



8 Year Duration

**List of Acceptable Plastics for
Optical Lenses and Reflex Reflectors
Used on Motor Vehicles**

June 21, 2024



TM

AMECA

8 Year Duration

**List of Acceptable Plastics for
Optical Lenses and Reflex Reflectors
Used on Motor Vehicles**

June 21, 2024 Edition

**Automotive Manufacturers Equipment Compliance Agency, Inc.
1025 Connecticut Avenue, NW Suite #1000
Washington DC 20036**

www.ameca.org

1. STATUS

The following materials have been accepted by the Automotive Manufacturers Equipment Compliance Agency as meeting the 8 year version of the weathering test of FMVSS 108. No evaluation has been made as to the suitability of individual materials for particular automotive uses, or to the manufacturing methods.

You must contact the resin or coating manufacturer to determine the best material for your application.

Every plastics resin manufacturer has specialized products for different applications, processing conditions, manufacturing equipment, light sources and final use.

Please contact the manufacturer directly for more information.

The device manufacturers must ensure that the lenses molded from acceptable materials meet the color and plastic stability test requirements for each individual device.

2. LISTING

The material is listed by the manufacturer's name, trade name and flow formulation, type of resin, color number and color.

3. MATERIAL COATINGS and HAZE

When these materials are used for state/provincial regulated lighting device lenses, the applicable state/provincial regulations shall be met.

4. DISTRIBUTION

This list is updated and distributed free on a weekly basis. Any revised or pre-release editions may be obtained by contacting AMECA.

5. DEFINITIONS

Coating -- Material applied to surface of the lens to improve some aspect of performance.

Coated materials-- a material which has a coating applied to the surface of the finished sample to impart some protective properties. Coating identification means a mark of the manufacturer's name, formulation designation number, and recommendations for application.

Color bleeding -- the migration of color out of a plastic part onto the surrounding surface.

Cracking -- a separation of adjacent sections of a plastic material with penetration into the specimen.

Crazing -- a network of apparent fine cracks on or beneath the surface of materials.

Delamination -- a separation of the layers of a material including coatings.

Hard Coat -- 1) Coating which is cured by UV radiation.

2) Coating which provides additional resistance to abrasion or scratching which may be cured by thermally or by UV radiation. May contribute to long term durability of material.

Note: Both definitions are being used--please verify the intended performance when discussing hard coats.

Haze -- the cloudy or turbid appearance of an otherwise transparent specimen caused by light scattered from within the specimen or from its surface.

UV-protective Coat -- Coating designed to provide additional protection from the sun's electromagnetic radiation, particularly those wavelengths in the UV bandwidth. Often used on polycarbonate substrates to improve weathering performance. Polycarbonates must be coated for use in or in front of reflex reflectors.

Reflex reflectors-- devices used on vehicles to give an indication to approaching drivers using reflected light from the lamps of the approaching vehicle.

Substrate -- Base material to which all other performance enhancing materials are added.

UV radiation -- Short wavelength, high energy radiation emitted by the sun or other object (HID lamp). Wave lengths between 10 and 380 nm.

HID Lamp -- High Intensity Discharge Lamp. Lamps produce light by the use of a stabilized arc. Lamps can produce significant UV radiation which may require special materials. See SAE J1647

6. Note ON COLOR

The colors listed have been determined to be in compliance with SAE J-578 using the ASTM E 308-66 method required by FMVSS 108 or in thicknesses specified by the resin manufacturer.

**NOT EVERY COLOR LISTED WILL MEET SAE J-578 COORDINATES
FOR YOUR INTENDED THICKNESS**

**NOT EVERY MATERIAL IN EVERY COLOR WILL MEET J578 WITH
LED OR ILLUMINANT C LIGHTSOURCES**

CHECK WITH THE RESIN MANUFACTURER'S COLOR SPECIALIST

The ASTM E 308-66 method uses an illuminant A light source energized to 2856k. *If you use anything other than an incandescent light source at 2856k you MUST verify that the resulting color meets the specifications of SAE J-578 for your intended thickness.* Halogen light sources at 3200k, illuminant C (strobe) and LED light sources can dramatically alter the color output. In addition, some light sources do not emit color or luminous flux uniformly. Measurements should be made to verify that the emitted light using your intended lightsource meets the specifications of J-578 throughout its photometric range.

