JEITA

Standard of Japan Electronic and Information Technology Industries Association

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Digital Color Photo Print Stability Evaluation

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Preface

The Digital Photo Print Stability Standardization G, Digital Camera Standardization G under the Technical Standardization Committee on AV & IT Devices, Japan Electronics and Information Technology Industries Association (**JEITA**) has prepared this Standard in accordance with **JEITA** standard **TSC-16** (Rules for the drafting and presentation of **JEITA** Standards).

Japan Electronics and Information Technology Industries Association Standard

Digital Color Photo Print Stability Evaluation

1 Scope

This **JEITA** Standard describes accelerated test methods for predicting the image degradation in ordinary home environments of digital color photo prints produced with household-use printers. This Standard also describes methods for calculating the print life in each test method. This Standard is applicable to digital color photo prints produced with inkjet printers using dye or pigment inks, dye-sublimation printers, and electro-photographic printers. The Standard does not, however, include porous printed materials.

2 Normative References

The following referenced documents, through reference in this text, constitute provisions of this Standard. For those normative references given with the year of issuance, only the cited version constitutes provisions of this Standard; revisions, amendments, and supplements to the normative reference after the cited version do not apply. For those normative references given without a year of issuance, the most recent versions (including amendments and supplements) apply.

a) ISO Standards

ISO 5-3:1995, Photography – Density measurements – Part 3: Spectral conditions

ISO 5-4:1995, Photography – Density measurements – Part 4: Geometric conditions for reflection density

ISO 1431-3:2000, Rubber, vulcanized or thermoplastic – Resistance to ozone cracking – Part 3: Reference and alternative methods for determining the ozone concentration in laboratory test chambers

ISO 11664-1:2007, Colorimetry – Part1: CIE standard colorimetric observers

ISO 13964:1998, Air quality – Determination of ozone in ambient air – Ultraviolet photometric method

ISO 18909:2006, Photography – Processed photographic color films and paper prints – Methods for measuring image stability

ISO 18909:2006/Cor 1:2006, Photography – Processed photographic color films and paper prints – Methods for measuring image stability, Technical Corrigendum 1

ISO 18920:2000, Imaging materials – Processed photographic reflection prints – Storage practices

ISO 18924:2000, Imaging materials – Test method for Arrhenius-type predictions

b) IEC Standards

IEC 61966-2-1:1999, Multimedia systems and equipment – Color measurement and management – Part 2-1: Color management – Default RGB color space – sRGB

c) ASTM Standards

ASTM G151-06, Standard Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources

d) JIS Standards

JIS Z8113:1998, Lighting vocabulary

3 Definitions of Terms

The definitions of key terms used in this Standard are given below. The terms described in the **Annex** of this Standard also constitute part of this provision.

Household-use printer

A printer primarily intended for use in an ordinary home environment.

Digital color photo print

Printed materials, such as L-ban-size photographs, of digitalized color images produced with a printer.

Predicted print life

The predicted number of years for a digital color photo print to reach its endpoint when stored in compliance with the print-life conversion criteria.

Methods of calculating the predicted print life are stipulated in this Standard, in **Section 6**.

Endpoint

The point in time when the color loss caused by storage or accelerated testing of the print image's reflection density reaches a predetermined level.

ISO standards refer to this state as the "endpoint". In indoor thermal stability testing, special endpoints such as "1/2 endpoints" or "1/3 endpoints" are sometimes used. These expressions indicate endpoints that have been specially chosen to reduce testing durations for indoor thermal stability tests conducted at comparatively low temperatures and for tests on specimens that degrade very slowly. See **Section 9.4 in this Standard for more details about 1/2 endpoints and 1/3 endpoints. Note that 1/2 endpoints and 1/3 endpoints** terms are used only with indoor thermal stability test methods and are not used in indoor light stability test methods or indoor ozone stability test methods.

Print-life conversion criteria

These are the criteria for the environment in which the digital color photo print is stored that are stipulated for print-life predictions. The print life is computed by comparing the print-life conversion criteria with the environmental conditions used in accelerated tests. This Standard stipulates print-life conversion criteria for each accelerated test.

Reciprocity failure

Reciprocity failure is a phenomenon in which the degree of color loss in two separate accelerated tests (a long, low-intensity test versus a short, high-intensity test) is different even though the product of the testing duration and the intensity of the controlled environmental factor in the two tests is equivalent. For instance, reciprocity failure occurs when the color loss of specimens is different in two indoor light stability tests — the first where specimens are exposed to high light intensity for a short period and the second where specimens are exposed to low light intensity for a long period — even though the intensity-time products are the same.

Reflection density

The values obtained from density measurements using the spectral conditions for **Status A** densitometry described in **ISO 5-3** and the geometric conditions described in **ISO 5-4**.

Accelerated tests

Tests designed to promote color loss in print images in a short timeframe by elevating a controlled environmental factor above the levels found in the ordinary home environments where digital color photo prints are stored. This standard includes tests where the illuminance, ozone concentration, and the temperature are elevated independently as controlled environmental factors.

Illuminance and irradiance

Illuminance indicates the luminous flux per unit area, expressed in lux (symbol: lx), on a specimen exposed to light. Because the light stability test equipment governs illuminance by the irradiance (W/m^2) at a given wavelength, attention must be paid to the relationship between the irradiance and the illuminance at the specimen. Refer to **JIS Z 8113** for more details.

Composite neutral patch and composite secondary-color patch

Neutral-color patches printed using multiple colors and secondary-color patches printed using multiple colors.

Color imbalance

The state when the combination of any two colors is found to be out of balance when measuring the RGB densities of neutral patches or white patches.

White patch

A Dmin patch where the R, G, B input value is (255, 255, 255).

Ongoing test

The state in indoor thermal stability testing when four or more temperature conditions have not reached the endpoints prescribed by **Table 1**, **6**, or **7** in **JEITA CP-3901**, or when four or more temperature conditions have been met, but the testing temperature range is less than 20 °C (for test condition (I)) or 15 °C (for test condition (II)).

Intermediate value

Data obtained from an ongoing test in indoor thermal stability testing. This test indicates time data for each temperature in an ongoing test until an endpoint is reached.

4 Sample Preparation

4.1 Print-Life Prediction Charts

4.1.1 Overview

This describes the print-life prediction charts used in image stability testing of digital color photo prints.

4.1.2 Definitions of Terms

The terminology relating to print-life prediction charts is defined below.

(1) Print-life prediction chart data

The digital data that constitutes the digital input image signals from which the print-life prediction charts are obtained.

(2) Print-life prediction chart

The printed chart obtained by printing the print-life prediction charts data.

4.1.3 Print-life prediction chart data

This data is specified in **Annex 2**.

4.1.4 Preparation of Specimens

4.1.4.1 Printing Method

Image charts shall be printed by one of the following two methods.

(1) Print-life prediction charts data is copied to a memory card and the image chart is printed directly from the memory card slot of the printer under test.

(2) Image charts are printed from a computer via a printer driver.

4.1.4.2 Print Size

Postcard size or L-ban size charts are preferred. If these sizes are unavailable, charts shall be printed on the closest available size.

4.1.4.3 Print Settings

The driver mode corresponding to the print paper in use and the default image compensation setting shall be used.

4.1.4.4 Print Paper

The print paper under evaluation shall be used as the print paper.

4.1.4.5 Number of Prints

Two prints shall be made as needed.

4.1.4.6 Drying After Printing

Prints shall be dried following the recommended drying conditions for the print paper/ink used, but, where necessary, specimens shall be left to dry for two weeks after printing.

4.1.5 Selection of Patches Used for Print-Life Predictions

4.1.5.1 Density Measurements

The reflection density of each patch on the print-life prediction chart shall be measured.

4.1.5.2 Patch Selection

Select color (i.e. composite-neutral or single-color) and white patches from the print-life prediction charts, as indicated below.

