



Product Color Specification

Sun Proprietary/Confidential: Need to Know

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Product Color Specification

1. Overview & Audience

An important aspect of perceived quality is the aesthetic appearance of product finish and color. The Sun Product Color Program is designed to ensure consistent quality color matches in the many materials that are used in the manufacture of its products. This Specification provides information on color matching and measuring techniques to be followed by suppliers and acceptable tolerances for suppliers providing resin, paint coatings, or ink to Sun Microsystems, Inc.

For further information on Global Cosmetic Quality and Workmanship Standards see specification 923-2001-xx. This document applies to all products manufactured by Sun worldwide.

2. Sun's Product Color Program

The Product Color Specification ("Specification"), together with a color standard (also known as a color chip), defines the product color control system for worldwide use by Sun and its suppliers. This Specification provides information essential to achieving quality material color matches.

In addition to this Specification, the Product Color Program includes the development of new color standards. These durable color standards are manufactured to exacting color control specifications. Their large size and the important reference data printed on the reverse side will assist Sun suppliers in achieving precise material color matches (see example in section 2.1.7).

When a material color match is initiated, it is important to provide the supplier with this Specification and a color standard. Once a supplier has this Specification, additional matches for different color require only the specific color standards.

2.1 Sun Standards ("Color Chips")

The following color standards (color chips) define the physical part of the color control system (used in conjunction with the written specification). These color standards represent custom colors that Sun has developed for use on its products. Because these are custom colors there are not equivalents in ink matching systems (such as the Pantone Matching System or the RAL Design System) or in commercial, pre-mixed paints or resins.

Any colors used on Sun hardware that are not custom colors are called out in detail on part drawings. See section 2.1.6 for information on Sun colors that do not have standards or have been retired from use.

The following color standards (both 950 and 255 part numbers) are physical parts and are therefore not ECO controlled. Revisions or changes will be tracked only in this document and not according to ECO standard practices.

2.1.1 Sun Product Color Standards

| | |
|---|-------------|
| • White Grey | 950-3390-02 |
| • Dove Grey | 950-3391-01 |
| • Blue Purple | 950-3392-01 |
| • Bright Purple | 950-3279-02 |
| • HF Green | 255-1119-01 |
| • Slate Gray (formerly Server Medium Gray) | 950-3393-01 |
| • Charcoal Gray (formerly Server Dark Gray) | 950-3394-01 |
| • Deep Purple (formerly Server Dark Purple) | 950-3395-01 |
| • 20th Anniversary Red/Blue Shift | 255-1111-01 |
| • Blue/Red Shift | 255-1115-01 |
| • Detail Silver | 255-1118-01 |
| • Metallic Deep Purple | 255-1117-01 |
| • Sun Alloy Silver | 950-4696-01 |
| • Sun Alloy Gray | 950-4697-01 |
| • Sun Alloy Logo Blue | 255-1121-01 |
| • Sun Alloy Ghost Grey | 255-1122-01 |

NOTE: Sun transitioned from Server Medium Gray, Server Dark Grey and Server Dark Purple color names to Slate Grey, Charcoal Grey and Deep Purple color names for all products using these previous colors. These are visual equivalents. It is acceptable to Sun for vendors to substitute the new colors for the older colors when ordering material. The new colors are to be phased in as soon as possible. It is acceptable to deplete any existing inventory of the old color formulations before ordering new material.

2.1.2 Sun Ink Standards

| | |
|--|-------------|
| • Sun Trans White | 255-1116-01 |
| • Sun Logo White -Manufacturing Match standard | 255-1110-01 |
| • Sun Logo White -Applicator's standards: | |
| Over Charcoal (Texture #2) wet paint | 255-1112-01 |
| Over Charcoal powder coat | 255-1113-01 |
| Over Slate powder coat | 255-1114-01 |

2.1.3 Sun Powder Coat Standards

| | |
|------------------------------|-------------|
| • Powder Coat: Slate Gray | 950-3608-01 |
| • Powder Coat: Charcoal Gray | 950-3609-01 |
| • Powder Coat: Deep Purple | 950-3610-01 |
| • Powder Coat: Bright Purple | 255-1120-01 |

