SURFACE VEHICLE RECOMMENDED PRACTICE

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Procedure for Visual Evaluation of Interior and Exterior Automotive Trim

RATIONALE

Added LED in as a daylight alternative. LED sources may be used in addition to cool white fluorescent to simulate typical viewing conditions.

1. SCOPE

This SAE Recommended Practice applies to parts and materials used in vehicle manufacture which are intended to be acceptable color matches to a specified standard. This document is intended for use with parts or materials which are opaque or nearly so. Materials covered by this document include topcoat paint finishes, interior soft trim, interior and exterior hard trim, and exterior film and flexible trim. This practice requires judgments by observers with a minimum of normal color vision and preferably superior as rated with the FM-100 hue test as specified in ASTM E1499.

1.1 Purpose

The intent of this document is to precisely specify procedures for the visual evaluation of appearance of colored materials or parts incorporated in the manufacture of vehicles. The document provides a consistent engineering practice for the determination of visual color difference between materials or parts of the same or like materials. A suitable fixture providing daylight, fluorescent, and horizon lighting conditions is necessary for this evaluation.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM D1729 Standard Practice for Visual Appraisal of Colors and Color Differences of Diffusely-Illuminated Opaque Materials

ASTM E284 Standard Terminology of Appearance

ASTM E308 Standard Practice for Computing the Colors of Objects by using the CIE System

ASTM E1499 Standard Guide for Selection, Evaluation and Training of Observers

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

For more information on this standard, visit
https://www.sae.org/standards/content/J361_202210/

2.1.2 CIE Publications

Available from CIE Central Bureau, Babenbergerstrasse 9/9A, 1010 Vienna, Austria, Tel: +43 1 714 31 87, www.cie.co.at.

ISO 23603/CIE S012 Standard Method of Assessing the Spectral Quality of Daylight Simulators for Visual Appraisal and Measurement of Colour (previously designated as CIE Publication 51.2)

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM D1729 Standard Practice for Visual Appraisal of Colors and Color Differences of Diffusely Illuminated Opaque Materials

2.2.2 Wiley Publications

Available from Wiley Publishers, 111 River Street, Hoboken, NJ 07030-5774, Tel: 201-748-6000, www.wiley.com.

Billmeyer and Saltzman's Principles of Color Technology, 3rd Edition, by Roy S. Berns, April 2000.

3. DEFINITIONS

3.1 Master Standard, Sample

3.1.1 MASTER STANDARD

The appropriately identified engineering approved standard sample against which specified similar materials are evaluated.

3.1.2 SAMPLE

The material or part that is evaluated for color and appearance match to the master standard.

3.2 Color Attributes

The color of a material can be described by three basic attributes. Figure 1 shows a diagram of Munsell hue, value, and chroma and their relationship to one another.

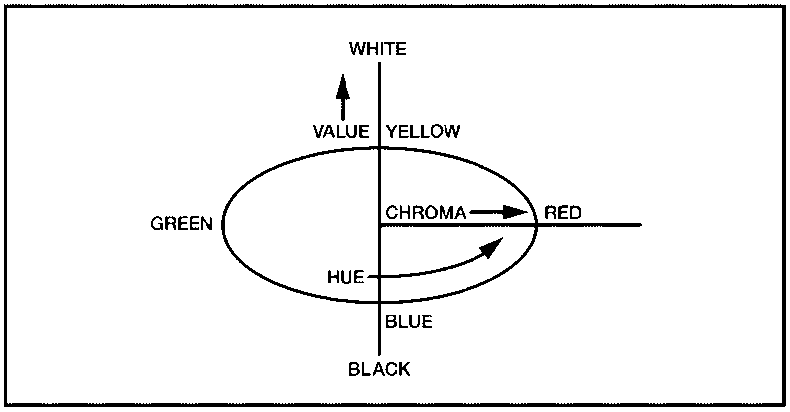

Figure 1 - Munsell hue, value, and chroma diagram

3.2.1 HUE

The attribute of color perception by means of which an object is judged to be red, yellow, green, blue, or intermediate between some adjacent pair of these.

3.2.2 VALUE

The attribute of color perception by means of which an object is judged to appear light or dark relative to an object of the same hue and chroma.