White patch

- 0.5 density patch (density range: 0.5 ± 10 %)
- 1.0 density patch (density range: 1.0 ± 10 %)
- 1.5 density patch (density range: 1.5 ± 10 %)
- Dmax density patch (when the maximum density is lower than 1.5, then the patch with the highest density is the Dmax density patch)

When the maximum print density is less than 1.5 or 1.0, the maximum print density is taken as Dmax and the corresponding patch is used in the print-life prediction as the Dmax density patch; it is not necessary to select patches with higher densities than this in this case. Note that if a patch exists that matches the density ranges above, then that patch must be used in the print-life prediction.

Below are some examples of patch selection.

1) Maximum print density is 0.7: selection becomes — White patch, 0.5 density patch, Dmax density patch
2) Maximum print density is 1.2: selection becomes — White patch, 0.5 density patch, 1.0 density patch, Dmax density patch
3) Maximum print density is 2.4: selection becomes — White patch, 0.5 density patch, 1.0 density patch, 1.5 density patch

4.1.5.3 Interpolation Method for Patches Not at Exact Intermediate Densities

Below are some examples of the procedure for measuring changes when reflection density equals 1.0. When calculating other reflection densities (0.5 or 1.5), use the same procedure, utilizing the same print-life prediction charts.

1) Output the print-life prediction charts data, and measure the reflection density of each patch. → [Specimen A]

2) As shown in **Figure 1**, plot a chart of "RGB level (arbitrary number of levels)" versus "reflection density" and, using the chart, find the RGB level that corresponds to density 1.0, with a straight-line approximation between the two adjacent steps on the chart.

3) Perform the test with Specimen A.

4) After test (exposure) interval T, remove Specimen A and measure its reflection density.

5) After testing, plot a "RGB level" versus "reflection density" chart again and, using the RGB level calculated in **2)** above, calculate the reflection density from the graph.

6) Repeat until the endpoint is reached.

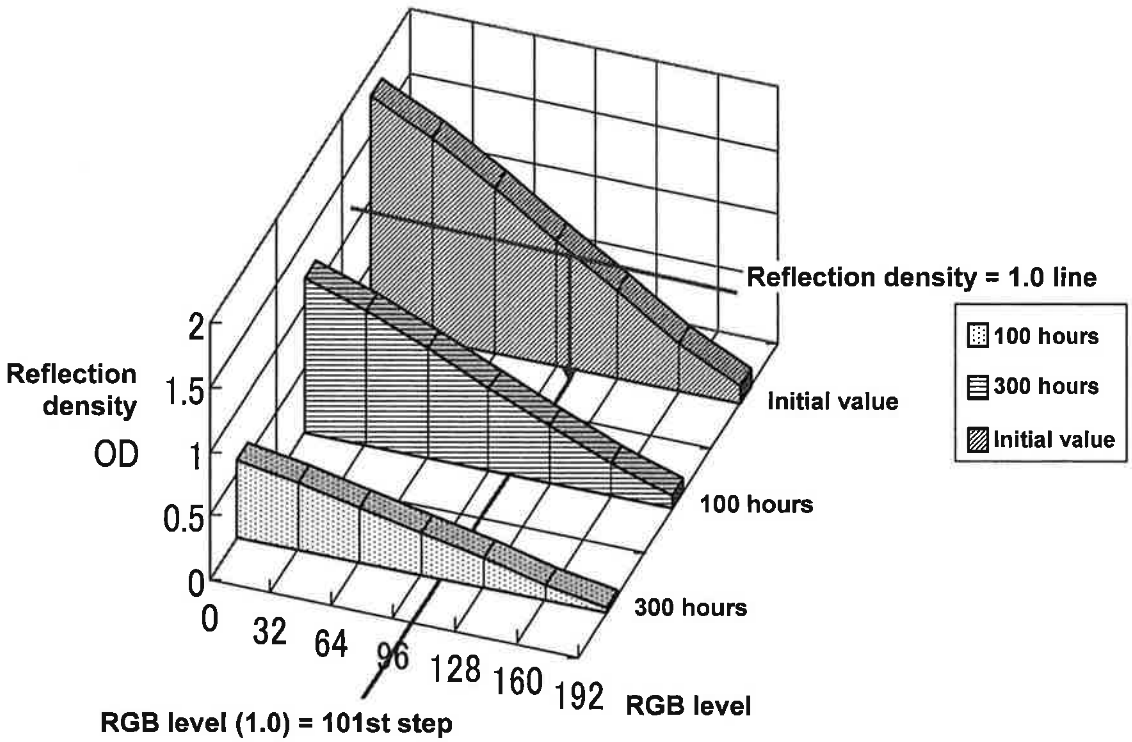

Figure 1 – Interpolation Method for Patches Not at Exact Intermediate Densities

4.1.5.4 Printing Specimens After Patch Selection

If the patch on the print-life prediction charts that is necessary for print-life prediction has been identified in accordance with the above, then in subsequent tests, it is possible to use just the print-life prediction charts for the patches necessary for print-life prediction. However, results using such specimens must be identical to the results obtained from specimens produced with all patches.

4.1.6 Density Measurements

See **Section 5** for the **density measurement** method.

4.2 Image Charts

4.2.1 Overview

This describes the image charts used in image stability testing of printed digital color photo prints.

4.2.2 Definitions of Terms

The terminology relating to image charts is defined below.

(1) Image chart data

The digital data that constitutes the digital input image signals from which the image charts are obtained.

(2) Image chart

The printed chart obtained by printing the image chart data.

4.2.3 Image Chart Data

This data is specified in **Annex 2**.

4.2.4 Preparation of Specimens

4.2.4.1 Printing Method

Image charts shall be printed by one of the following two methods.

(1) Image chart data is copied to a memory card and the image chart is printed directly from the memory card slot of the printer under test.

(2) Image charts are printed from a computer via a printer driver.

4.2.4.2 Print Size

Postcard size or L-ban size charts are preferred. If these sizes are unavailable, charts shall be printed on the closest available size.

4.2.4.3 Print Settings

The driver mode corresponding to the print paper in use and the default image compensation setting shall be used.

4.2.4.4 Print Paper

The print paper under evaluation shall be used as the print paper.

5 Density Measurements

5.1 Overview

Image density shall be measured using the spectral conditions specified for **ISO Status A** densitometry as described in **ISO 5-3**. Reflection density shall be measured as described in **ISO 5-4**.

5.2 Definition of the Density Symbol

The letter d shall represent actual measured densities. (In other words, no correction for minimum density is made.)

5.3 Density Values to be Measured

The following densities of the specimens shall be measured before and after accelerated testing.

a) **dmin(R)t, dmin(G)t, dmin(B)t**

These represent the red, green, and blue minimum densities (in the white patch) of the specimen at accelerated test interval t, where t is a value taken from 0 to the end of the test.

b) **dN(R)t, dN(G)t, dN(B)t**

These represent the red, green, and blue densities at accelerated test interval t, where t is a value taken from 0 to the end of the test, of neutral image patches that initially had densities of 0.5 ± 20 %, 1.0 ± 20 %, and 1.5 ± 20 %.

c) **dC(R)t, dM(G)t, dY(B)t**
These represent the red, green, and blue densities at accelerated test interval t, where t is a value taken from 0 to the end of the test, of cyan, magenta, and yellow image patches that initially had densities of 0.5 ± 20 %, 1.0 ± 20 %, and 1.5 ± 20 %.
(The red density value is taken with respect to the cyan patch, the green density value with the magenta patch, and the blue density value with the yellow patch.)

d) **dR(G)t, dR(B)t, dG(R)t, dG(B)t, dB(R)t, dB(G)t**
These represent the red, green, and blue densities at accelerated test interval t, where t is a value taken from 0 to the end of the test, of RGB-composite secondary-color image patches that initially had densities of 0.5 ± 20 %, 1.0 ± 20 %, and 1.5 ± 20 %. Note that predicted print lives are not calculated using RGB-composite secondary-color image patches.

