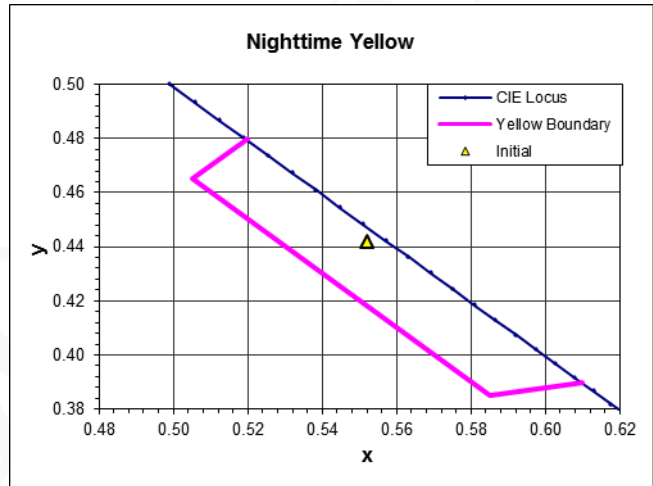
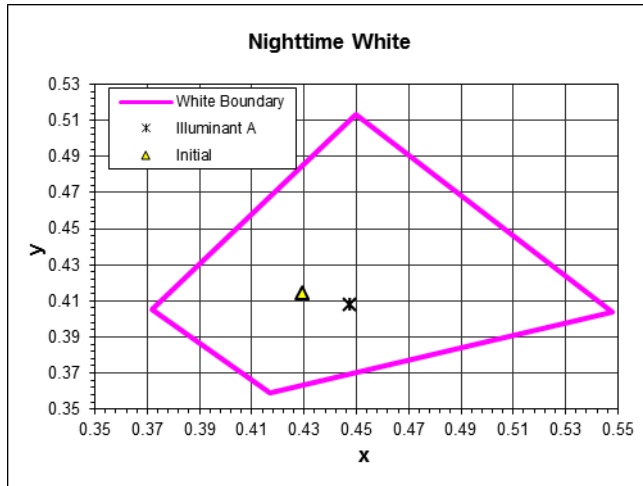
Project Name: XW 8200 Series Retroreflective License Plate Sheeting

**6.11 Nighttime Color**

Requirement: Table 3  
 Test Method: ASTM E811, E308  
 (Illuminant A, 2° Observer, +5°/0.33° Geometry at 10 feet)  
 Average of 3 reads at  $\epsilon=0^\circ$   
 Instrument: Photo Research PR-650 Spectroradiometer

Sample	x	y
XW 8212 White #9	0.4292	0.4142
XW 8204 Yellow #9	0.5521	0.4418

Samples meet Nighttime Color requirements.



**8 Temperature Resistance**

Requirement: At the end of the test, the reflective material, the letters and digits shall show no peeling off the substrate, no cracking, blistering, or appreciable distortion.

Test Method: Samples were exposed to the following environmental conditions in sequence:

- 7 hours at 65°C, 10% R.H.
- 1 hour at 23°C, 50% R.H.
- 15 hours at -20°C

Sample	Results
XW 8212 White #2A	No peeling off the substrate, no cracking, blistering, or appreciable distortion
XW 8204 Yellow #2A	No peeling off the substrate, no cracking, blistering, or appreciable distortion

Samples meet Temperature Resistance requirements.

**TEST DATA SHEET**

Project Name: XW 8200 Series Retroreflective License Plate Sheeting

**9 Adhesion to the Substrate**

Requirement: It shall not be possible to remove retroreflective material physically in one piece from the substrate.

Test Method: Samples were conditioned at -20°C for 1 hour after which each sample was removed from the chamber and its retroreflective sheeting was attempted to be removed.

Sample	Results
XW 8212 White #2B	Could not remove the retroreflective material from the substrate.
XW 8204 Yellow #2B	Could not remove the retroreflective material from the substrate.

Samples meet Adhesion to the Substrate requirements.

**10 Impact Resistance**

Requirement: The retroreflective material shall show no cracking or separation from the substrate outside a distance of 5 mm from the impacted area.

Test Method: Samples were conditioned at -20°C for 1 hour. After removal from the test chamber, the sample was placed, reflective side facing up, on a concrete floor and a 25 mm diameter steel ball was dropped from a height of 2 m using a guide tube onto a flat area of the sample and avoiding the embossed numbers and letters.

Sample	Results
XW 8212 White #3	No cracking or separation of the retroreflective material.
XW 8204 Yellow #3	No cracking or separation of the retroreflective material.

Samples meet Impact Resistance requirements.

**TEST DATA SHEET**

Project Name: XW 8200 Series Retroreflective License Plate Sheeting

**11 Bending Resistance**

Requirement: There shall be no cracking.

