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Submitted for recognition as an American National Standard

(R) PROCEDURE FOR VISUAL EVALUATION OF INTERIOR AND EXTERIOR AUTOMOTIVE TRIM

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 color 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.
- 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 Publications**—The following publications form a part of this specification to the extent specified herein.
- 2.1.1 **ASTM PUBLICATION**—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.
- ASTM E 1499-92a—Standard Practice for Operating Light- and Water-Exposure Apparatus (Carbon-Arc Type) for Exposure of Plastics
- 2.1.2 **OTHER PUBLICATION**
- Colour Physics for Industry, R. McDonald, Society of Dyers & Colourists, 1987
3. **Definitions**
- 3.1 **Master Standard, Sample**
- 3.1.1 **MASTER STANDARD**—The appropriately identified engineering approved standard sample against which specified like 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 four basic attributes. Figure 1 shows a diagram of Munsell hue, value, and chroma and their relationship to one another.

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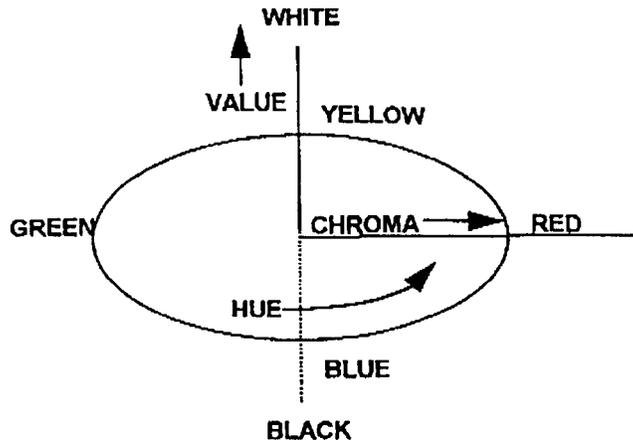


FIGURE 1—MUNSELL HUE, VALUE, AND CHROMA DIAGRAM

- 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 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.
- 3.2.4 METALLIC BRILLIANCE—Departure from solid color (straight shade) appearance to a highly metallized or opalescent appearance, often accompanied by a change in the angle of viewing (goniochromatic effect).
- 3.3 Metamerism—**(See 2.1.2).
- 3.3.1 ILLUMINANT METAMERISM—Occurs when two objects match one another under a light source, but do not match under a different light source. Illuminant Metamerism results when a pair of objects have different spectral reflectance curves but the same color coordinates for one set of conditions.
- 3.3.2 OBSERVER METAMERISM—Occurs when a metameric pair matches for one person, but fails to match when seen by another person.
- 3.3.3 FIELD SIZE METAMERISM—Occurs when the field size changes, for example from 2 degrees to 10 degrees. A metameric pair which match 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 light meter are essential for consistent appearance evaluation. Figure 2 shows the critical dimensions and relative positions of an examination perch/stand and lighting sources.