5.4 Calculations

5.4.1 Changes in Dmin Patches

a) Red density change : $\Delta dmin(R)t = dmin(R)t - dmin(R)_0$
b) Green density change: $\Delta dmin(G)t = dmin(G)t - dmin(G)_0$
c) Blue density change : $\Delta dmin(B)t = dmin(B)t - dmin(B)_0$

5.4.2 Density Changes as a Percent in Single-Color Patches

a) Cyan : $\%\Delta dC(R)t = [|dC(R)t - dC(R)_0| \div dC(R)_0] \times 100$
b) Magenta: $\%\Delta dM(G)t = [|dM(G)t - dM(G)_0| \div dM(G)_0] \times 100$
c) Yellow : $\%\Delta dY(B)t = [|dY(B)t - dY(B)_0| \div dY(B)_0] \times 100$

5.4.3 Color-Density Changes as a Percent in Composite Secondary-Color Patches

a) Magenta in red patches : $\%\Delta dR(G)t = [|dR(G)t - dR(G)_0| \div dR(G)_0] \times 100$
b) Yellow in red patches : $\%\Delta dR(B)t = [|dR(B)t - dR(B)_0| \div dR(B)_0] \times 100$
c) Cyan in green patches : $\%\Delta dG(R)t = [|dG(R)t - dG(R)_0| \div dG(R)_0] \times 100$
d) Yellow in green patches : $\%\Delta dG(B)t = [|dG(B)t - dG(B)_0| \div dG(B)_0] \times 100$
e) Cyan in blue patches : $\%\Delta dB(R)t = [|dB(R)t - dB(R)_0| \div dB(R)_0] \times 100$
f) Magenta in blue patches: $\%\Delta dB(G)t = [|dB(G)t - dB(G)_0| \div dB(G)_0] \times 100$

5.4.4 Color-Density Changes as a Percent in Composite Neutral Patches

a) Cyan in neutral patches : $\%\Delta dN(R)t = [|dN(R)t - dN(R)_0| \div dN(R)_0] \times 100$
b) Magenta in neutral patches: $\%\Delta dN(G)t = [|dN(G)t - dN(G)_0| \div dN(G)_0] \times 100$
c) Yellow in neutral patches : $\%\Delta dN(B)t = [|dN(B)t - dN(B)_0| \div dN(B)_0] \times 100$

5.4.5 Color Balance Changes in Composite Neutral Patches

This change is found as a density change percentage between two single colors. The respective single-color density change percentages in a neutral patch are defined in **Section 5.4.4**.

a) Cyan-magenta change : $\%\Delta dN(R\text{–}G)t = |\%\Delta dN(R)t - \%\Delta dN(G)t|$
b) Magenta-yellow change: $\%\Delta dN(G\text{–}B)t = |\%\Delta dN(G)t - \%\Delta dN(B)t|$
c) Cyan-yellow change : $\%\Delta dN(B\text{–}R)t = |\%\Delta dN(B)t - \%\Delta dN(R)t|$

5.4.6 Color Balance Changes in Composite Secondary-Color Patches

This change is found as a density change percentage between two single colors in a secondary-color patch. The respective single-color density change percentages in a secondary-color patch are defined in **Section 5.4.3**.

a) Cyan-magenta change in blue patches: %ΔdB(R – G)t = |%ΔdB(R)t – %ΔdB(G)t|

b) Magenta-yellow change in red patches: %ΔdR(G–B)t = |%ΔdR(G)t – %ΔdR(B)t|

c) Yellow-cyan change in green patches : %ΔdG(B–R)t = |%ΔdG(B)t – %ΔdG(R)t|

5.4.7 Color Balance in Dmin Patches

a) Cyan-magenta change : Δdmin(R–G)t =|Δdmin(R)t – Δdmin(G)t|

b) Magenta-yellow change: Δdmin(G–B)t =|Δdmin(G)t – Δdmin(B)t|

c) Yellow-cyan change : Δdmin(B–R)t =|Δdmin(B)t – Δdmin(R)t|

5.4.8 Sample Calculation: Color Balance Change in a Composite Neutral Patch

Example Cyan-magenta change

Given that the initial cyan reflection density of 1.2 ($dN(R)_0$ = 1.2) changes to a post-processing density of 0.8 (dN(R)t = 0.8) and the initial magenta reflection density of 0.8 ($dN(G)_0$ = 0.8) changes to a post-processing density of 0.6 (dN(G)t = 0.6), it follows from the equations in **Section 5.4.5** and **Section 5.4.4** that:

$$\%\Delta dN(R\text{–}G)t = [\%\Delta dN(R)t - \%\Delta dN(G)t]$$
$$= [|dN(R)t - dN(R)_0| \div dN(R)_0] \times 100 - [|dN(G)t - dN(G)_0| \div dN(G)_0] \times 100$$

Substituting in the values from this example gives:

$$\%\Delta dN(R\text{–}G)t = [|0.8 - 1.2| \div 1.2] \times 100 - [|0.6 - 0.8| \div 0.8] \times 100$$
$$= 33.3\ \% - 25\ \%$$
$$= 8.3\ \%$$

Consequently, the color balance change between cyan and magenta in the composite neutral patch is 8.3 %.

5.5 Color Measurement

This Standard proposes a method using 1/2 endpoints or 1/3 endpoints as a means of reducing test intervals in indoor thermal stability tests when the time to reach the stipulated endpoint is prohibitively long. In these test methods, the yellow discoloration of white patches is measured as a color change (color differential) not as a density change. Color differentials of colors before and after accelerated tests are calculated with the ΔE equation given in the next section using the **CIE** 1976 L*a*b* color system recommended by the International Commission on Illumination (**CIE**) in 1976. Various colorimeter types are used in the measurements. The colorimetric conditions are: an illumination color temperature of either D65 or D50, a view angle of 2 degrees, and either white or black backing material.

5.5.1 Color Differential Measurements

① Measure the L*a*b* (L1*, a1*, b1*) color values of the specimen prior to the accelerated test.

② Measure the L*a*b* (L2*, a2*, b2*) color values of the specimen after the accelerated test, and find ΔE, the change in color differential from prior to the test, with the equation below:

$$\Delta E = \sqrt{\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2}}$$

Where,

ΔL^* = L2* – L1*

Δa^* = a2* – a1*

Δb^* = b2* – b1*

6 Print-Life Prediction Methods

6.1 Test Conditions When Calculating Print Life

Calculations of predicted print lives must be done using the standard conditions defined within each test method. However, assuming the print life calculated with the standard conditions is recorded, it is permissible to also record the print life calculated with conditions other than the standard conditions.

6.2 Endpoints (perception thresholds (permissible limits) of color changes and color-balance changes)

The color change percentages and the color-balance change percentages of the colors selected as the patches (see **Section 4.1.5.2**) and the reflection densities of the minimum reflection density area (white patch) must be no greater than the values given in **Table 1**. The endpoints in this table indicate levels where differences can be clearly recognized, but do not indicate levels of personal tolerance to changes (for example, feeling that you can no longer stand using the image).

Table 1 – Color Image Endpoints

Permissible limit of reflection density change	Image change parameter
30 %	Decline in red density in a neutral patch
30 %	Decline in green density in a neutral patch
30 %	Decline in blue density in a neutral patch
30 %	Decline in red density in a single-color cyan patch
30 %	Decline in green density in a single-color magenta patch
30 %	Decline in blue density in a single-color yellow patch
15 %	Color imbalance in the differential between red density and green density in a neutral patch
15 %	Color imbalance in the differential between red density and blue density in a neutral patch
15 %	Color imbalance in the differential between green density and blue density in a neutral patch
Permissible limit of the reflection density in white patches	
0.06	Increase in red density or green density
0.1	Increase in blue density
0.05	Imbalance between red density and green density
0.1	Imbalance between red density and blue density
0.1	Imbalance between green density and blue density

* Red density corresponds to the cyan component.
** Green density corresponds to the magenta component.
*** Blue density corresponds to the yellow component.