7. Note ON INNER LENS COLOR

Combinations of inner and outer lenses with various colors may not perform predictably. Output can change with different light sources. Check with the resin manufacturer's color specialist when making selections

8. Note ON "EQUIVALENT" FORMULATIONS.

Many companies have distributed manufacturing facilities, cooperative agreements or joint ventures. In order to list a facility or another company the company which has done the FIVE year weathering testing

must send documentation stating that the materials, processes and end products are equivalent between itself and the new applicant. Due to industry complaints, the List of Acceptable Plastics has revised the listing to more accurately reflect the test data from various parent companies. ***In addition, if the joint venture is terminated or the manufacturing facility is sold, the subsidiary or joint company must be able to provide weathering test data on its own. A company can no longer rely on the parent company data and processes if they have no relationship to the parent company who conducted the original testing.***

10. Note ON SUBMITTING FOR ADDITIONAL COLORS

If you plan to add an additional color number to your listing, please list the existing colors which have undergone the eight year weathering that are a greater and lesser concentration. The colors listed MUST be in the same color space.

11. Note on Inner Lens Testing

Only inner and outer lens materials, tested together, may be registered for an inner lens system. Not every manufacturer's materials will qualify for the outer lens. Other manufacturers lens material may NOT be used as an outer lens even if those materials have successfully been used as an outer lens for a different material. The inner lens/coating and outer lens/coating must be tested together as a system.

Currently the DOT has issued no guidelines for inner lenses. If and when they do, they will be the requirements that everyone must follow. In the meantime, we would recommend for following guidelines for inner lens test setup.

- 1) You must bracket test every color combination (light/dark) you want to use—red, blue, amber, etc. The light/dark colors must be in the same color space.
- 2) You must bracket test molecular weight (heavy/light) for both outer lens and inner lens.
- 3) The test setup—airspace, ventilation, should duplicate as close as possible the conditions in an inner automotive lens including factors such as ventilation, spacing between inner and outer lens and coatings.
- 4) For more information, please see SAE Paper: <http://papers.sae.org/2004-01-0800>

Inner lens materials will be listed with their outer lens material jointly as a system. Both the inner lens and outer lens material/color will be listed with both materials specified. If you only test a limited range of lens colors, thicknesses or materials that is how they will be listed.

12. Special Note on the definition of “Protected Inner Lens” and/or “Protected Applications”

Protected Inner Lenses or Protected Applications for polycarbonate lenses refers to an outer lens which has a UV absorbing capabilities. NOT physical protection but UV protection.

Frequently Asked Questions

Q1) If someone else has weathered a polycarbonate/PMMA material, do I have to weather my polycarbonate/PMMA material?

A) Yes, every company's material stands independently from what another company has done. Each coating, pigment and additive must be tested with each company's own material. Each separate material stands alone for weathering performance unless bracketed by materials of higher and lower concentrations or molecular weights.

Q2) If someone else has weathered a pigment with another plastic do I have to weather the pigment with my plastic?

A) Yes, every company's material stands independently from what another company has done. Each coating, pigment and additive must be tested with each company's own material. Each separate material stands alone for weathering performance unless bracketed by materials of higher and lower concentrations or molecular weights.

Q3) If someone else has weathered a coating do I have to weather my material with that coating?

A) Yes, every company's material stands independently from what another company has done. Each coating, pigment and additive must be tested with each company's own material. Each separate material stands alone for weathering performance unless bracketed by materials of higher and lower concentrations or molecular weights.