2.1.4 Sun Translucent Standards

see section 2.1.6 below

2.1.5 Sun Paint Texture Standard

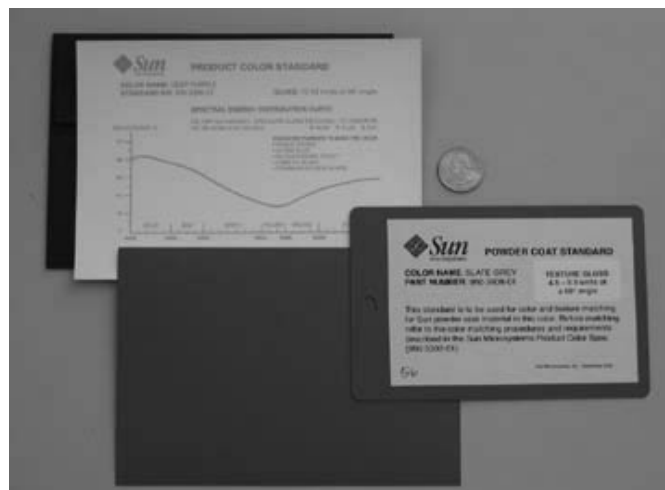
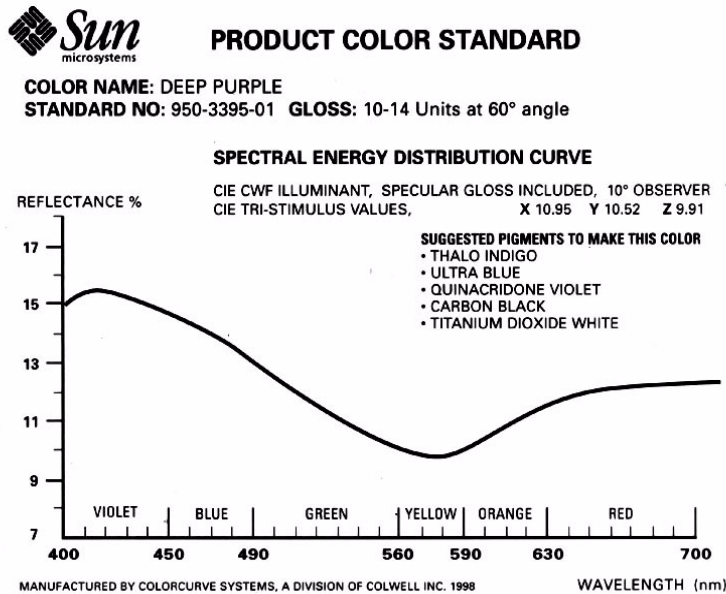
| | |
|--------------------------------------|-------------|
| • Paint Texture Standard -Texture #1 | 950-3458-01 |
| • Paint Texture Standard -Texture #2 | 950-3816-01 |

2.1.6 Retired Sun Standards or Standards in Limited Usage

The following standards are color and materials that have been used on Sun products in the past, but have now been retired or are in limited usage. Standards for these colors and materials are no longer generally available. If one of these colors or materials is called out on a drawing, information about obtaining match standards will be called out on the drawing as well, or you can contact your Sun Supplier Management representative to get information on obtaining a match sample.

- Sun Pearl Ink 950-3398-01
- Logo Purple Ink 950-3607-01
- Translucent Blue Purple (Translucent resin) 950-3611-01
- Purple Halo (Translucent resin) 950-3710-01
- Titanium Frost (Metallic resin) 950-3709-01

2.1.7 Sample - Sun Color Standard



2.2 Distribution of the Color Standards and Specification

To obtain product color standards, product texture standards, ink standards and for additional copies of this Specification 950-3302-xx please contact your Sun Supplier Management representative

Distribution sources for color standards can be designated by the Sun SPM with written consensus from the User Centered Design Group at Sun.

This Specification can also be obtained internally through Utool under Specification number 950-3302-xx.

The supplier is responsible for requesting replacement standards whenever the standards are no longer suitable for color matching.

2.3 Materials Color Match Evaluation Source

Sun's designated contractor for color matching and color evaluation will provide to Sun a product materials color match evaluation service. This service is currently being performed by:

COLOR MARK
Attn: Christina Zappata
Color Communications Inc.
Colormark Division
4000 W. Fillmore St.
Chicago, IL 60624

Tel: 773-638-1400 x104

If for any reason this color lab is unavailable to perform this service, an alternative color matching lab can be designated by the Sun SPM with written consensus from the User Centered Design Group at Sun.