7 Test Method — Indoor Light Stability

7.1 Overview

This section describes a method of testing the indoor light stability of digital color photo prints produced with a household-use printer as well as a method of calculating the print life of the photo prints. This test method assumes a digital color photo print that is exhibited in a typical home and that mainly comes into contact with sunlight through windows and into indirect contact with sunlight reflected from walls, floors, and other objects.

7.2 Test Equipment and Test Conditions

The test shall be conducted with the specimen exposed to a xenon light. Other conditions are as given below.

7.2.1 Light Source

A xenon arc lamp shall be used as the light source for light stability tests. The xenon arc lamp shall have a continuous spectrum over the wavelengths between 300 nm and 1200 nm, at the very least, and, through the combination of optical filters described in **Section 7.2.3**, shall have the emission distribution assumed for indoor light.

7.2.2 Illuminance

The illuminance at the surface of the specimen shall be between 30 klx and 100 klx. In evaluations of indoor light stability, it is permissible to govern the light intensity by the irradiance (in W/m^2) and by the illuminance at the surface of the specimen (in klx) at the narrow end (420 nm) or the wide end (300-400 nm) of the ultraviolet band. In either case, record the illuminance (klx). Whether controlled automatically or adjusted manually, the irradiance shall be regulated so that the irradiance varies by no more than 10% from its set value. To discern reciprocity failure characteristics, it is preferable the test is conducted also at a illuminance of one-tenth of that given above. Since the print life cannot be predicted when the reciprocity failure is large, tests are conducted at illuminances as close as possible to the illuminances digital color photo prints are actually exposed to. Because of the prohibitive time required to reach the final endpoint at low illuminances, it is permissible in the interest of convenience to estimate the reciprocity failure characteristics with respect to high-illuminance exposure at color changes in the vicinity of 5 to 10 %.

7.2.3 Optical Filter

In order to simulate the spectrum distribution of indoor light that passes through window glass, a standard window glass filter and, preferably, an ultraviolet light filter are placed between the xenon light source and the specimen. An air gap of no less than 5 mm shall be made between the filter and the specimen and an adequate airflow shall pass across the specimen. When a water-cooled xenon arc lamp is equipped with a water jacket that uses soda lime filter glass, this glass shall be counted as a standard window glass filter.

A filter composed of soda lime float glass with a thickness of 2 to 7 mm and the relative spectral transmittance described in **ISO 18909** shall be used as the standard window glass. To approach the spectral distribution of indoor light, it is preferable to use a sharp cut-off filter with 50 % transmittance (λ (T = 50 %)) at 375 ± 10 nm, with substantial blocking in the ultraviolet band — 1 % or less transmittance at wavelengths at or below 340 nm, and with 85 % transmittance or greater at wavelengths at or above 410 nm as the ultraviolet light filter [1].

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[1] For example, the Fujifilm SC-37 filter or the Hoya Candeo Optronics L-37 filter can be used as the sharp cut-off filter.

7.2.4 Temperature and Humidity

The black panel temperature shall be set to 40 °C or lower, preferably with a maximum of 35 °C or lower, with temperature controlled at ± 2 °C. Measurement of the black panel temperature is conducted following **ASTM G151**. The air temperature inside the chamber shall be set in the range of 20 ± 5 °C, controlled to ± 2 °C, and the relative humidity shall be 50 ± 5 %RH. It is preferable that the surface temperature of the specimen be as close as possible to room temperature (23 °C). For this reason, it is better to control the temperature with stability testing equipment that is outfitted with a cooling unit. Furthermore, since light stability is humidity dependent, where the envisioned application environment includes high humidities, it is preferable to test at a higher relative humidity — for example, 60 ± 5 %RH — in addition to testing at the standard conditions.

7.2.5 Other Precautions

In all positions the equipment holds the specimen in (the specimen holder), a dummy specimen with the same reflectance as the specimen should be attached to prevent non-uniform light incidence. When testing a specimen where there is concern of ozone-related color changes, the ozone concentration within the test station should be kept below 4 ppb to ensure color changes due to ozone do not occur during the test. After exposure, specimens are placed in a vinyl bag and stored in a cool dark location until density measurements are made.

7.3 Density Measurements

The reflection density shall be measured following the provisions in **Section 5** before exposure (after the specimens have been printed and dried in accordance with the provisions in **Section 4**) and after each exposure.

7.4 Calculation of the Predicted Print Life

7.4.1 Endpoint Provisions

The stipulated endpoints shall be those given in **Section 6.2**.

7.4.2 Standard Illuminance for Print-Life Conversions

The illuminance used in calculations of the predicted print life shall be 250 lx * 12 hours/day.

7.4.3 Formula for Calculating the Predicted Print Life

The predicted print life for indoor light stability is calculated in years using the formula below. The integral illuminance used in the calculation is the integral illuminance of the first patch of each color patch tested to reach the endpoint.

Indoor light stability (years) = integral illuminance (klx*hr) ÷ [0.250 (klx) * 12 (hrs/day) * 365 (days/year)]

It is preferable to use measurements from an integrating illuminometer for the integral illuminance (klx*hr), but it is acceptable to use actual measured illuminance, or the illuminance setting when irradiance is regulated, multiplied by time.

Actual measured illuminance refers to the measured illuminance when the irradiance is regulated at λ = 420 nm or λ = 300-400 nm, or illuminance at the surface of the specimen (klx).

7.5 Test Reports

Results shall be reported following the procedure defined in **Section 10**. In particular, the names of all filters used, the fixed black panel temperature, and the (average) temperature and humidity within the chamber during the test shall be recorded.

7.6 Precautions During Operation

Measures are necessary to prevent light from the xenon light source from reaching the unprotected eyes of operators because the source's light includes ultraviolet light and is extremely strong. (**Example**: a mechanism that automatically turns off the xenon lamp when the test chamber door is opened.)

8 Test Method — Indoor Ozone Stability

8.1 Overview

This section describes a method of testing the indoor ozone stability of digital color photo prints produced with a household-use printer as well as a method of calculating the print life of the photo prints. Here is described a test method that assumes the influence ozone gas has on image degradation over time when a digital color photo print that is not under a glass frame or other covering is exhibited in a typical home.

8.2 Test Equipment and Test Conditions

The test shall be conducted by placing and evaluating the printed material in a test chamber where the ozone concentration is set at a fixed level.

8.2.1 Test Chamber

The test chamber shall be a completely sealed apparatus, shall be constructed from a material that is not easily corroded by the gas used in the test, and shall be able to control the temperature to within ± 2 °C and the relative humidity to within ± 5 %RH. Also, the test chamber is outfitted with a window and a light to permit observations of the specimen.

8.2.2 Gas Supply

The air used for ozone generation is first passed through an activated carbon filter for purification. It is permissible to use either an ultraviolet lamp or silent electric discharge to generate the ozone, provided conditions on the amount and purity of the ozone and on the airflow are met. The NOx concentration must not exceed 1% of the fixed ozone gas concentration.

8.2.3 Gas Concentration Adjustment

There shall be a means of measuring and automatically adjusting the gas concentration within the test chamber. The adjustment method shall have the adjustment capability given in **Section 8.2.8**. The gas concentration within the test chamber is controlled so that it is at the set concentration for at least 80% of the total test duration in tests where the test chamber is opened and closed during the test to insert, remove, or inspect specimens. The test chamber shall have a means to detoxify and release the gas inside the chamber when operation is paused or completed. Specifically, such means include ozone-destruction filters or activated carbon filters.