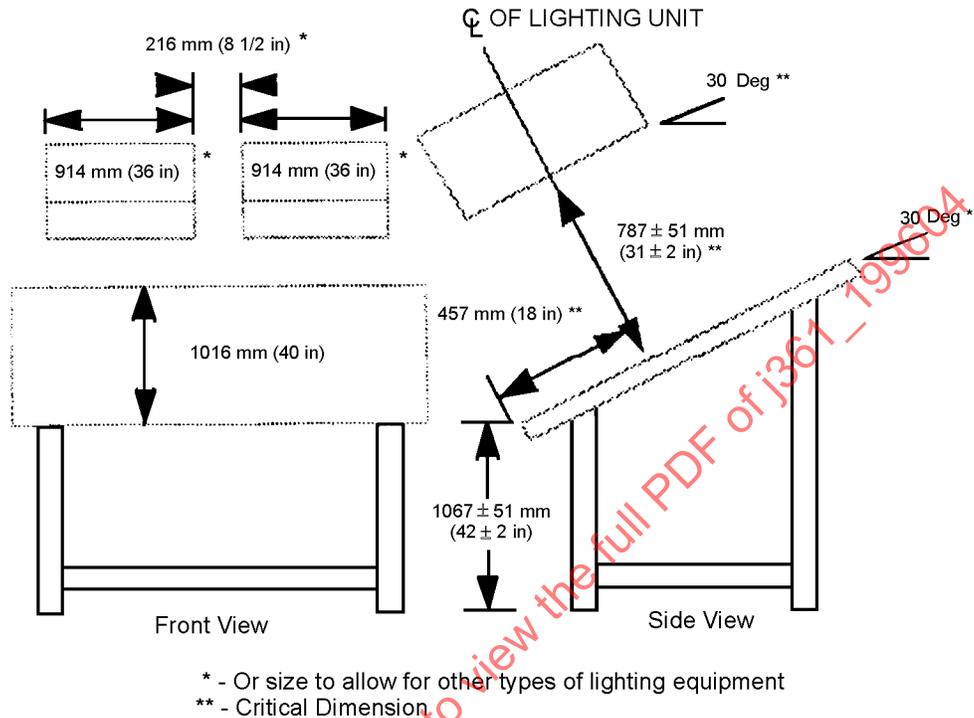


FIGURE 2—RECOMMENDED INSTALLATION FOR LIGHTING UNIT(S)

- 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 types of simulated lighting conditions:
- 4.1.1 Daylight capable of providing a color temperature of $6500\text{ K} \pm 200\text{ K}$ at an illumination of 970 to 1290 lux (90 to 120 ft-candles). This source is typically provided by four filtered 750 W Tungsten Halogen Lamps. The daylight filters must be certified by the manufacturer to ensure consistency of the transmitted color temperature between each filter/location. The resulting spectral power distribution of the transmitted light must be maintained to conform to that of the filter manufacturer's standard.
- 4.1.2 Cool White Fluorescent (CWF) capable of providing a color temperature of $4150\text{ K} \pm 200\text{ K}$ at a minimum illumination of 860 lux (80 ft-candles). This source is typically provided by four 30 W Cool White Fluorescent tubes.
- 4.1.3 Simulated horizon sunlight source providing a color temperature of $2300\text{ K} \pm 200\text{ K}$ at a minimum illumination of 860 lux (80 ft-candles). This source is typically provided by eight 500 W Tungsten Halogen Lamps to simulate early morning sunrise or late afternoon sunset conditions.

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- 4.1.4 As an alternative, an ultraviolet lighting source (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 A UV LIGHT SOURCE BECAUSE EYE DAMAGE CAN OCCUR FROM PROLONGED EXPOSURE TO UV LIGHT.
- 4.1.5 **POWER SUPPLY**—Input voltage to the unit is critical to maintain color temperature and should be controlled according to manufacturer's recommendations.
- 4.2 **Lighting Booths**—As a minimal condition, 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 in) 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 properly calibrated, traceable spectroradiometer can be used to check the color temperature of the lighting unit light sources. Also, a properly calibrated X,Y Color Temperature meter using a glass filter (calibrated at 6500 K using a filtered tungsten-halogen source) can be utilized to measure the color temperature of the lighting unit light sources.
5. **Viewing Environment**—The lighting unit(s) and examination perch/stand shall be placed in an area that will not admit ambient light into the viewing environment. An enclosed room is the preferred location for installation of the lighting unit(s). If a room is not available, an enclosing curtain is suitable. If the lighting unit(s) are placed into an enclosed room, adequate ventilation of the room must be provided.
- 5.1 **Enclosing Curtain**—An enclosing curtain, dull in finish and light neutral gray in color, should be used to surround the viewing area to prevent ambient light from entering the evaluation area. Munsell N6-BN7.5 neutral gray is required for this purpose.
- 5.2 **Enclosed Viewing Room**—The walls and examination perch/stand shall be painted with Munsell N6-N7.5 flat paint. This paint is available from any major paint supplier.
- 5.3 **Examination Perch/Stand Material**—Foam rubber or a napped knit cloth, gray in color, Munsell N6-N7.5, shall cover the examination perch/stand. The material should be suitably textured so that materials or parts will not slide off of the perch/stand. As an option a napped knit fabric, black in color, Munsell No.5-1, 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.
- 5.4 **Enclosure Size**—The size of the room that the lighting unit(s) and examination perch/stand(s) are placed in should allow for comfortable viewing. There should be enough room to view materials or parts from all angles and from several feet in front of the examination perch/stand.
6. **Maintenance**—Proper maintenance in accordance with the manufacturer's recommendations of the lighting unit(s) is essential to maintain consistent lighting conditions over time and with respect to other lighting units.
- 6.1 **Color Temperature**—The specified color temperature of all lighting unit sources must be maintained and regularly recorded, per the manufacturer's recommendations. Color temperature measurements should be made at least 10 min after the unit has been operating in daylight (D65) mode.