3.2.3 CHROMA

The attribute of color perception that expresses the degree of departure from gray, toward the pure hue, at the same value and hue.

3.3 Changes in Viewing Geometry

3.3.1 METALLIC BRILLIANCE

Departure from solid color (straight shade) appearance to a highly metallic or opalescent appearance, often accompanied by a change in the angle of viewing (goniochromatic effect).

3.3.2 GONIOCHROMATISM

Change in value/lightness, hue, or chroma of a specimen upon change in angular illuminating or viewing conditions but without change in light source or observer. When two specimens are compared to each other, they may or may not exhibit metamerism in addition to differences in goniochromatism. They should also be viewed under different lights to check for metamerism (refer to ASTM E284).

3.3.3 METAMERISM

Property of two specimens that match under a specified illuminator and to a specified observer and whose spectral reflectances or transmittances differ in the visible wavelengths (refer to ASTM E284).

3.3.4 ILLUMINANT METAMERISM

Occurs when two objects match under one light source, but do not match under a different light source. This results when the objects have different spectral reflectance curves but the same color coordinates for one set of viewing conditions.

3.3.5 OBSERVER METAMERISM

Occurs when a metameric pair matches for one person but fails to match when seen by another person under the same viewing conditions.

3.3.6 FIELD SIZE METAMERISM

Occurs when the field size changes, for example from 2 to 10 degrees. A metameric pair which matches when seen at a distance (small field of view) may no longer match when seen closer to the eyes (large field of view).

4. EQUIPMENT

The proper lighting unit(s) and measuring equipment are essential for consistent appearance evaluation. Figure 2 shows the critical dimensions and relative positions of an examination perch/stand and lighting sources.

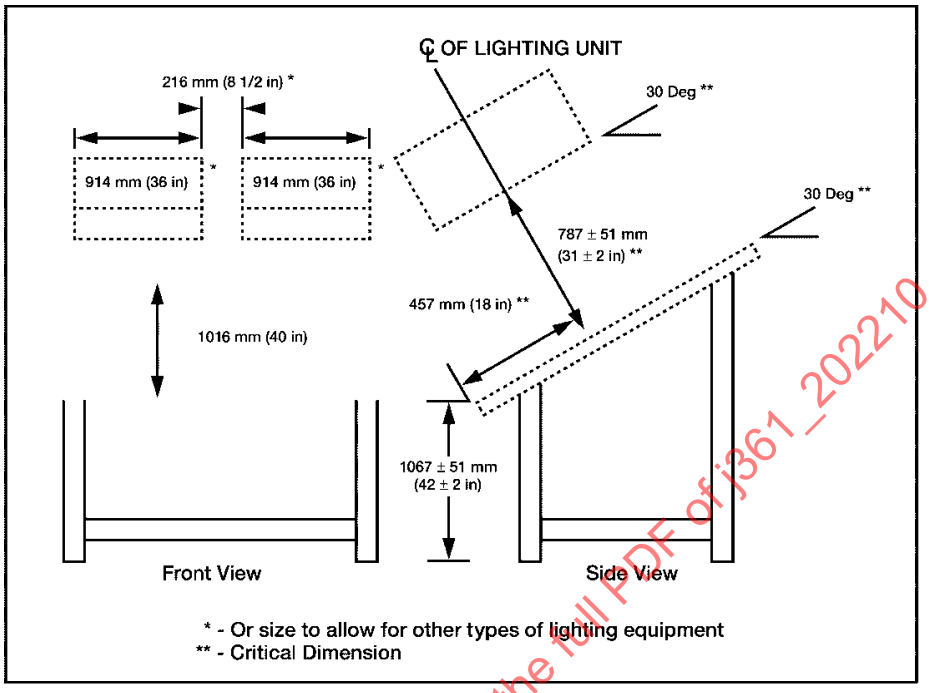

Figure 2 - Recommended installation for lighting unit(s)

4.1 Lighting Unit(s)

Each color evaluation area shall be provided with an overhead lighting unit (along with an accompanying material examination perch/stand) capable of broadcasting the following lighting conditions:

4.1.1 Daylight capable of providing a color temperature of 6500 K ± 200 K at an illuminance of 1080 to 1730 lx (100 to 160 ft-c). Although typically provided by filtered tungsten halogen lamps, daylight fluorescent lamps with equivalent spectral and illuminance characteristics can be used as an acceptable alternative. The resulting spectral power distribution of the incident light must be maintained to conform to ASTM E308 and ISO 23603/CIE S012 with a quality grade of B/C or better. LED lamps may be used as daylight simulators provided, they meet the spectral qualities and illuminance characteristics as specified.