8.2.4 Gas Concentration Measurement

The ozone concentration within the test chamber should be measured by either electrochemistry or ultraviolet absorption spectrometry (**ISO 13964**) and the chamber's ozone concentration should be adjusted and recorded. Calibration of these devices shall be conducted following **ISO 1431-3**.

8.2.5 Gas Rate-of-Flow Control

The ozone gas flow supplied to the test chamber shall be controlled so that the set test concentration is satisfied even if there are differences in the degree of ozone breakdown because of the number or area of specimens. Furthermore, the gas flow rate shall be controlled so that the gas concentration within the test chamber has no non-uniformities. It is preferable, for example, to have an airflow of 0.3 to 0.6 m/s inside the test chamber. It is also preferable that the ozone gas within the test chamber can be exchanged three times or more every sixty minutes.

8.2.6 Specimen Placement

Specimens shall be placed so that the specimen face is parallel to the gas flow. The jig to fix the specimens shall be constructed of a material that is not easily corroded by the gas. To prevent ozone permeation from the reverse side of the specimen, it is preferable to conduct the test while protecting the specimen with stainless steel, aluminum, or similar material.

8.2.7 Temperature and Humidity

The temperature shall be 23 °C ± 2 °C and the relative humidity shall be 50 ± 5 %RH. Furthermore, since ozone stability is humidity dependent, where the envisioned application environment includes high humidities, it is preferable to test at a higher relative humidity — for example, 60 ± 5 %RH — in addition to testing at the standard conditions.

8.2.8 Gas Concentration

The ozone concentration within the test chamber shall be 1 to 5 ppm ± 10 %.

8.3 Test Procedure

Operation of the test equipment begins after the specimens are placed in the test chamber and the test conditions are set. It is preferable that the set ozone concentration is achieved within 30 minutes so that the concentration in the chamber is at the set level for at least 80 % of the total test duration. The test shall be controlled so that the temperature, humidity, or gas concentration do not exceed their control ranges during operation. The start point of the test shall be when half the set concentration is reached; the final point shall be determined by the product of the concentration and time (ppm*hr). It is preferable that the printed material is exposed while free hanging and while protected with stainless steel, aluminum, or similar material to prevent ozone permeation from the reverse side. After exposure, specimens are placed in a vinyl bag and stored in a cool dark location until density measurements are made.

8.4 Density Measurements

The reflection density shall be measured following the provisions in **Section 5** before exposure (after the specimens have been printed and dried in accordance with the provisions in **Section 4**) and after each exposure.

8.5 Calculation of the Predicted Print Life

8.5.1 Endpoint Provisions

The stipulated endpoints shall be those given in **Section 6.2**.

8.5.2 Standard Concentration for Print-Life Conversions

The integral concentration per year used in calculations of the predicted print life shall be 40 ppm*hr.

8.5.3 Formula for Calculating the Predicted Print Life

The predicted print life for indoor ozone stability is calculated in years using the formula below. The integral ozone concentration used in the calculation is the integral ozone concentration of the first patch of each color patch tested to reach the endpoint.

Indoor ozone stability (years) = integral concentration (ppm*hr) ÷ 40 (ppm*hr/year)

The integral ozone concentration (ppm*hr) is the product of the set ozone concentration (ppm) and time (hr).

8.6 Precautions During Operation

Test operators must take precautions when handling ozone gases since they are toxic. The Permissible Concentration Committee of the Japan Society for Occupation Health in 1985 set the maximum permissible workplace ozone concentration at 0.1 ppm (0.20 mg/m^3). The Committee also ruled it desirable that the average ozone concentration exposure over any 15-minute period does not exceed 1.5 times the permissible value. Necessary precautions during operation include the provision of a means to fill the test chamber with air and other equipment measures (such as rear air-blowers) to prevent human exposure to ozone gas.

9 Test Method — Indoor Thermal Stability

9.1 Overview

This section describes a method of testing the indoor thermal stability of digital color photo prints produced with a household-use printer as well as a method of calculating the print life of the photo prints. This method assumes the photo prints are stored in a dark location at 23 °C in a typical home and describes a method of predicting the print life for dark storage using a thermal stability test and the Arrhenius equation for the temperature dependence of a chemical reaction rate.

9.2 Specimen Characteristics and Test Conditions

Some specimens with low glass transition temperature (Tg) when used in high-temperature accelerated tests exhibit different properties that in actual exposure conditions at room temperatures; thus, accurate print lives cannot be calculated. Furthermore, the deterioration rate of some specimens is very slow, requiring considerable time to reach the stipulated endpoint and making print life predictions impractical. Consequently, this Standard, in consideration of the above, permits a choice of test conditions and print-life calculation methods, as listed below.

Test Condition (I) ISO compliant (**ISO 18909** compliant, test temperature range: 20 °C or more, endpoint is as specified)

Test Condition (II) JEITA compliant (test temperature range: 15 °C or more, endpoint: (1) as specified, (2) 1/2 the specification, (3) 1/3 the specification)

Print-life prediction using intermediate value of Test Conditions (I) and (II) (test temperature range: 10 °C or more, endpoint is as specified)

Examples of selecting the test method

1) Where Tg is low and it is difficult to obtain a test temperature range of 20 °C or greater (such as thermal wax transfer printers)
   → **Test condition (II) JEITA compliant**, endpoint (1) as specified
2) Where Tg is high and a test temperature range of 20 °C or greater can be sufficiently assured (such as inkjet printers)
   → **Test condition (I) ISO compliant**
3) Where results are wanted in a relatively short period regardless of Tg (all printers)
   → **Test condition (II) JEITA compliant**, endpoint (2) 1/2 the specification or endpoint (3) 1/3 the specification

9.3 Test Condition (I) ISO compliant (ISO 18909 compliant, test temperature range: 20 °C or more, endpoint is as specified)

The long-term thermal stability is evaluated by a series of tests on specimens carried out at several elevated temperatures at a particular relative humidity.

9.3.1 Test Chamber

It is preferred that the test chamber can be adjusted to maintain a relative humidity of 50 ± 5 %RH at each test temperature and that the test chamber has a mechanism, such as fan, to force circulation of the atmosphere within the chamber. When testing a specimen where there is concern of ozone-related color changes, the ozone concentration within the test station should be kept below 4 ppb to ensure color changes due to ozone do not occur during the test. The test chamber shall be able to regulate the temperature to within ± 2 °C.

9.3.2 Test Humidity

The relative humidity shall be 50 ± 5 %RH. Furthermore, since thermal stability is humidity dependent, where the envisioned application environment includes high humidities, it is preferable to test at a higher relative humidity — for example, 60 ± 5 %RH — in addition to testing at the standard conditions.

9.3.3 Test Temperatures

Specimens shall be tested at a minimum of four different temperatures at the stipulated humidity level. The difference between the highest temperature and the lowest temperature shall be at least 20 °C and the test temperature tolerance shall be ± 0.5 °C.

9.3.4 Test Methods

There are two thermal stability test methods: free hanging and sealed bag.

1) **Free-hanging method**

   Free-hanging method Tests are run at the four test temperatures. The optical densities of the specimens are measured before the thermal test and at predetermined intervals thereafter when the specimens are withdrawn from the temperature/humidity-controlled test chambers. The same specimens can be used throughout the test period.

2) **Sealed-bag method**

   <<Test equipment and operation for specimens sealed in sealed-bags>>

   The two test samples (the material sealed in the sealed bag) for each test temperature condition shall be formed by sandwiching the printed specimens between filler (blank) specimens and then heat-sealed in a moisture-proof aluminum-foil-laminated bag after the air has been squeezed out. (More realistic predictions are possible by placing more filler specimens in the bag.)

   Double bagging shall be used to reduce any effect of pinholes in the aluminum foil layer of the bags.

   In sealed-bag tests, specimens are removed from the test chamber for measurement after the test period has elapsed. Once specimens have been removed from a bag for density measurements, the specimens shall not be subjected to further testing.