Q4) Testing laboratories typically use a 1-10 numbering scale according to ASTM D660 to indicate the degree of crazing, cracking or delamination associated with weathering. What numerical value from ASTM D660 is acceptable for listing?

A) FMVSS 108 does not refer to any numerical values from ASTM D660. The numerical values are done by the test laboratory for manufacture convenience.

FMVSS 108 states:

S14.4.2.2.4.2 After completion of the outdoor exposure test materials used for headlamp lenses must show no deterioration.

S14.4.2.2.4.3 After completion of the outdoor exposure test all materials, when compared with the unexposed control samples, must not show physical changes affecting performance such as color bleeding, delamination, crazing, or cracking. **Additionally materials used for reflex reflectors and lenses used in front of reflex reflectors must not show surface deterioration or dimensional changes.**

Your tested samples must not show any changes affecting performance. The only value which shows no change is a numerical value of 10.

Q5) How many thicknesses to I have to test?

A) FMVSS 108: S14.4.2.1.3 Samples must be furnished in thicknesses of 1.6 ± 0.25 mm, 2.3 ± 0.25 mm, 3.2 ± 0.25 mm, and 6.4 ± 0.25 mm.

Q6) Even if it's for a coating?

A) Yes.

Q7) Do materials have to meet the color requirements before testing?

A) Yes: S14.4.2.1.4 All samples must conform to the applicable color test requirement of this standard prior to testing.

Q8) What about the plastics used in non-FMVSS applications such as emergency vehicle lighting which also require three year weathering?

A) Yes, those can be listed with non-standard colors as long as they are NOT used on FMVSS 108 lighting devices.

Testing outline. Note, we also recommend you send DOUBLE samples to prevent any errors.

► 4 Thicknesses

- For each colour
- For each coating
- For each molecular weight (MW)

► For example:

- 4 thickness samples of dark red, uncoated, Lowest MW
- 4 thickness samples of light red, uncoated, Lowest MW
- 4 thickness samples of dark red, uncoated, Highest MW
- 4 thickness samples of light red, uncoated, Highest MW

- 4 thickness samples of dark red, coating 1, Lowest MW
- 4 thickness samples of light red, coating 1, Lowest MW
- 4 thickness samples of dark red, coating 1, Highest MW
- 4 thickness samples of light red, coating 1, Highest MW

- Now repeat for clear, yellow, blue, coating 2 & coating 3

**AMECA 5 Year Duration
List of Acceptable Plastics for Optical Lenses and Reflex Reflectors**

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Listing of Coating Suppliers

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<u>MFR.</u>	<u>TRADE NAME and FLOW FORMULATION</u>	<u>TYPE OF RESIN</u>	<u>NUMBER</u>	<u>COLOR</u>
Covestro Deutschland AG (Europe) Covestro LLC (America) Covestro (Hong Kong) Limited. (Asia Pacific)	MAKROLON AL2447 (coated only)	POLYCARBONATE	550396	Clear %
www.covestro.com				

Note: KUV-5000 is only listed in 3.2mm thickness.

Coated Covestro Deutschland AG (Europe), LLC and Ltd. Makrolon AL plastics may only be treated with the following acceptable coatings applied to the molded lens:

Coating in Alphabetical Order and Corresponding Manufacturer

KUV-5000: See KCC Corporation

Coating Manufacturer in Alphabetical Order




Information on, KUV-5000 coatings may be obtained by writing:

KCC Corporation
83 Mabook-Dong, Giheung-Gu, Yongin-Si
Gyunggi-Do, South Korea
www.kccworld.co.kr

Note: KUV-5000 is only listed in 3.2mm thickness.