The Sun requestor for an evaluation should provide the following information with the color match sample:

- Requestor's name, telephone, and fax number (business card)
- Supplier's name and material identification
- Supplier's color match number and date
- Sun's product application (i.e., keyboard, keycaps, etc.)
- Purchase Order number and project name (if requested by the internal Sun project team)

In submission of an evaluation, please use the Sun Color Evaluation Template that can be provided to you by the Sun SPM.

A color match qualification report that indicates acceptance or rejection of the material color match for production is sent to the requestor and to Sun. If the material is rejected, the report provides instructions to the supplier on methods for improving the color match.

3. General Information

3.1 Responsibilities

This section defines the color qualification method for plastics, paints, and inks. The Sun Supplier Management contact for a Project shall provide the supplier with this specification. The supplier is responsible for obtaining the required color and texture standards from Sun's designated contractor.

The supplier color match samples are submitted to the designated color lab for qualification analysis and approval.

The use of proper storage methods and periodic checking by the supplier will ensure that the Sun Product Color Standards have not drifted from the spectrophotometer data. The supplier is responsible for requesting replacement standards when their standards are no longer suitable for color matching.

3.2 Applicable Reference Documents

The following documents may be used as additional reference sources to this Specification. This Specification may expand on certain aspects of the test methods. In the event of a conflict between this Specification and these documents, this Specification shall take precedence.

- ASTM D2244 Standard Method for Instrumental Evaluation of Color Differences of Opaque Materials
- ASTM D1729 Standard Practice for Visual Evaluation of Color Differences of Opaque Materials
- ASTM D4086 Standard Practice for Visual Metamerism
- ASTM D523 Standard Test Method for Specular Gloss
- ASTM D4674 Standard Test Method for Indoor Color Stability
- SPI Plastic Surface Finishes, Society of the Plastics Industry

3.3 Formulation of the Sun Colors

Each Sun color has been specifically formulated with a minimum number of pigments, usually two colors plus black and white. The pigment identification and simple formulation will assist the supplier in achieving precise color matches without metamerism. The use of additional pigments to achieve a color is not recommended.

3.4 Pigment Substitution

When a supplier must substitute a pigment because of material incompatibility, the pigment substitution should possess a similar spectral energy distribution (SED) curve. The pigments used to make the Sun colors are selected for their attributes; therefore, a pigment substitution must have these characteristics:

- Meets current U.S. health and environmental requirements. Pigments and additives containing heavy metals such as chromium, cadmium, mercury, and lead are not permitted. Polybrominated biphenyls (PBBs), polybrominated biphenyl oxides and ethers (PBBOs and PBBEs), and polybrominated diphenyl oxides and ethers (PBDOs and PBDEs) are also not permitted.
- Worldwide availability
- Excellent UV (ultraviolet) stability
- Color stability within material processing temperature range (plastics, paints)

4. Color Match Samples for Material Production Qualification Color Matches

To assure the highest quality and consistency of matches, any custom color materials used on Sun hardware (resin, paint, powder coat, ink, etc.) must go through an initial qualification match before going into production.

This Material Production Quality Color Match must be done with any new supplier producing material for use on Sun hardware or with any new material or formulation from a current supplier. Sections 4-8 in this specification give guidelines for the Material Production Quality Color Match.

Once a Material Production Quality Color Match is approved the material can go into production. While in production the supplier is expected to follow Sun's guidelines for Supplier Lot/Batch Monitoring (see Section 9 in this specification)

For information on when to requalify a color match see Section 7.7

4.1 Number of Match Samples Required

Four (4) samples are required for Material Production Qualification Color Match evaluation. Each sample should be packaged separately to eliminate surface scratches that can occur during shipment. The samples should be accompanied by complete identification for documentation purposes:

- Sun color name and identification number
- Name of supplier
- Type of material
- Material grade and number
- Supplier color match number