9.3.5 Specimen Storage After Testing

After the accelerated test, specimens are placed in a vinyl bag and stored in a cool dark location until density measurements are made.

9.3.6 Density Measurements

The reflection density shall be measured following the provisions in **Section 5** before exposure (after the specimens have been printed and dried in accordance with the provisions in **Section 4**) and after each exposure.

9.3.7 Calculation of the Predicted Print Life

The free-hanging method shall be the standard condition for the print-life calculation.

9.3.7.1 Endpoint Provisions

The stipulated **endpoints** shall be those given in **Section 6.2**. If, however, increasing the testing time makes it much more susceptible to measurement errors, then the print life may be determined by assuming in the calculation that reflection density difference = 0.1 is equivalent to ΔE = 10. ΔE is calculated by finding the CIE LAB (L*a*b*) color values in accordance with **ISO 11664-1** and comparing $(L^*a^*b^*)_1$, prior to the test, with $(L^*a^*b^*)_2$ after the accelerated test.

9.3.7.2 Calculation of the Predicted Print Life by the Arrhenius Method

① **Print life value at the four temperatures (a, b, c, d [°C])**

(accelerated tests are continued until one of the endpoints defined in **Table 1** is reached)

Legend for **Table 2** (dY(B)t): density B for yellow patch in accelerated test time *t*

Legend for **Table 2** (%ΔdY(B)t): rate of change of density B for yellow patch in accelerated test time *t*

$$\%\Delta dY(B)t = [|dY(B)t - dY(B)_0| \div dY(B)_0] \times 100$$

Table 2 – Changes in Reflection Density with Time

Accelerated Test Time *t* (days)	dY(B)t	%ΔdY(B)t
0	1.02	0
28	0.98	4
56	0.95	7
112	0.89	13
231	0.71	30

At least five measurements

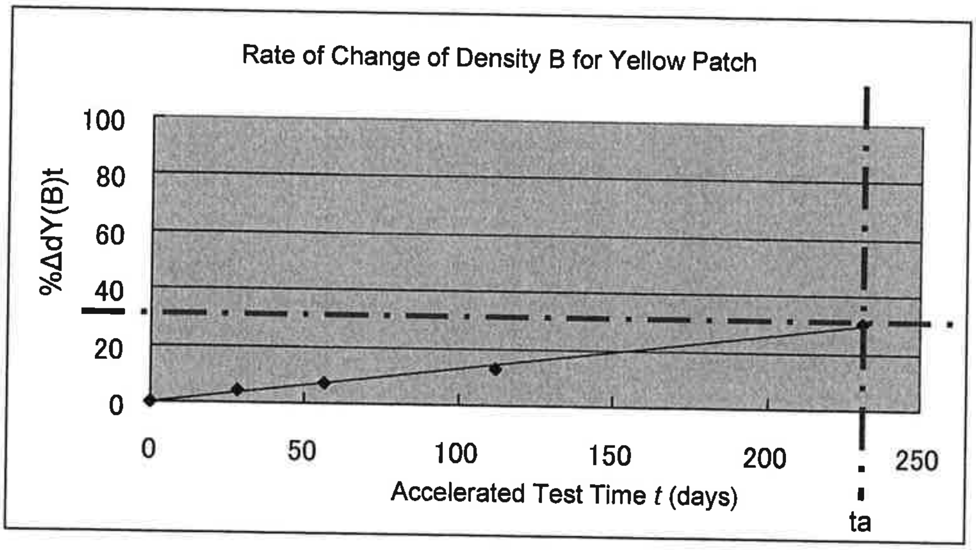

Figure 2 – Changes in Reflection Density with Time

The time *ta* to reach the endpoint at test temperature a [°C] can be found from **Figure 2**.

② **Predicting the print life at room temperature (23 °C)**

Find the times ta, tb, tc, and td (the print lives at each test temperature) to reach the endpoint at the four temperature points a, b, c, and d with the method in ① above. The endpoints must be reached at all four temperature points. Based on the Arrhenius theory, taking the inverse of the absolute temperatures (Kelvin) of a, b, c, and d and the logarithm of the print life gives the plot in **Figure 3** (which uses the test temperatures of 85, 77, 68, and 60 °C as an example).

Table 3 – Arrhenius Plot Data

Test temperature (°C)	T = inverse of the test temperature (in Kelvin)	Print life at the test temperature (days)	Logarithm of the print life
85	0.00279	18	1.26
77	0.00286	40	1.60
68	0.00293	95	1.98
60	0.00300	228	2.36

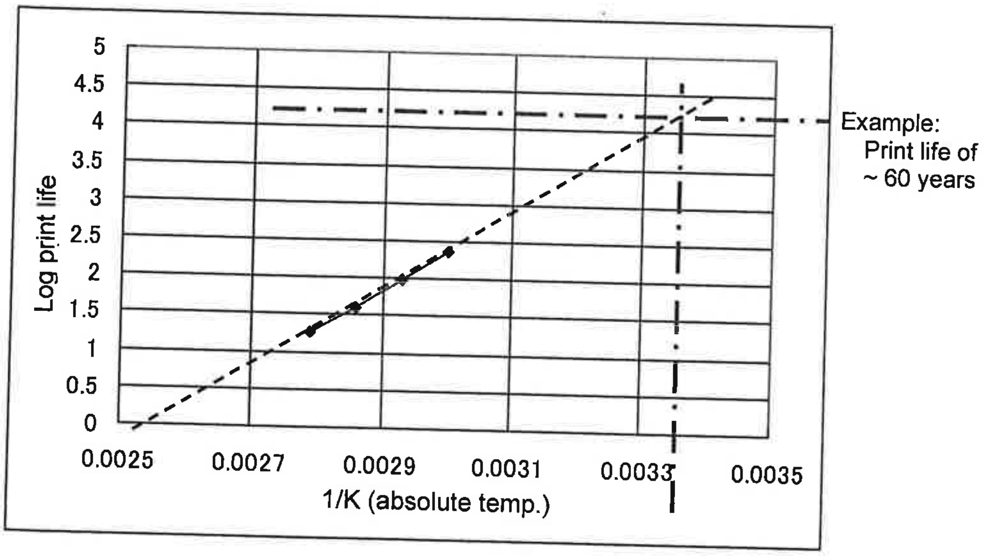

Figure 3 – Arrhenius Plot

In **Figure 3**, the Arrhenius plot is extrapolated to 1/K = 0.003377 — the inverse value of the absolute temperature of room temperature (23 °C) — and the [Logprint life] at that point is found. Finding the inverse of this [Logprint life] gives the predicted print life in years.

9.4 Test Condition (II) JEITA compliant (test temperature range: 15 °C or more, endpoint as specified, 1/2 the specification, or 1/3 the specification)

The long-term thermal stability is evaluated by a series of tests on specimens carried out at several elevated temperatures at a particular relative humidity.

9.4.1 Test Chamber

It is preferred that the test chamber can be adjusted to maintain a relative humidity of 50 ± 5 %RH at each test temperature and that the test chamber has a mechanism, such as fan, to force circulation of the atmosphere within the chamber. When testing a specimen where there is concern of ozone-related color changes, the ozone concentration within the test station should be kept below 4 ppb to ensure color changes due to ozone do not occur during the test. The test chamber shall be able to regulate the temperature to within ± 2 °C.

9.4.2 Test Humidity

The relative humidity shall be 50 ± 5 %RH. Furthermore, since thermal stability is humidity dependent, where the envisioned application environment includes high humidities, it is preferable to test at a higher relative humidity — for example, 60 ± 5 %RH — in addition to testing at the standard conditions.

9.4.3 Test Temperatures

Specimens shall be tested at a minimum of four different temperatures at the stipulated humidity level. The difference between the highest temperature and the lowest temperature shall be at least 15 °C, and the temperature intervals are, preferably, approximately equal; for example, 65 °C, 60 °C, 55 °C, and 50 °C. The test temperature tolerance in this provision shall be ± 1.0 °C.