Test Method: After Impact Resistance, the embossed borders of the side not impacted were cut from the top and bottom to facilitate the bending test. Samples were conditioned for a minimum of 1 hour at 23°C after which the test area was placed, reflective side up, on a 50 mm diameter mandrel and bent to an included angle of 90° within 2 seconds.

Sample	Results
XW 8212 White #3	No cracking of the retroreflective material.
XW 8204 Yellow #3	No cracking of the retroreflective material.

Samples meet Bending Resistance requirements.

**12 Water Resistance**

Requirement: Samples shall show no evidence of deterioration which could reduce its efficiency.

Test Method: Samples placed in a bath of deionized water at 23°C for 24 hours then allowed to dry for 48 hours at normal room temperature in a semi-vertical position.

Sample	Results
XW 8212 White #4	No evidence of deterioration.
XW 8204 Yellow #4	No evidence of deterioration.

Samples meet Water Resistance requirements.

**13 Cleanability**

Requirement: Samples shall be easily cleaned without damage to the reflective surface.

Test Method: A mixture of lubricating oil (10W-40 motor oil) and dry powdered graphite was smeared onto a section of each sample. After a minimum of 1 hour, the smeared mixture was wiped with a paper towel soaked with heptane then the samples cleaned with a mild detergent (1% 'Dreft').

Sample	Results
XW 8212 White #5	No damaged observed on the reflective surface.
XW 8204 Yellow #5	No damaged observed on the reflective surface.

Samples meet Cleanability requirements.

**TEST DATA SHEET**

Project Name: XW 8200 Series Retroreflective License Plate Sheeting

**14 Resistance to Fuel**

Requirement: Samples shall not show any visual change which would reduce its efficiency.

Test Method: An area of the sample not used for Cleanability including letters and numbers (the number "3") was immersed for 1 minute in a fuel solution of 70% n-heptane / 30% toluol (by volume). Upon removal, sample was rinsed with water and allowed to dry before inspection.

Sample	Results
XW 8212 White #5	Ink from the embossing and letters was removed by the fuel solution but no visible change observed on the sheeting reflective surface.
XW 8204 Yellow #5	Ink from the embossing and letters was removed by the fuel solution but no visible change observed on the sheeting reflective surface.



Samples post fuel - ink removed from embossing/letters

Samples meet Resistance to Fuel requirements.

**15 Resistance to Saline Mist**

Requirement: Samples shall have no corrosion which would reduce its efficiency.

Test Method: Samples were placed in an ASTM B117 Salt Fog chamber at 35°C with a 5% salt solution for 22 hours, then removed and allowed to dry at room temperature for two hours, then subjected to another 22 hours in the Salt Fog chamber. Upon completion, samples were rinsed with water and allowed to dry before inspection.

Sample	Results
XW 8212 White #6	No corrosion.
XW 8204 Yellow #6	No corrosion.

Samples meet Resistance to Saline Mist requirements.



**TEST DATA SHEET**

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**16 Durability**Requirement: 50% of Table 1, 0°20' (0.33°) observation / +5° entrance only  
Table 2, 80% of luminance factorTest Method: ISO 105-B02 Colour fastness to artificial light; Xenon arc  
fading lamp testWeather until blue wool standard L7 has faded to number 4  
contrast of the grey scale.Performed at: New Jersey Industrial Controls (report # 2018-1263)  
samples exposed for 500 hoursCoefficient of Retroreflection

Test Method: ASTM E810 - Test Distance 30.5 m

Projector: Hoffman GPS-102 (Illuminant A, 10 Lux, 75 cm diameter)

Sample Area: masked to 100 mm x 150 mm (0.015 m<sup>2</sup>)  
to avoid embossing and letters

0.33° (0° 20') Observation Angle

Entrance Angle:	R <sub>a</sub> (Cd / Lx / m <sup>2</sup> )						Max.
	+5°		+30°		+40°		
Sample	Meas.	Min.	Meas.	Min.	Meas.	Min.	
XW 8212 White #7A	65.9	15	44.3	-	20.2	-	250
XW 8212 White #7B	62.6	15	45.1	-	21.1	-	250
XW 8204 Yellow #7A	22.6	10	12.5	-	6.1	-	250
XW 8204 Yellow #7B	22.5	10	12.7	-	6.3	-	250

Daytime Color and LuminanceTest 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 Spectrocolorimeter (No SCF available)

Sample	x	y	Y	
			Measured	Minimum
XW 8212 White #7A	0.3066	0.3240	34.98	28
XW 8212 White #7B	0.3064	0.3238	34.89	28
XW 8204 Yellow #7A	0.5058	0.4808	33.12	22
XW 8204 Yellow #7B	0.5054	0.4807	33.15	22

see plots of post exposure Color on page 4.

Samples meet Durability requirements.



Durability samples 7A (left side) and 7B (right side), post exposure