4.1.2 Cool white fluorescent (CWF) capable of providing a color temperature of 4150 K ± 200 K at a minimum illuminance of 860 lx (80 ft-c). This source is typically provided by CWF tubes simulating standard illuminant F2.

NOTE: Changes in energy legislation has altered the spectral power of some cool white lamps to more closely simulate standard illuminant F11. LED sources may be used in addition to CWF to simulate typical viewing conditions.

4.1.3 Simulated horizon sunlight source providing a color temperature of 2300 K ± 200 K at a minimum illuminance of 860 lx (80 ft-c). This source is typically provided by tungsten halogen lamps to simulate early morning sunrise or late afternoon sunset conditions. Due to reduced availability of incandescent lamps, LED lamps may be substituted for incandescent representing horizon sunlight lighting provided they are approximately equal in correlated color temperature and spectral characteristics.

4.1.4 As an option, an ultraviolet lighting source providing energy near the visible spectrum, and also known as black light (no Kelvin value associated), can be used alone or in combination with any of the previous light sources to exaggerate the effects of optical brighteners, whitening agents, fluorescent pigments, dyes, or resins. DO NOT USE ULTRAVIOLET LIGHT FOR A COLOR MATCH DECISION. DO NOT LOOK DIRECTLY INTO AN ULTRAVIOLET LIGHT SOURCE BECAUSE EYE DAMAGE CAN OCCUR FROM PROLONGED EXPOSURE TO UV LIGHT.

4.1.5 Input Voltage

Follow manufacturer's installation instructions for proper input voltage requirements.

4.2 Lighting Booths

As an acceptable alternative, a light booth can be utilized for color evaluation purposes only if agreed upon by the customer and supplier. The booth should be placed so that it is at least 1070 mm (42 inches) above floor level and should be set-up so that direct viewing into the booth is possible.

4.3 Light Meter

A calibrated light meter is required for checking the intensity levels of the lighting sources.

4.4 Color Temperature Measuring Instrument

A spectroradiometer or colorimeter must be used to check color temperature of the light sources. These units must be calibrated using a NIST traceable 6500 K source. Only a spectroradiometer with current traceability and capable of measuring 300 to 700 nm in a minimum of 5 nm intervals can be used for calibration and re-certification as specified in ISO 23603/CIE S012.

5. VIEWING ENVIRONMENT

To perform accurate visual color matching, the viewing environment must be set up and maintained to be consistent with other locations in the industry (see Appendix B).

5.1 Perch and Surround

Color of perch and surround shall be neutral gray, defined as Munsell N6-N7 (L*61-71) with a maximum Chroma C* = 1.0, visually appearing neutral.

5.2 Ambient Light

The light units and examination perch shall be placed in an area that WILL NOT ADMIT ambient light into the viewing environment.

5.2.1 Enclosed Room

An enclosed room is the preferred location for the installation of the light units. The walls shall be painted with Munsell N6-N7 (L*61-71) flat paint. (This paint is available from any major supplier.) Adequate ventilation of the room must be provided to prevent overheating of the lamps.

5.2.2 Enclosing Curtain

If a room is not available, an enclosing curtain will be suitable. The curtain must be dull in finish and the color must be as close as possible to Munsell N6-N7 (L*61-71). Curtain must also be dense enough to prevent ambient light penetration and must surround the viewing area. A minimum distance of 914 mm (3 feet) must be maintained between the enclosure or curtain and the front of the perch to allow proper viewing from all directions.

5.3 Examination Perch

Gray foam matting, Munsell N6-N7 (L*61-71), napped knit fabric or carpet shall be used on the perch surface. The material shall be suitably textured so that materials and parts will not slide off the perch. As an option, a napped knit fabric, black in color, Munsell N0.5-N1.5 (L*5.1-15.4) with a maximum Chroma C* of 1.0, visually appearing neutral, can be used, provided that it is located on a separate examination perch/stand or is able to be easily removed from the primary perch/stand (see 10.1).

