



INDUSTRIAL TESTING LABORATORY

Report No.: 190321-01A

Page 1 of 4

TEST REPORT

Report Date: 24 April 2019

Project Name: Aura 149-TL Yellow FRA-224 Railcar Conspicuity Tape

Submitted by: Aura Optical Systems
Ft. Worth, TX 76118

Test Laboratory: Calcoast - ITL
San Leandro, CA 94577

Samples Submitted: Six (6) 4" x 18" strips, labeled "Batch: 37p18-4"
submitted 21 March 2019

SUMMARY

Specification: 49CFR224.103 / ASTM D4956-04 Type V Sheeting, Class 1 Backing

49 CFR 224.103

- (a) Construction ...Passed
(b) Color ...Passed
(c) Performance (Coefficient of Retroreflection) ...Passed
(d) Certification ...Passed
(e) Alternative standards ...Not Applicable

ASTM D4956-04

- 6.3 Daytime Color and Luminance ...Passed
6.4 Accelerated Outdoor Weathering ...Not Tested
6.5 Colorfastness ...Not Tested
6.6 Shrinkage ...Not Tested
6.7 Flexibility ...Not Tested
6.8 Liner Removal ...Not Tested
6.9 Adhesion ...Not Tested
6.10 Impact Resistance ...Not Tested
6.11 Specular Gloss ...Not Tested

Written by:

[Signature of Douglas G. Cummins]

Douglas G. Cummins
Photometric Engineer

Approved by:

[Signature of Mark A. Evans]

Mark A. Evans
Laboratory Director

TEST DATA SHEET

Project Name: Aura 149-TL Yellow FRA-224 Railcar Conspicuity Tape

224.103(a) Construction

Retroreflective sheeting consists of a smooth, flat, transparent exterior film with microprismatic retroreflective elements embedded in or suspended beneath the film so as to form a non-exposed retroreflective optical system.

The sheeting appears to be metalized and so will be considered a Type V retroreflective sheeting material.

224.103(b) Color / ASTM D4956-04 6.3 Daytime Color

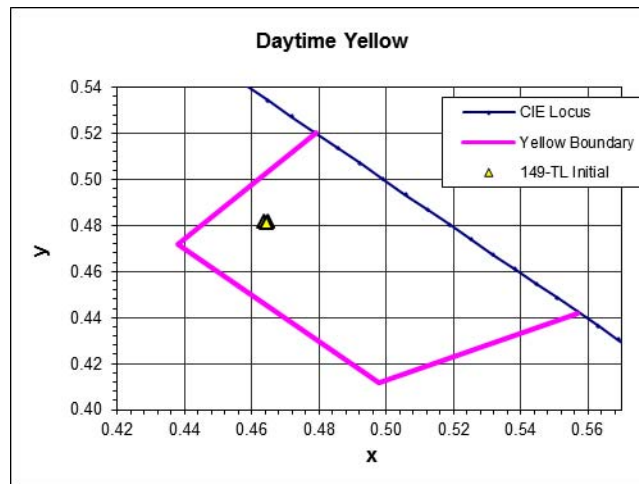
Requirement: ASTM D4956-04 Tables 12 and 17 (Type V Sheeting)

Test Method: ASTM E308, E1347, E1349, E991, E1164
(Illuminant D65, 2° Observer, 45/0 Geometry)

Instrument: Hunterlab Colorflex Spectrocolorimeter (No SCF available)

Product		x	y	Y		
				Measured	Minimum	Maximum
149-TL Yellow	#1	0.4647	0.4813	17.19	12	30
	#2	0.4637	0.4814	17.43		
	#3	0.4645	0.4810	17.33		

Samples meet Daytime Color and Luminance requirements.



TEST DATA SHEET

Project Name: Aura 149-TL Yellow FRA-224 Railcar Conspicuity Tape

224.103(c) Performance

Requirement: 49 CFR 224.103 / Table 1
 Test Method: ASTM E810 - Test Distance 100 feet (30.5 m)
 Samples tested in four orientations (0°, 90°, 180°, and 270°)
 Projector: Hoffman GPS-102 (Illuminant A, 10 lx, 76 cm diameter)
 Sample Area: 203 mm x 203 mm, 0.0413 m²

Samples created by mounting sheeting on 203 mm x 203 mm x 1 mm thick 6061-T6 aluminum panels and trimming off the excess material. $\epsilon=0^\circ$ arbitrarily chosen as the tape in a vertical orientation with the certification marking "FRA-224" in a normal operating position and parallel to the projector-detector half-plane (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.

Sample	Entrance Angle	Orientation	Coefficient of Retroreflection (Candela / Lux / m ²)			
			0.2° Obs. Angle		0.5° Obs. Angle	
			Measured	Required	Measured	Required
#1	-4°	Horizontal (0°)	495.4	400	116.3	100
		Vertical (90°)	497.0		102.8	
		Horizontal (180°)	501.1		119.1	
		Vertical (270°)	495.5		102.6	
	+30°	Horizontal (0°)	272.3	220	127.3	45
		Vertical (90°)	259.1		116.4	
		Horizontal (180°)	257.8		120.2	
		Vertical (270°)	266.1		117.9	
#2	-4°	Horizontal (0°)	524.9	400	115.0	100
		Vertical (90°)	530.0		105.5	
		Horizontal (180°)	530.8		117.6	
		Vertical (270°)	528.0		105.0	
	+30°	Horizontal (0°)	287.6	220	131.3	45
		Vertical (90°)	278.7		124.2	
		Horizontal (180°)	272.7		124.5	
		Vertical (270°)	286.8		125.9	
#3	-4°	Horizontal (0°)	515.0	400	112.0	100
		Vertical (90°)	519.8		103.3	
		Horizontal (180°)	521.0		114.6	
		Vertical (270°)	518.7		103.2	
	+30°	Horizontal (0°)	283.1	220	129.0	45
		Vertical (90°)	274.4		122.1	
		Horizontal (180°)	268.2		122.5	
		Vertical (270°)	282.8		124.1	
Average	-4°	Horizontal (0°)	511.8	400	114.4	100
		Vertical (90°)	515.6		103.9	
		Horizontal (180°)	517.6		117.1	
		Vertical (270°)	514.1		103.6	
		Average	514.8		109.8	
	+30°	Horizontal (0°)	281.0	220	129.2	45
		Vertical (90°)	270.7		120.9	
		Horizontal (180°)	266.2		122.4	
		Vertical (270°)	278.6		122.6	
		Average	274.1		123.8	