The specimens must be tested at temperatures less than the specimens' melting point or glass transition temperature (Tg). Lowering the test temperatures naturally brings the tests closer to normal storage conditions, but it increases the required time to reach the endpoint of the specimens selected for the test. For this reason, this provision permits a difference between the highest temperature and the lowest temperature of at least 15 °C in regard for testing specimens with low melting points or Tg.

9.4.4 Test Methods

There are two thermal stability test methods: free hanging and sealed bag.

1) **Free-hanging method**

   Free-hanging method Tests are run at the four test temperatures. The optical densities of the specimens are measured before the thermal test and at predetermined intervals thereafter when the specimens are withdrawn from the temperature/humidity-controlled test chambers. The same specimens can be used throughout the test period.

2) **Sealed-bag method**

   <<Test equipment and operation for specimens sealed in sealed-bags>>

   The two test samples (the material sealed in the sealed bag) for each test temperature condition shall be formed by sandwiching the printed specimens between filler (blank) specimens and then heat-sealed in a moisture-proof aluminum-foil-laminated bag after the air has been squeezed out. (More realistic predictions are possible by placing more filler specimens in the bag.)

   Double bagging shall be used to reduce any effect of pinholes in the aluminum foil layer of the bags. In sealed-bag tests, specimens are removed from the test chamber for measurement after the test period has elapsed. Once specimens have been removed from a bag for density measurements, the specimens shall not be subjected to further testing.

9.4.5 Specimen Storage After Testing

After the accelerated test, specimens are placed in a vinyl bag and stored in a cool dark location until density measurements are made.

9.4.6 Density Measurements

The reflection density shall be measured following the provisions in **Section 5** before exposure (after the specimens have been printed and dried in accordance with the provisions in **Section 4**) and after each application of heat.

9.4.7 Calculation of the Predicted Print Life

The free-hanging method shall be the standard condition for the print-life calculation.

9.4.7.1 Endpoint Provisions

The stipulated **endpoints** shall be those given in **Section 6.2**. If, however, increasing the testing time makes it much more susceptible to measurement errors, then the print life may be determined by assuming in the calculation that reflection density difference = 0.1 is equivalent to ΔE = 10. ΔE is calculated by finding the CIE LAB (L*a*b*) color values in accordance with **ISO 11664-1** and comparing $(L^*a^*b^*)_1$, prior to the test, with $(L^*a^*b^*)_2$ after the accelerated test.

9.4.7.2 Calculation of the Predicted Print Life by the Arrhenius Method

9.4.7.2.1 Basic Method Using the Endpoint from Section 6.2

① **Print life value at the four temperatures (a, b, c, d [°C])**

(accelerated tests are continued until one of the endpoints defined in **Table 1** is reached)

Legend for **Table 4** (dY(B)t): density B for yellow patch in accelerated test time t

Legend for **Table 4** (%ΔdY(B)t): rate of change of density B for yellow patch in accelerated test time t

$$\%\Delta dY(B)t = [|dY(B)t - dY(B)_0| \div dY(B)_0] \times 100$$

Table 4 – Changes in Reflection Density with Time

Accelerated Test Time *t* (days)	dY(B)t	%ΔdY(B)t
0	1.02	0
28	0.98	4
56	0.95	7
112	0.89	13
231	0.71	30

At least five measurements

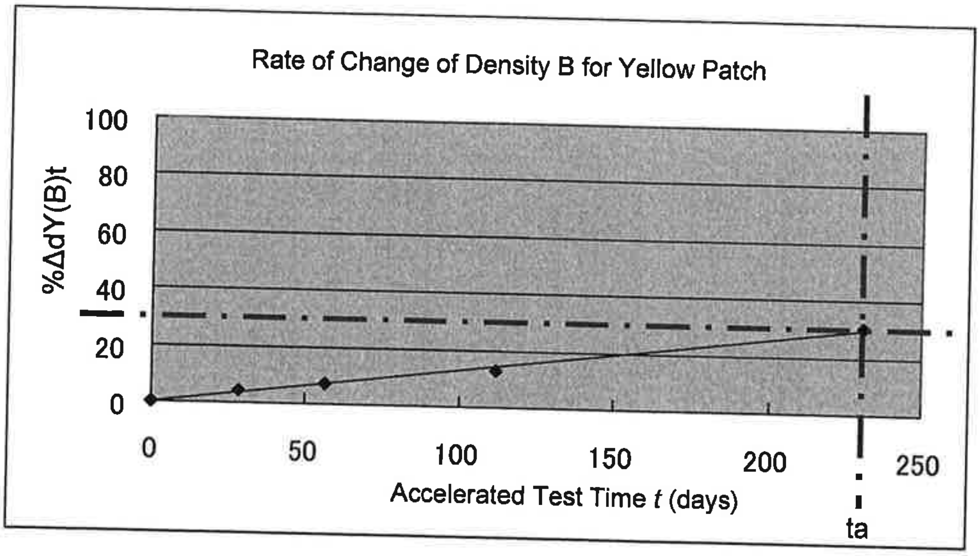

Figure 4 – Changes in Reflection Density with Time

The time ta to reach the endpoint at test temperature a [°C] can be found from **Figure 4**.

② **Predicting the print life at room temperature (23 °C)**

Find the times ta, tb, tc, and td (the print lives at each test temperature) to reach the endpoint at the four temperature points a, b, c, and d with the method in ① above. The endpoints must be reached at all four temperature points. Based on the Arrhenius theory, taking the inverse of the absolute temperatures (Kelvin) of a, b, c, and d and the logarithm of the print life gives the plot in **Figure 5** (using the test temperatures of 85, 77, 68, and 60 °C as an example).

Table 5 – Arrhenius Plot Data

Test temperature (°C)	T = inverse of the test temperature (in Kelvin)	Print life at the test temperature (days)	Logarithm of the print life
85	0.00279	18	1.26
77	0.00286	40	1.60
68	0.00293	95	1.98
60	0.00300	228	2.36

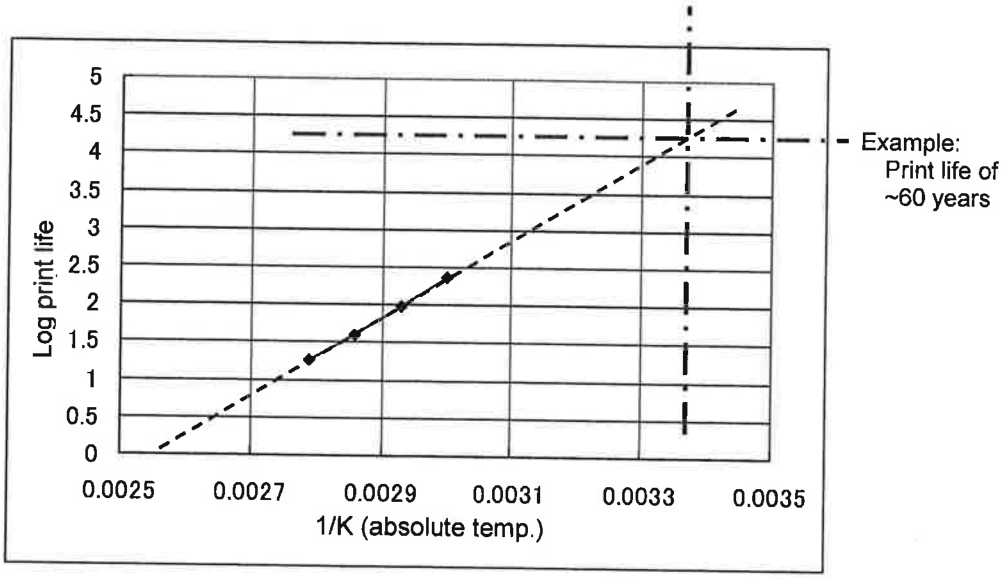

Figure 5 – Arrhenius Plot

In **Figure 5**, the Arrhenius plot is extrapolated to 1/K = 0.003377 — the inverse value of the absolute temperature of room temperature (23 °C) — and the Logprint life at that point is found. Finding the inverse of this Logprint life gives the predicted print life in years.