Note: All Covestro 8 year weathering data submitted by KCC Corporation

<u>MFR.</u>	<u>TRADE NAME and FLOW FORMULATION</u>	<u>TYPE OF RESIN</u>	<u>NUMBER</u>	<u>COLOR</u>
	SABIC LEXAN® LS-1	POLYCARBONATE	111	White %
	USA LEXAN® LS-2 (Coated Only)			
	www.sabic.com			

Note: SABIC LS-1-111 is listed only in 2.3 mm, 3.2 mm and 6.4 mm

Coated SABIC USA plastics may only be treated with the following acceptable coatings applied to the molded lens:

Coating in Alphabetical Order and Corresponding Manufacturer

KUV-5000: See KCC Corporation

Coating Manufacturer in Alphabetical Order



Information on KUV-5000 coatings may be obtained by writing:

KCC Corporation
83 Mabook-Dong, Giheung-Gu, Yongin-Si
Gyeonggi-Do, South Korea
www.kccworld.co.kr

Note: SABIC LS-1-111 is listed only in 2.3 mm, 3.2 mm and 6.4 mm

<u>MFR.</u>	<u>TRADE NAME and FLOW FORMULATION</u>	<u>TYPE OF RESIN</u>	<u>NUMBER</u>	<u>COLOR</u>
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SABIC	LEXAN® LS-1	POLYCARBONATE	111 White %
Brazil	LEXAN® LS-2 (Coated Only)		

www.sabic.com

Note: SABIC LS-1-111 is listed only in 2.3 mm, 3.2 mm and 6.4 mm

Coated SABIC Brazil plastics may only be treated with the following acceptable coatings applied to the molded lens:

Coating in Alphabetical Order and Corresponding Manufacturer

KUV-5000: See KCC Corporation


Coating Manufacturer in Alphabetical Order



Information on KUV-5000 coatings may be obtained by writing:

KCC Corporation
 83 Mabook-Dong, Giheung-Gu, Yongin-Si
 Gyunggi-Do, South Korea
www.kccworld.co.kr

Note: SABIC LS-1-111 is listed only in 2.3 mm, 3.2 mm and 6.4 mm

<u>MFR.</u>	<u>TRADE NAME and FLOW FORMULATION</u>	<u>TYPE OF RESIN</u>	<u>NUMBER</u>	<u>COLOR</u>
	SABIC LEXAN® LS-1 POLYCARBONATE Nansha LEXAN® LS-2 China (Coated Only) www.sabic.com		111	White %

Coated SABIC Nansha, China plastics may only be treated with the following acceptable coatings applied to the molded lens:

Coating in Alphabetical Order and Corresponding Manufacturer

KUV-5000: See KCC Corporation

Coating Manufacturer in Alphabetical Order




Information on KUV-5000 coatings may be obtained by writing:

KCC Corporation
 83 Mabook-Dong, Giheung-Gu, Yongin-Si
 Gyunggi-Do, South Korea
www.kccworld.co.kr

Note: SABIC LS-1-111 is listed only in 2.3 mm, 3.2 mm and 6.4 mm

<u>MFR.</u>	<u>TRADE NAME and FLOW FORMULATION</u>	<u>TYPE OF RESIN</u>	<u>NUMBER</u>	<u>COLOR</u>
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	SABIC LEXAN® LS-1	POLYCARBONATE	111	White %
	Shanghai LEXAN® LS-2 China (Coated Only)			
	www.sabic.com			

Note: SABIC LS-1-111 is listed only in 2.3 mm, 3.2 mm and 6.4 mm

Coated SABIC Shanghai, China plastics may only be treated with the following acceptable coatings applied to the molded lens:

Coating in Alphabetical Order and Corresponding Manufacturer

KUV-5000: See KCC Corporation


Coating Manufacturer in Alphabetical Order



Information on KUV-5000 coatings may be obtained by writing:

KCC Corporation
83 Mabook-Dong, Giheung-Gu, Yongin-Si
Gyunggi-Do, South Korea
www.kccworld.co.kr

Note: SABIC LS-1-111 is listed only in 2.3 mm, 3.2 mm and 6.4 mm

<u>MFR.</u>	<u>TRADE NAME and FLOW FORMULATION</u>	<u>TYPE OF RESIN</u>	<u>NUMBER</u>	<u>COLOR</u>
	SABIC LEXAN® LS-1 Europe White % (Coated Only) www.sabic.com	POLYCARBONATE LEXAN® LS-2	111 White % 111S	