4.2 Size of the Plastic Match Sample

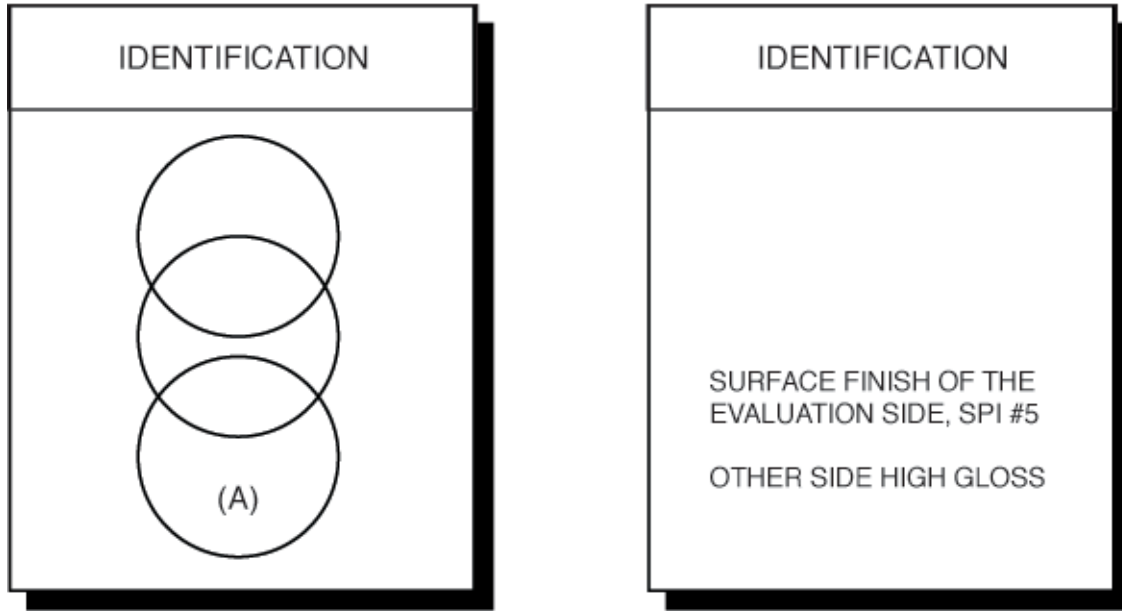
The ability to determine the quality of the color match is largely dependent on the sample size. For this reason, samples that are larger than the Sun minimum size indicated in the chart below are encouraged.

The color match surface and the back surface should be large enough to make multiple 1-inch diameter (25.4 mm) spectrophotometer measurements (See Diagram A below).

Note to resin suppliers: Raised or molded names, trademarks, and design ridges prevent the match sample from being placed parallel to the spectrophotometer port. The practice of molding in variations in the surface plane is discouraged because it can cause measurement abnormalities.

4.3 Surface Finish of the Plastic Sample

A high-quality surface finish is an asset in making color matching judgements. The Sun mold surface is described in the illustration below. The plastic samples should have an SPI #5 finish on one side and a high gloss finish on the other. (Refer also to the gloss and surface requirements in Section 5) This finish is used for color match qualification and does not represent the product texture. The samples should not have steps and different textures because these elements reduce the ability to make color comparisons. Good injection molding practices are required. The match samples must not have scratches, flow marks, bloom, fingerprints, or other blemishes that may detract from the visual and numeric evaluation process.



MINIMUM SIZE OF CHIP = 2 X 3 INCHES (50 X 76 MM), THICKNESS = 0.1 INCH (2.5 MM)

4.4 Paint and Powder Coat Color Match Samples

The paint match samples (applied wet) are smooth-coated on one side using the recommended film thickness, gloss, and supplier application and cure procedures. Powder paint match samples should include the specified texture measurements or requirements.

4.5 Ink Color Match Samples

Manufacturer's ink match samples for Sun Logo White should be created according to the following guidelines:

Nazdar ADE Series Epoxy Ink: ADE78 High Intensity White (or equivalent), 5 parts by weight

Catalyst: ADE 677 Catalyst (or equivalent)

Silica Powder: 0.5% AeroSil 200 powder (or equivalent) by weight

Reducer: RE190 Thinner (or equivalent) addition of 5-15% recommended

Screen: Saatiprint 140/80 monofilament polyester fabric (or equivalent)

Tension: 20 N/cm²

Stencil: Solvent resistant direct emulsion or capillary film stencil

Screen: Two wet on wet impressions, smooth coat on substrate panel

Air Dry: 2 Hours at room 70 degree F (21 degree C)

5. Gloss of the Match Sample

5.1 Same Gloss Objectives

Virtually all computer and office products are manufactured with low-gloss finishes. Suppliers who provide color match samples with the same low gloss as the color standards achieve close high-quality color matches. This practice eliminates the ambiguity that can occur in qualification match judgements when the match sample and the color standard gloss are different.