- 6.2 Lighting Levels**—Lighting levels should be checked on a regularly scheduled basis. Measurements should be taken directly under each daylight bulb with the measuring surface of the light meter located 640 mm (25 in) below the diffuser. This is necessary to take into account the different size light meters currently in use and to give a common measurement reference point. The maintenance of a control chart with 1290 and 970 lux (120 and 90 ft-candles) as the upper and lower control limits, respectively, will help in monitoring the proper lighting levels of the daylight sources. Lighting levels should not be adjusted at the expense, loss or gain, of color temperature. The power supply to the daylight sources should be calibrated every six months or as specified by the manufacturer.
- 6.3 Filter Replacement**—All daylight filters should be checked once per month for cracks and breakage and should be replaced if necessary.
- 6.4 Lamp Replacement**—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 Cleaning**—Cleaning of the lighting unit(s) is recommended at least every 3 months or more if the unit(s) are located in an area where there is a high amount of airborne dust or lint. A 50/50 mixture of isopropyl alcohol and water, or a glass cleaner which does not leave a residue, is recommended for cleaning the lighting unit(s). Clean only when the unit(s) are cool. Clean all parts of the unit(s) or as specified by the manufacturer.
- 6.6 Maintenance Log**—A template for a Monthly Lighting Unit Maintenance Log is included in Appendix A. All maintenance activities such as cleaning, calibration, bulb replacement and light output and color temperature readings can be recorded.
- 7. Visual Color Evaluation**—Proper viewing conditions and positioning of samples and master standards on the examination perch/stand is essential to maintain a common practice between viewing locations. The optional black background helps in eliminating random specular reflections, and is helpful when viewing dark, glossy parts. Use of the alternate black background should be noted with the color comments.
- 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 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 evaluation, 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, directly on the centerline from the light bank to the perch/stand, and in the center of that light bank. With the exception of materials that require face, flop, or travel viewing, it is important that the samples be parallel in direction and touching one another on the viewing plane. Reflectance will vary with materials and it is often necessary to move about the room so that the hue, lightness, and chroma may be assessed accurately. All samples should be viewed under daylight, followed by fluorescent and horizon light. Daylight is the most important lighting source to make a color determination followed by fluorescent and horizon lighting conditions, which are used to evaluate metamerism. Refer to ASTM E 1499-92a, section 8.3, for changes in observer sensitivity.

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- 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 degree 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 staight shade and (b) metallic 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 attained when the observed surface is nearly vertical 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 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. Differences in two samples (or a sample and a master standard) of the same color may occur at the intermediate angle as a result of varied paint technologies or spray conditions.
- 7.2.3 When viewing materials to a master always reverse them left to right and top to bottom to observe any affects on color due to placement of materials relative to one another.
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 which are potential stainers shall be isolated to themselves.
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 E 1499-92a for recommended color testing methodology.