Note: SABIC LS-1-111 is listed only in 2.3 mm, 3.2 mm and 6.4 mm

Coated SABIC Europe plastics may only be treated with the following acceptable coatings applied to the molded lens:

Coating in Alphabetical Order and Corresponding Manufacturer

KUV-5000: See KCC Corporation

Coating Manufacturer in Alphabetical Order



Information on KUV-5000 coatings may be obtained by writing:

KCC Corporation
 83 Mabook-Dong, Giheung-Gu, Yongin-Si
 Gyunggi-Do, South Korea
www.kccworld.co.kr

Note: SABIC LS-1-111 is listed only in 2.3 mm, 3.2 mm and 6.4 mm

<u>MFR.</u>	<u>TRADE NAME and FLOW FORMULATION</u>	<u>TYPE OF RESIN</u>	<u>NUMBER</u>	<u>COLOR</u>
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SABIC LEXAN® LS-1
 Japan LEXAN® LS-2
 (Coated Only)

POLYCARBONATE

111 White %

www.sabic.com

Note: SABIC LS-1-111 is listed only in 2.3 mm, 3.2 mm and 6.4 mm

Coated SABIC Japan plastics may only be treated with the following acceptable coatings applied to the molded lens:

Coating in Alphabetical Order and Corresponding Manufacturer

KUV-5000: See KCC Corporation

Coating Manufacturer in Alphabetical Order




Information on KUV-5000 coatings may be obtained by writing:

KCC Corporation
 83 Mabook-Dong, Giheung-Gu, Yongin-Si
 Gyunggi-Do, South Korea

www.kccworld.co.kr

Note: SABIC LS-1-111 is listed only in 2.3 mm, 3.2 mm and 6.4 mm

<u>MFR.</u>	<u>TRADE NAME and FLOW FORMULATION</u>	<u>TYPE OF RESIN</u>	<u>NUMBER</u>	<u>COLOR</u>
	SABIC LEXAN® LS-1 Korea (Coated Only) www.sabic.com	POLYCARBONATE LEXAN® LS-2		111 White %

Note: SABIC LS-1-111 is listed only in 2.3 mm, 3.2 mm and 6.4 mm

Coated SABIC Korea plastics may only be treated with the following acceptable coatings applied to the molded lens:

Coating in Alphabetical Order and Corresponding Manufacturer

KUV-5000: See KCC Corporation

Coating Manufacturer in Alphabetical Order



Information on KUV-5000 coatings may be obtained by writing:

KCC Corporation
 83 Mabook-Dong, Giheung-Gu, Yongin-Si
 Gyunggi-Do, South Korea
www.kccworld.co.kr

Note: SABIC LS-1-111 is listed only in 2.3 mm, 3.2 mm and 6.4 mm

Teijin Limited	Panlite L-1225Z	POLYCARBONATE	100	Clear &
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www.teijin.co.jp

Note: Teijin Panlite L-1225Z-100 is listed only in 2.3 mm and 3.2 mm

Coating in Alphabetical Order and Corresponding Manufacturer

KUV-5000: See KCC Corporation

Coating Manufacturer in Alphabetical Order



Information on KUV-5000 coatings may be obtained by writing:

KCC Corporation
83 Mabook-Dong, Giheung-Gu, Yongin-Si
Gyeonggi-Do, South Korea
www.kccworld.co.kr

Note: Teijin Panlite L-1225Z-100 is listed only in 2.3 mm and 3.2 mm

Teijin Polycarbonate China Ltd.	Panlite L-1225Z	POLYCARBONATE	100	Clear &
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www.teijin.co.jp