5.2 Gloss Requirement for Resin Samples

The gloss of the evaluation side of the match sample must meet the gloss requirements listed on the Product Color Standard (color chip) for the color being matched. The other side of the match sample should have a high-gloss surface, and is used for the ASTM D4674 Indoor Color Stability Test, when applicable. If needed, refer to the ASTM D523 Standard Test Method For Specular Gloss.

5.3 Gloss Requirement for Wet Paint Samples

The gloss of the evaluation side of the match sample must meet the gloss requirements listed on the Product Color Standard (color chip) for the color being matched.

5.4 Gloss Requirement for Powder Paint Samples

The gloss of the evaluation side of the match sample must meet the gloss requirements listed on the Product Color Standard (color chip) for the color being matched with the following exception. The colors listed in section 2.1.3 have unique Powder Coat Standards these should be referred to for gloss requirements for this application. If needed, refer to the ASTM D523 Standard Test Method For Specular Gloss.

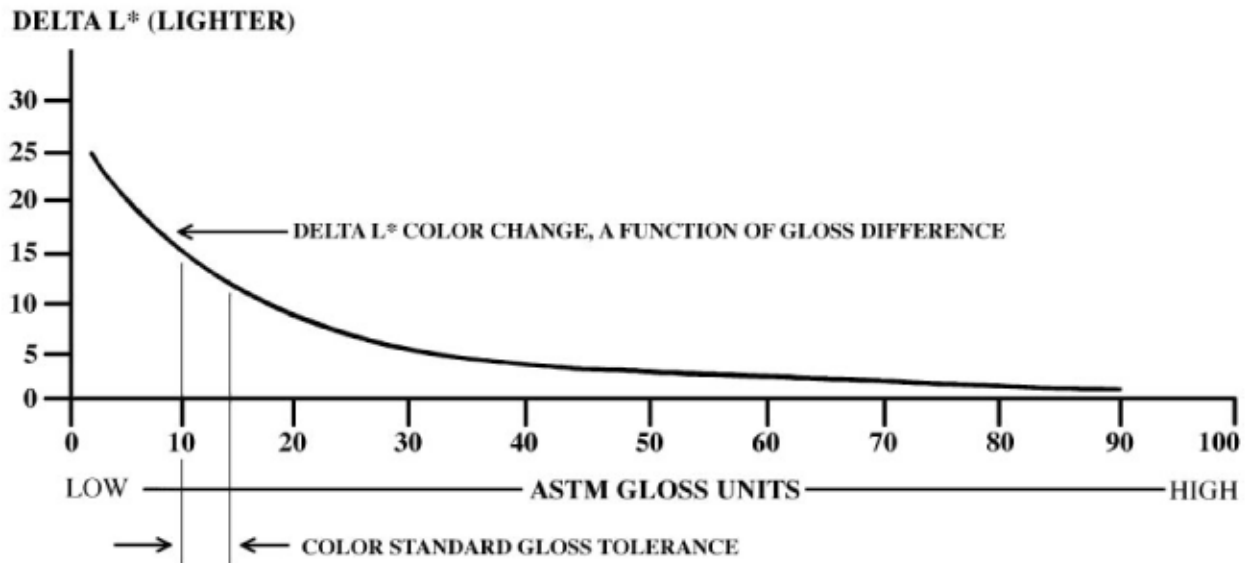
5.5 Dark Color Match Samples

It is especially important to provide dark color match samples in a correct gloss. Dark colors are sensitive to gloss variations that can create a significantly different appearance.

5.6 L* Value Change, a Function of Gloss

Gloss variations between the match sample and the standard in the mid- to high-gloss range have little effect on color difference (value and chroma). Gloss variations in the low-gloss range can significantly change the chroma and lighten or darken a color (see chart below).

THE INFLUENCE OF GLOSS ON THE L* VALUE OF A DARK COLOR



6. Visual Color Evaluation

6.1 Visual Color Match

Visual color match evaluations should be performed by a trained observer who has been qualified by passing the Farnsworth-Munsell 100 Hue Color Discrimination test. The visual closeness of the color match that is required is based on the aesthetic application of the color to the product and system interrelationship. The visual color match evaluation is used in conjunction with the spectrophotometer CIE L*a*b* color difference data. When an anomaly occurs, the visual match supersedes the spectrophotometer match.