TEST DATA SHEET

Project Name: Aura 149-TL Yellow FRA-224 Railcar Conspicuity Tape

224.103(c) Performance (continued)

Samples meet Coefficient of Retroreflection requirements per ASTM E810 10.7.1.

Note: Although 49CFR224.106 *Location of retroreflective sheeting* specifies both Vertical and Horizontal applications, the ASTM subcommittee for ASTM E810 has stated that this does not constitute an explicit statement that a rotation angle is specified and therefore ASTM E810 10.7.1 is applicable.

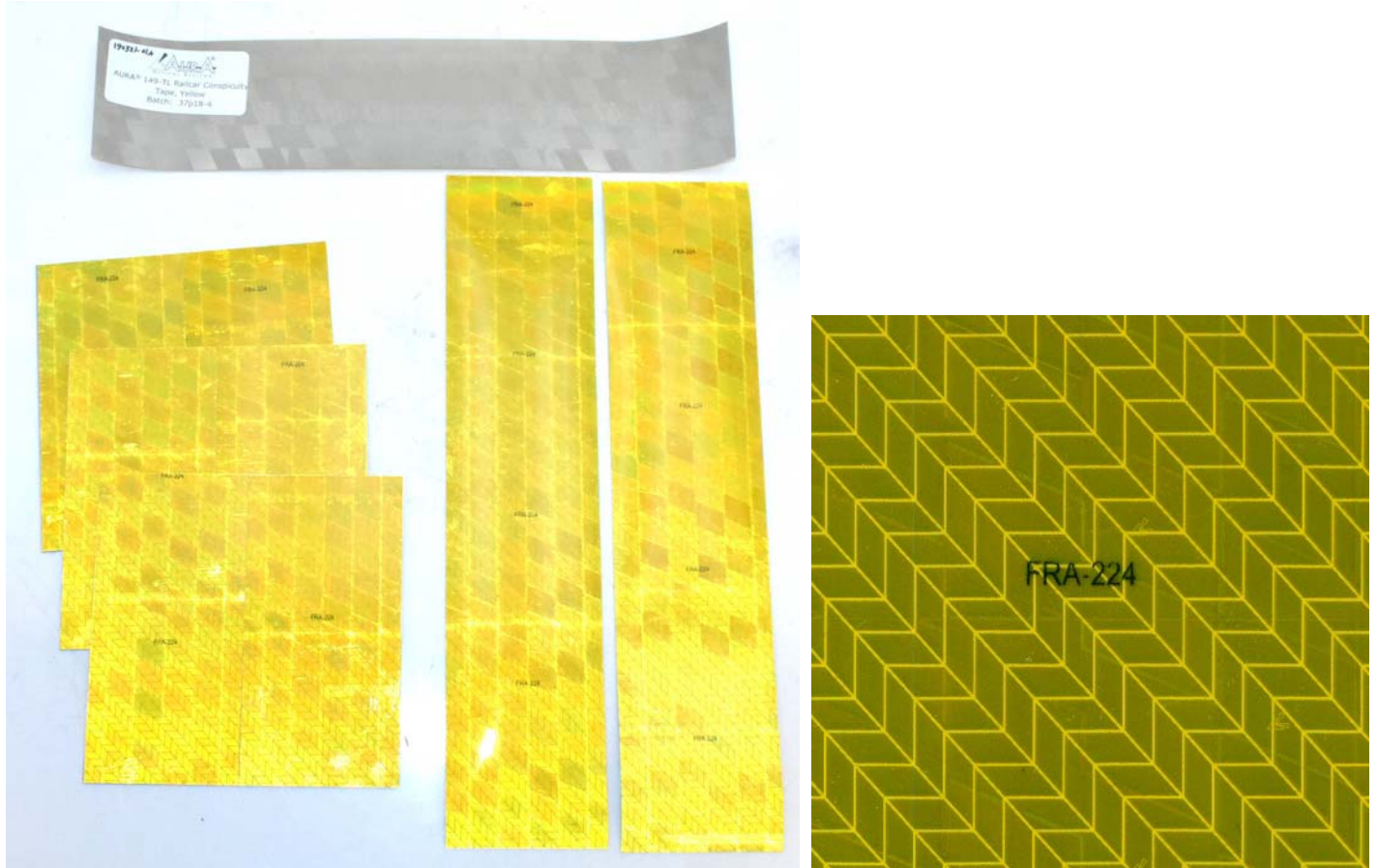
224.103(d) Certification

The characters "FRA-224" appear once every 101 mm (4.0 inches) vertically in characters 3.4 mm high.

Characters are at least 3 mm high and are permanently stamped, etched, molded, or printed within the product and spaced no more than 4 inches apart. See photos.

Samples meet Certification requirements.

Photographs



Sheeting Orientation