Note: Teijin Panlite L-1225Z-100 is listed only in 2.3 mm and 3.2 mm

Coating in Alphabetical Order and Corresponding Manufacturer

KUV-5000: See KCC Corporation

Coating Manufacturer in Alphabetical Order



Information on KUV-5000 coatings may be obtained by writing:

KCC Corporation
83 Mabook-Dong, Giheung-Gu, Yongin-Si
Gyeonggi-Do, South Korea
www.kccworld.co.kr

Note: Teijin Panlite L-1225Z-100 is listed only in 2.3 mm and 3.2 mm

Teijin Polycarbonate Singapore PTE Ltd.	Panlite L-1225Z	POLYCARBONATE	100	Clear &
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www.teijin.co.jp

Note: Teijin Panlite L-1225Z-100 is listed only in 2.3 mm and 3.2 mm

Coating in Alphabetical Order and Corresponding Manufacturer

KUV-5000: See KCC Corporation

Coating Manufacturer in Alphabetical Order

Note: FUJIHARD HH2540U was tested on L1225Z 100M Clear Only.



Information on KUV-5000 coatings may be obtained by writing:

KCC Corporation
83 Mabook-Dong, Giheung-Gu, Yongin-Si
Gyeonggi-Do, South Korea
www.kccworld.co.kr

Note: Teijin Panlite L-1225Z-100 is listed only in 2.3 mm and 3.2 mm

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Appendix A: AMECA Accredited Laboratory Information

Arizona Desert Testing
21212 West Patton Road
Wittman, Arizona 85361
Tel: (623) 388-9500
FAX: (623) 388-9007
Website: www.aztest.com

Q-Lab Arizona Test Services
24742 West Durango Street
Buckeye, Arizona 85326
Tel: (623) 386-5140
FAX: (623) 386-5143
Website: www.q-lab.com

Atlas Weathering Services Group
DSET Laboratories
45601 N. 47th Avenue
Phoenix, Arizona 85027-7042
Tel: (623) 465-7356; (800) 255-DSET
FAX: (623) 465-9409
Website: www.atlaswsg.com

Q-Lab Florida Test Services and
1005 S.W. 18th Avenue,
P.O. Box 349490
Homestead, Florida 33034
Tel: (305) 245-5600
FAX: (305) 245-5656
Website: www.q-lab.com

Atlas Weathering Services Group
South Florida Test Services
Everglades Division
16100 S.W. 216th Street
Miami, Florida 33170
Tel: (305) 245-3659
FAX: (305) 245-9122
Website: www.atlaswsg.com

Appendix B: Federal Standard for Plastics

Definitions in FMVSS 108

Coated materials means a material which has a coating applied to the surface of the finished sample to impart some protective properties. Coating identification means a mark of the manufacturer's name, formulation designation number, and recommendations for application.

Color Fundamental definitions of color are expressed by Chromaticity Coordinates according to the CIE 1931 Standard Colorimetric System, as described in the CIE 1931 Chromaticity Diagram (incorporated by reference, see § 571.5).

Color bleeding means the migration of color out of a plastic part onto the surrounding surface.

Cracking means a separation of adjacent sections of a plastic material with penetration into the specimen.

Crazing means a network of apparent fine cracks on or beneath the surface of materials.

Exposed means material used in lenses or optical devices exposed to direct sunlight as installed on the vehicle.

Excerpts from Section 14 from FMVSS 108

Plastic and Coating Requirements

S14.1.2 Plastic optical materials. All plastic materials used for optical parts such as lenses and reflectors on lamps or reflective devices required or allowed by this standard must conform to the material test requirements of S14.4.2.

S14.1.3 All coatings used on optical materials must have added to their formulations an optical brightener, whose presence is detectable by ultraviolet light, to aid in testing for their presence. Other equivalent industry accepted methods may be used as an alternative.

Color Specifications

S14.4.1 *Color test*. The requirement applies to the overall effective color of light emitted by the device and not to the color of the light from a small area of the lens. It does not apply to any pilot, indicator, or tell-tale lights. The color of the sample device must comply when tested by either the Visual Method or the Tristimulus Method.