6.2 Color Match Light Booth

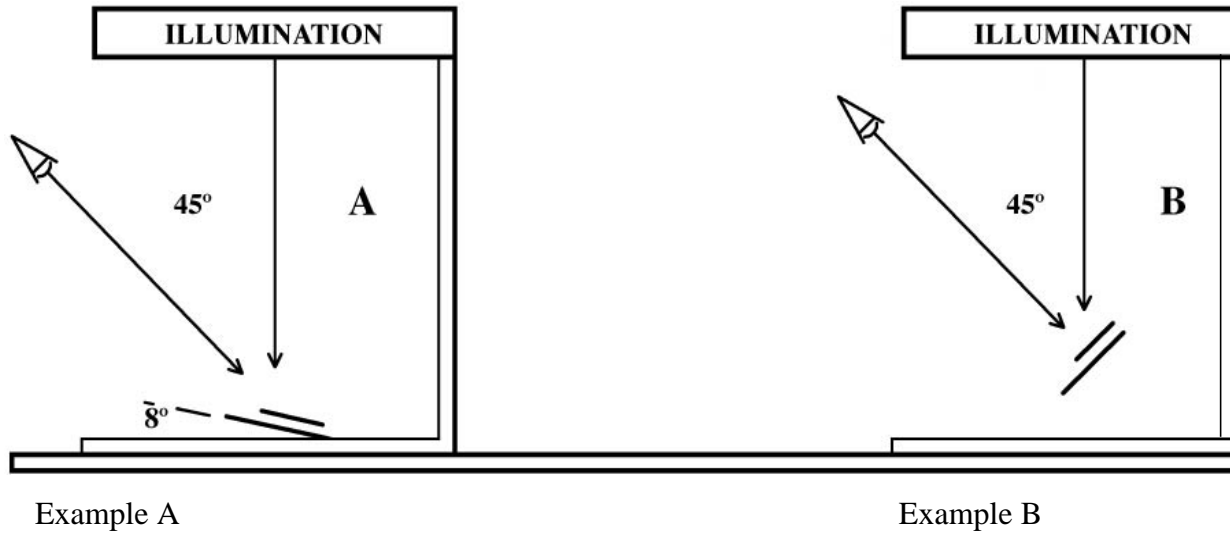
All color match evaluations should be performed in a light booth that is equipped with CIE CWF 4400 K, CIE D 6500 K, and CIE A 2854 K illuminants. The booth should be configured to ASTM D 1729 requirements.

6.3 Purpose of the Illuminants (Metamerism)

Color formulation and qualification color match evaluations should be performed under the CIE CWF (cool white fluorescent) illuminant. Metameric evaluations should be performed by viewing the match sample and the color standard under the CIE A illuminant and CIE D 6500 K illuminant. The aesthetic quality of the color match should remain constant and not appear different. Metamerism is a cause for color qualification rejection.

6.4 Light Booth Viewing Techniques

The match sample and color standard should be evaluated under many viewing angles. This is important when there are specular reflection differences. Comparisons of dark colors should be made using Example B (below). This angle reduces the specular gloss variations that can interfere with L* value (lighter or darker) match comparisons.



7. Spectrophotometer Color Match and Evaluation Procedures

7.1 Spectrophotometer Color Analysis

It is important that the same measurement parameters are used for material color matching and for match sample color evaluation. The color measurement parameters described below pertain only to opaque materials.

7.2 Instrumentation

The spectrophotometer should have capabilities within the acceptance range established by the Manufacturing Council on Color and Appearance (MCCA).

7.3 Color Measurement Parameters

The supplier should use the following color measurement parameters when color matching all Sun opaque colors:

- CIE delta L*a*b*
- CIE CWF Illuminant (4400 k)
- Specular Gloss Included
- 10 Degree Observer

Sun will evaluate the quality of the color match using two additional parameters:

- Metameric Index (MI) between the match sample and the color standard
- Spectral Energy Distribution (SED) Curve of the match sample and the color standard

7.4 Color Measurement Data

The supplier will furnish the CIE delta L*a*b* and delta E* color differences between the match sample and color and the color standard.

7.5 Color Match Qualification Tolerance

Sun does not provide CIE delta L*a*b* color tolerances for production color qualification matches. Tolerances for each color can vary and are dependent on the aesthetic importance of the color application to the product.