The optional black perch material helps in eliminating random specular reflections and is helpful when viewing dark colors or parts at the deep flop angle. Use of this alternate black perch material should be noted with the color comments. Comply with Figure 2 for perch dimensions.

6. MAINTENANCE

Consistency of correlated color temperature, light levels (illuminance), and spectral power distribution among all locations within the lighting unit must be certified by the manufacturer. Proper maintenance of the lighting unit, in accordance with the manufacturer's recommendation, is essential to ensure consistent lighting conditions over time and with respect to other units. A checklist for environmental evaluation is provided in Appendix A.

6.1 Diffuser

The diffuser should be cleaned every 3 months with a glass cleaner.

6.2 Daylight Filters

The daylight filters if applicable, should be cleaned and checked for cracks every 6 months. These filters should be cleaned with a non-streaking glass cleaner and allowed to air dry. (CAUTION: Allow adequate cooling of the daylight filters and lamps before attempting to remove.) If filter replacement is required, replacement filters must be evaluated for spectral power distribution of the transmitted light per 4.1.1.

6.3 Perch

The perch should be cleaned once a month. If any discoloration has occurred, the perch material must be replaced.

NOTE: Some materials, such as gray foam material turn yellow over time. When this has occurred, it must be replaced to conform to 5.1.

6.4 Calibration and Certification

Lighting units must be calibrated with NIST traceable certification at least once a year. Prior to and following calibration, the illuminance values, correlated color temperature, and ISO 23603/CIE S012 publication ΔE_m^* should be recorded for each position. Calibration sticker must be affixed to the front of the unit.

Lamps should be replaced when the unit is out, of specification for color temperature and/or intensity, provided all other factors affecting color temperature or intensity are within tolerance (i.e., units properly calibrated. unit cleanliness, etc.). It is good practice to replace the lamp series (i.e., all daylight bulbs) when one lamp becomes defective.

6.5 Light Level Balance

The light level (illuminance) should be checked monthly. Measurements should be taken directly under each daylight lamp, 635 mm (25 inches) below the diffuser. This distance is necessary in order to give a common measurement reference point. Any measurements taken within the viewing area shall not differ from the mean value of the measurements taken by more than 20%. The viewing area is defined as that which falls within ±20% of the illumination level of that average.

6.6 Maintenance Log

All maintenance activities, such as cleaning, calibration, bulb replacement, etc., should be recorded. Control charts, including upper and lower control limits, should be maintained for illuminance and correlated color temperature. Follow QS 9000 procedures within your company for establishing a maintenance log.

7. VISUAL COLOR EVALUATION

Proper viewing conditions and positioning of samples and master standards on the examination perch/stand are essential to maintain a common practice between viewing locations.

7.1 Viewing Conditions

There should be no other materials present on the examination perch/stand when samples of one color are being viewed. Also, there should not be any distracting or brightly colored decorations present in the evaluation area. Persons wearing bright or very chromatic clothing should wear a covering such as a smock of neutral gray color to eliminate the influence of extraneous color. Persons viewing color shall not wear tinted contacts or glasses, as these affect perceived color. Smoking shall not be allowed in the evaluation area.

In some instances, it is good practice to evaluate materials under natural daylight. There is, however, little control over standard practices due to the natural variability in day-to-day weather conditions, global latitude of the viewing location, time of day during valuation, and the time of the year of the evaluation. As a general rule of thumb, limit outside evaluations to midday hours and view the specimens at waist level.

7.2 Viewing and Positioning

Samples should be placed on the examination perch/stand, centered relative to the overhead lighting unit. It is important that the samples be parallel in direction and touching one another. When viewed on the perch surface, it is often necessary for the observer to change position and distance relative to the sample so that hue, lightness, and chroma may be assessed accurately. All samples should be viewed under daylight, fluorescent and horizon light. Daylight is the most important lighting source to make a color determination with fluorescent and horizon lighting used to evaluate metamerism. Color appraisals should be made quickly because sensitivity of the eye to color differences decreases with time of exposure (adaptation). Refer to ASTM E1499.