S14.4.1.3 *Visual method*.

S14.4.1.3.1 *Visual method procedure*. The color of light from the sample device must be compared visually with the color of the light from a standard. The standard may consist of a filter or limit glass. In the case of white, CIE Source A is used only as a color reference. The chromaticity coordinates of the color standards must be as close as possible to the limits listed. The color of the standard filters is determined spectro-photometrically.

S14.4.1.3.2 *Visual method performance requirements*. The color must comply with the applicable requirement.

S14.4.1.3.2.1 *Red*. Red is not acceptable if it is less saturated (paler), yellower, or bluer than the limit standards.

S14.4.1.3.2.2 *Yellow (Amber)*. Yellow is not acceptable if it is less saturated (paler), greener, or redder than the limit standards.

S14.4.1.3.2.3 *White*. White is not acceptable if its color differs materially from that of CIE Source A.

S14.4.1.3.2.4 *Green*. Green is not acceptable if it is less saturated (paler), yellower, or bluer than the limit standards.

S14.4.1.3.2.5 *Blue*. Blue is not acceptable if it is less saturated (paler), greener, or redder than the limit standards.

S14.4.1.4 *Tristimulus method*.

S14.4.1.4.1 *Tristimulus method procedure*.

S14.4.1.4.1.1 The color of light from the H–V point of a sample device must be measured by photoelectric receivers with spectral responses that approximate CIE standard spectral tristimulus valves.

S14.4.1.4.1.2 A sphere may be used to integrate light from a colored source provided that the color shift that results from the spectral selectivity of the sphere paint be corrected by the use of a filter, correction factor, or an appropriate calibration.

S14.4.1.4.1.3 Where the sample device does not have uniform spectral characteristics in all useful directions, color measurements must be made at as many directions of view as are required to evaluate the color for those directions that apply to the end use of the device.

S14.4.1.4.2 *Tristimulus method performance requirements*. The color must comply with the applicable requirement.

S14.4.1.4.2.1 *Red*. The color of light emitted must fall within the following boundaries:

$y = 0.33$ (yellow boundary)

$y = 0.98 - x$ (purple boundary)

S14.4.1.4.2.2 *Yellow (Amber)*. The color of light emitted must fall within the following boundaries:

$y = 0.39$ (red boundary)

$y = 0.79 - 0.67x$ (white boundary)

$y = x - 0.12$ (green boundary)

S14.4.1.4.2.3 *White (achromatic)*. The color of light emitted must fall within the following boundaries:

$x = 0.31$ (blue boundary)

$y = 0.44$ (green boundary)

$x = 0.50$ (yellow boundary)
 $y = 0.15 + 0.64x$ (green boundary)
 $y = 0.38$ (red boundary)
 $y = 0.05 + 0.75x$ (purple boundary)

S14.4.1.4.2.4 Green. The color of light emitted must fall within the following boundaries:

$y = 0.73 - 0.73x$ (yellow boundary)
 $x = 0.63y - 0.04$ (white boundary)
 $y = 0.50 - 0.50x$ (blue boundary)

S14.4.1.4.2.5 Restricted Blue. The color of light emitted must fall within the following boundaries:

$y = 0.07 + 0.81x$ (green boundary)
 $x = 0.40 - y$ (white boundary)
 $x = 0.13 + 0.60y$ (violet boundary)

S14.4.1.4.2.6 Signal Blue. The color of light emitted must fall within the following boundaries:

$y = 0.32$ (green boundary)
 $x = 0.16$ (white boundary)
 $x = 0.40 - y$ (white boundary)
 $x = 0.13 + 0.60y$ (violet boundary)

Plastic optical materials tests

S14.4.2 Plastic optical materials tests. Accelerated weathering procedures are not permitted.

S14.4.2.1 Samples.