7.6 Match Sample Qualification Report

Samples should be sent to Sun's designated contractor who will visually and instrumentally evaluate the match sample. The supplier will be notified of the approval or rejection of the sample. When a color match is rejected, additional data will be furnished to assist the supplier in resubmitting the sample for approval.

7.7 When to Requalify a Color Match

The supplier must requalify materials when changes have been made to the color formulation (except for pigment percentages), fillers, or molding compound and paint chemistry.

8. Product Material Color Stability

8.1 Objective

Sun's objective is to maintain a high-quality aesthetic product appearance commensurate with the product's life expectancy. The use of materials with a known level of color stability is the keystone of product color control. The use of materials with poor or unknown color stability characteristics can negate the efforts in achieving high-quality color matches.

8.2 Why Does a Material Change Color?

Most materials have an actinic activation spectrum, which is a sensitivity to specific ultraviolet (UV) and visible wavelengths. This sensitivity causes a color change and can occur in three areas of the materials formulation:

- The basic resin or compound
- Additives that improve the physical properties or processing characteristics
- Pigments or dyes that are used to achieve the color match

The color stability of most materials can be improved by:

- Adding or increasing the amount of UV stabilizers
- Selecting different engineering additives
- Selecting pigments that are more resistant to UV radiation and visible light color change

8.3 Material Suppliers

Most material suppliers in the U.S. can specify the level of color stability for their products. Suppliers who cannot specify the color stability of their materials must have them tested.

8.4 Color Stability Test Method

The ASTM D4674 Standard Test Method for Indoor Color Stability is used to determine the acceptable level of color change. The UV Actinic Exposure is UVAE-CWF irradiance of 2806 W-h/m² and represents an accelerated test equivalent to 3 years real time.

8.5 Color Stability Requirement

A CIE delta E* of 1.5 color change is generally acceptable. A delta E* color change of 1.5 is more noticeable on light colors and less noticeable on dark colors. High-chroma colors are inherently less color stable, requiring a larger delta E* limit. The Sun User Centered Design Department (Industrial Design) will specify color change limits for unique product applications.

9. Supplier Lot/Batch Monitoring

9.1 Objective

Once a material production qualification color match is approved, it becomes the supplier's color reference standard for plastics or paint. The color matches within each subsequent product lots will vary. This variance is called a color drift. The objective is to assure that the material is manufactured within the Sun color drift tolerances before it is shipped to the plastic molder or paint applicator. This Statistical Process Control (S.P.C). process virtually eliminates finished product part rejection and rework caused by poor production color matches.

9.2 Letter of Certification for Plastic Resins

At the completion of production, the supplier will furnish the designated color lab with a certificate of color difference analysis for all batches within a lot. It is not necessary to provide physical samples. The data should include:

- Sun product color name and identification number
- Plastic identification, resin grade, and color number
- Lot number and pounds (or kilograms)
- CIE delta L*a*b* of each batch, metamerism information and gloss level

9.3 Paint Batch Color Monitoring

The paint supplier will provide the designated color lab with a color match sample and spectrophotometer data of each batch for approval before packaging and shipment to the paint applicator. The paint sample should be smooth, using the correct application procedures and thickness for the specific paint resin. Powder coating samples should be textured with the approved Sun texture and should match the Sun Powder Coat Standard. Ink samples should be smooth. The data should include:

- Sun product color name and identification number
- Paint identification, type, and color number
- Batch number and gallons (or liters)
- CIE delta L*a*b* of the batch

9.4 Batch-to-Batch Color Drift Tolerances

The tolerances following apply to both paints and plastics:

- CIE delta L* ± 0.40
- CIE delta a* ± 0.40
- CIE delta b* ± 0.40
- Metameric Index < 0.30

9.5 Supplier Lot/Batch Tracking and Audit

The designated color lab and Sun will track and chart all color difference data between the supplier color standard values and the production batch values through a summary report. The supplier will be notified by the designated color lab when an out-of-tolerance trend is observed.

It is recommended that the supplier send in their provided Sun Color Standard to the designated color lab every 6 months for evaluations to ensure the standard is still compliant.

9.6 Acceptance of the Production Plastic or Paint

Acceptance of batches within a lot is based on the supplier's compliance with this Specification. Sun or its vendors will return any material that is not in compliance.