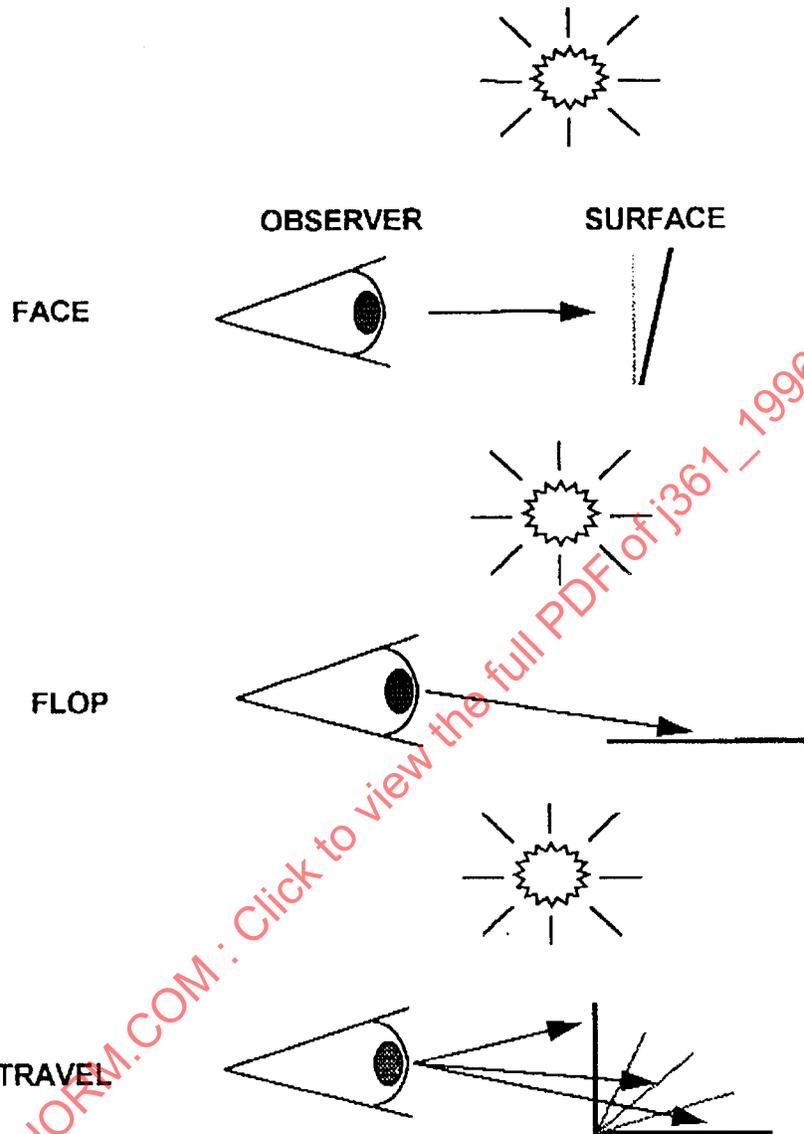


FIGURE 3—FLOP AND TRAVEL EVALUATION

10. Notes

10.1 **Marginal Indicia**—The change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. An (R) symbol to the left of the document title indicates a complete revision of the report.

PREPARED BY THE SAE TEXTILES AND FLEXIBLE PLASTICS COMMITTEE

APPENDIX A

MONTHLY DAYLIGHTING UNIT MAINTENANCE LOG

MONTH _____	YEAR _____
COMPANY _____	LOCATION _____
LIGHT MFG. _____	MODEL/TYPE _____ SERIAL NO. _____

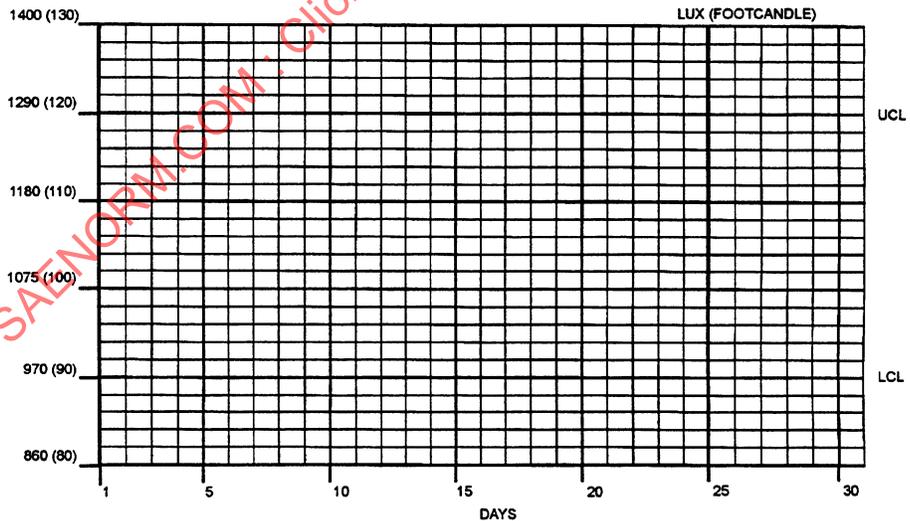
MAINTENANCE EVENT RECORD:

DATE _____ CLEAN CHECK FILTER CALIBRATION VOLTS _____
 COMMENTS: REPLACE BULBS OTHER (EXPLAIN BELOW)

DATE _____ CLEAN CHECK FILTER CALIBRATION VOLTS _____
 COMMENTS: REPLACE BULBS OTHER (EXPLAIN BELOW)

DATE _____ CLEAN CHECK FILTER CALIBRATION VOLTS _____
 COMMENTS: REPLACE BULBS OTHER (EXPLAIN BELOW)

ILLUMINATION MEASUREMENTS



LEGEND: DAYLIGHT BULB NO. (FROM LEFT) DUAL OVERHEAD UNIT

- #1 ● #3 ○
- #2 + #4 □

FIGURE A1—MONTHLY DAYLIGHTING UNIT MAINTENANCE LOG
 (KEEP A SEPARATE LOGSHEET FOR EACH LIGHTING UNIT AT YOUR LOCATION)