S14.4.2.1.1 Samples of materials shall be injection molded into polished metal molds to produce test specimens with two flat and parallel faces. Alternative techniques may be used to produce equivalent specimens.

S14.4.2.1.2 Test specimens shape may vary, but each exposed surface must contain a minimum uninterrupted area of 32 sq cm.

S14.4.2.1.3 Samples must be furnished in thicknesses of 1.6 +/- 0.25 mm, 2.3 +/- 0.25 mm, 3.2 +/- 0.25 mm, and 6.4 +/- 0.25 mm. *S14.4.2.1.4* All samples must conform to the applicable color test requirement of this standard prior to testing.

S14.4.2.1.5 A control sample, kept properly protected from influences which may change its appearance and properties of each thickness, must be retained.

S14.4.2.2 Outdoor exposure test.

S14.4.2.2.1 Outdoor exposure tests of 3 years in duration must be made on samples of all materials, including coated and uncoated versions, used for optical parts of devices covered by this standard. Tests are to be conducted in Florida and Arizona.

S14.4.2.2.2 Concentrations of polymer components and additives used in plastic materials may be changed without outdoor exposure testing provided the changes are within the limits of composition represented by higher and lower concentrations of these polymer components and additives previously tested to this section and found to meet its requirements.

S14.4.2.2.3 Procedure. S14.4.2.2.3.1 One sample of each thickness of each material must be mounted at each exposure site so that at least a minimum uninterrupted area of 32 sq cm of the exposed upper surface of the sample is at an angle of 45 degrees to the horizontal facing south. The sample must be mounted in the open no closer than 30 cm (11.8 in) to its background.

S14.4.2.2.3.2 During the exposure time the samples must be cleaned once every three months by washing with mild soap or detergent and water, and then rinsing with distilled water. Rubbing must be avoided.

S14.4.2.2.4 *Performance requirements.* Plastic lenses, other than those incorporating reflex reflectors, used for inner lenses or those covered by another material and not exposed directly to sunlight must meet the optical material test requirements when covered by the outer lens or other material.

S14.4.2.2.4.1 After completion of the outdoor exposure test the haze and loss of surface luster as measured by ASTM D1003–92 (incorporated by reference, see § 571.5) must not be greater than:

- (a) 30% for materials used for outer lenses, other than those incorporating reflex reflectors;
- (b) 7% for materials used for reflex reflectors and lenses used in front of reflex reflectors.

S14.4.2.2.4.2 After completion of the outdoor exposure test materials used for headlamp lenses must show no deterioration.

S14.4.2.2.4.3 After completion of the outdoor exposure test all materials, when compared with the unexposed control samples, must not show physical changes affecting performance such as color bleeding, delamination, crazing, or cracking. Additionally materials used for reflex reflectors and lenses used in front of reflex reflectors must not show surface deterioration or dimensional changes.

S14.4.2.2.4.4 After completion of the outdoor exposure test all materials, when compared with the unexposed control samples, must not have their luminous transmittance changed by more than 25% when tested in accordance with ASTM E308–66 (incorporated by reference, see § 571.5) using CIE Illuminant A (2856K). S14.4.2.2.4.5 After completion of the outdoor exposure test all materials must conform to the color test of this standard in the range of thickness stated by the material manufacturer.

S14.4.2.3 *Heat test.*

S14.4.2.3.1 *Procedure.* Two samples of each thickness of each material must be supported at the bottom, with at least 51 mm of the sample above the support, in the vertical position in such a manner that, on each side, the minimum uninterrupted area of exposed surface is not less than 3225 sq mm. The samples are placed in a circulating air oven at 79 Degrees +/- 3 Degrees for Two hours.

S14.4.2.3.2 *Performance requirements.*

After completion of the heat exposure and cooling to room ambient temperature, a test specimen must show no change in shape and general appearance discernable to the naked eye when compared with an unexposed specimen and continue to conform to the applicable color test requirement of this standard.

Appendix C: DOT Interpretation Files and Supplemental Lab Information