7.2.1 Textile Materials

The sample and master standard should be viewed looking into the nap (the surface fibers of a fabric) with the samples touching one another. They should be placed so that when rubbing the materials, the nap feels roughest as the hand moves along the fabric to the top of the examination perch/stand. Flat fabrics should be viewed with the machine direction yarns running up and down the examination perch/stand.

7.2.1.1 Flop Matching

The sample and the master standard shall match (with the nap running the same direction for both materials) when rotated in the plane of the examining table 180 degrees and at 90 degrees intermediate points in between.

7.2.2 Painted or Glossy Surfaces, Plastic, Leather, or Vinyl Materials

These materials should be considered in two categories: (a) solid or straight shade, and (b) metallic and/or opalescent colors. Solid colors should be viewed from two positions commonly referred to as the FACE and FLOP positions as illustrated by Figure 3. For plastic materials, view the samples/parts to the master with the gates facing in the same direction where the flow of the resin is the same or similar. The face position is attained when the observed surface is nearly parallel to the observer, making the surface nearly perpendicular to the line of sight. The flop position is attained by rotating the sample away from the observer and down 90 degrees from the face position. These two viewing positions should be considered critical to all color matching. Metallic and/or opalescent colors should be observed in the same manner. Additional attention should be given to the evaluation of the intermediate angles viewed in a continuous motion. This evaluation is commonly referred to as travel. Figure 3 also illustrates this viewing condition. Color differences between two samples (or a sample and a master standard) may occur at the intermediate angle as a result of varied paint technologies or spray conditions.

NOTE: When visually comparing a sample to a master, always reverse them left to right and top to bottom to observe any effects on color due to placement of materials relative to one another.

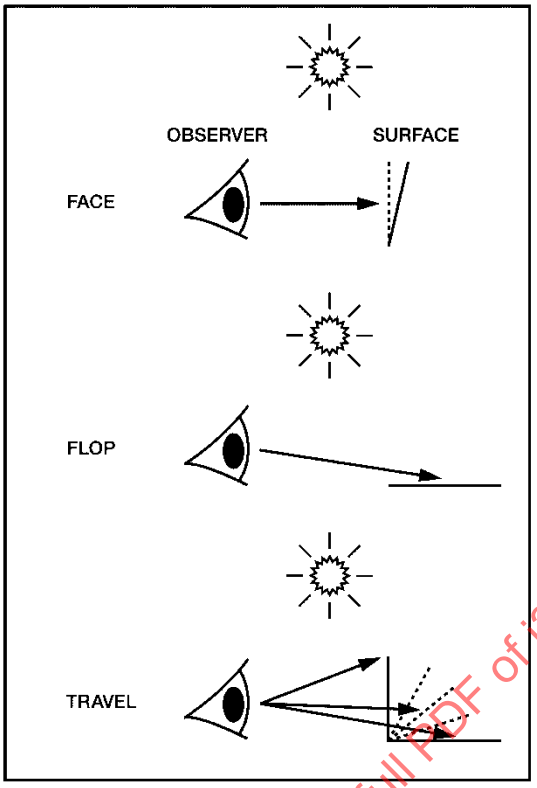

Figure 3 - Flop and travel evaluation

8. CARE OF MASTER STANDARDS

All master standards should be protected to ensure their original appearance and should be stored in a cool, dry, dark location. Care should be taken not to crush textile master standards or distort the surface in any way. The packaging material should not chemically attack or scratch the material inside. Specimens containing rubber, asphalt, or other materials that have the potential to stain shall be isolated to themselves, apart from other standards.

9. COLOR DISCRIMINATION

Several tests exist to measure color perception and discrimination. It is recommended that all personnel involved in viewing color pass both a color discrimination/perception test and a color blindness test. Refer to ASTM E1499-97 for recommended color testing methodology.

10. NOTES

10.1 Foam for Viewing Surface or Equivalent

Foam for the viewing surface, product code N9698 Gray Foam, is available from: Uniroyal Engineered Products, 501 South Water St., Stoughton, WI 53589, Tel: 800-873-8800.

10.2 Revision Indicator

A change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.