9.4.7.2.2 Time-Reduced Method When Reaching the Stipulated Endpoint is Prohibitively Long (1/2 Endpoint Method)

Normally, no print life at all can be predicted during the test period until the stipulated endpoints are reached, which for some samples can require a year or more, because the print life cannot be calculated before the endpoints for all test temperatures have been reached.

With this method, however, the endpoint is set at half the value of the stipulated value, which permits the 1/2 endpoint print life to be calculated when the 1/2 endpoint is reached. It must be emphasized that this calculated print life is only the print life to the 1/2 endpoint; it is not permissible to double this value to obtain the print life to the standard endpoint.

① **Example of a test at four temperature levels: 50 °C, 55 °C, 60 °C, and 65 °C**

The endpoints stipulated in **Section 6.2** are halved, as shown in **Table 6**. One exception is the yellow discoloration of white patches. Halving the reflection density increases the impact of measurement error, so the conversion is performed assuming that reflection density difference = 0.1 is equivalent to ΔE = 10. ΔE is calculated by finding the CIE LAB (L*a*b*) color values in accordance with **ISO 11664-1** and comparing $(L^*a^*b^*)_1$, prior to the test, with $(L^*a^*b^*)_2$ after the accelerated test. The accelerated test proceeds following the basic procedure, and the test and print-life prediction are conducted as described in **Sections 9.4.1 – 9.4.7** using the 1/2 endpoints in **Table 6**.

Table 6 – 1/2 Endpoints for Thermal Stability Tests

Permissible limit of reflection density change	Image change parameter
15 %	Decline in red density in a neutral patch
15 %	Decline in green density in a neutral patch
15 %	Decline in blue density in a neutral patch
15 %	Decline in red density in a single-color cyan patch
15 %	Decline in green density in a single-color magenta patch
15 %	Decline in blue density in a single-color yellow patch
7.5 %	Color imbalance in the differential between red density and green density in a neutral patch
7.5 %	Color imbalance in the differential between red density and blue density in a neutral patch
7.5 %	Color imbalance in the differential between green density and blue density in a neutral patch
Permissible limit of color difference in white patches	
5.0	Color difference in white patches

* Red density corresponds to the cyan component.
** Green density corresponds to the magenta component.
*** Blue density corresponds to the yellow component.

② **Test report exceptions**

The predicted print life found with this calculation shall be recorded as “xx years or more.” It is permissible to continue the test and change the expression to “yy years” when the long-term 30 %-endpoint data is obtained and the print life recalculated.

9.4.7.2.3 Time-Reduced Method When Reaching the Stipulated Endpoint is Prohibitively Long (1/3 Endpoint Method)

When the test using the 1/2 endpoints still takes too much time, it is permissible to use the 1/3 endpoints given in **Table 7**. The test method, calculation method, and reporting method are omitted here as they are the same as those described in **Section 9.4.7.2.2**.

Table 7 – 1/3 Endpoints for Thermal Stability Tests

Permissible limit of reflection density change	Image change parameter
10 %	Decline in red density in a neutral patch
10 %	Decline in green density in a neutral patch
10 %	Decline in blue density in a neutral patch
10 %	Decline in red density in a single-color cyan patch
10 %	Decline in green density in a single-color magenta patch
10 %	Decline in blue density in a single-color yellow patch
5 %	Color imbalance in the differential between red density and green density in a neutral patch
5 %	Color imbalance in the differential between red density and blue density in a neutral patch
5 %	Color imbalance in the differential between green density and blue density in a neutral patch
Permissible limit of color difference in white patches	
3.3	Color difference in white patches

* Red density corresponds to the cyan component.
** Green density corresponds to the magenta component.
*** Blue density corresponds to the yellow component.

9.5 Print-life prediction using intermediate value of Test Conditions (I) and (II) (test temperature range: 10 °C or more, endpoint is as specified)

Even if the 1/2 endpoint method or 1/3 endpoint method is selected in compliance with **Section 9.4**, if the test time is too long (e.g. 1 year or more), and it is necessary to be able to make an evaluation in a shorter time period, then it is possible to select the following lifetime calculation method, using the data from the ongoing test (intermediate value).

9.5.1 Test Conditions

The test chamber, test humidity, test method, method for storing the specimen after the test, and density measurement comply with **Sections 9.3.1**, **9.3.2**, **9.3.4**, **9.3.5**, and **9.3.6**, respectively.

9.5.2 Test Temperatures

Of the four or more test temperatures in **Section 9**, **"Test Method — Indoor Thermal Stability"**, perform the evaluation until the endpoints are reached for at least three test-temperature specimens, with a temperature range of at least 10 °C. The test temperature tolerance shall be ± 0.5 °C.

※Note Continue testing specimens until their endpoints are reached, and calculate the print-life prediction when the test conditions noted in **Section 9**, **"Test Method — Indoor Thermal Stability"** are reached.

9.5.3 Calculation of Predicted Print Life via Intermediate Value

Create an Arrhenius plot using the time data until endpoints are reached for three or more temperatures meeting the conditions above, and calculate the print-life prediction in years at room temperature (23 °C).

9.5.4 Cautions for Calculating Predicted Print Life via Intermediate Value

The following cautions are needed when using print-life predictions made via intermediate values.

1) Always continue the tests until test condition (I) or (II) are met.

2) When the print-life prediction is calculated in accordance with **JEITA CP-3901**, **Section 9 "Test Method — Indoor Thermal Stability"**, at a minimum, do not set the print-life calculated via intermediate values to greater than the print-life data obtained via back data as shown below, in order to prevent the print-life calculated via intermediate values from exceeding the print-life calculated by the method indicated in test condition (I) or (II). Print-life data obtained via back data includes:

① the print-life data calculated in accordance with the method described in test condition (I) or (II), by combining similar ink and media; and

② the print-life data at an endpoint that can be evaluated at a shorter time (e.g. 1/4 or 1/5 endpoint), at a level at least high enough to detect changes reliably.

3) If there is a difference between the print-life prediction via intermediate values and the print-life value calculated using the method described in test condition (I) or (II), it is preferable to amend the prediction immediately. The method of amendment will differ depending on when the evaluation ended, the product cycle, and the like, but post the amended text on each company's website or the like.

10 Test Reports

The test report must state the name of the person responsible for preparing the report and the date on which the report was prepared. The report author is also obliged to include reports as given below on the specimen preparation method, the light stability test, the ozone stability test, and the thermal stability test. A report must be made on the sample preparation method in all cases. In cases where all tests are not complete, only completed tests are to be reported and incomplete tests must be reported as "not tested" or "under test."

The following reports are permitted as a workaround in cases where the density changes are minute and the test does not complete.

Reporting the predicted print life as "xx years or more" is permitted for ozone stability and light stability. More specifically, even if in an accelerated test the density change is slight and the endpoint not reached, it is possible to find a value of "xx years" by converting the accumulated illuminance or ozone concentration, found as the product of the illuminance or ozone concentration in the accelerated test and the elapsed test time at that point, to print-life years with the print-life equation. It is this value that can be reported as "xx years or more." Even if the amount of change at that point is half the endpoint, however, the prediction must be stated as "xx years or more"; the obtained value cannot be doubled.

If the testing density in the ozone stability evaluation exceeds 1 ppm, however, it is preferable to test until the endpoint is reached.

Reporting the predicted print life as "yy years or more" is permitted for thermal stability when the print life found using the Arrhenius method at 1/2 or 1/3 of the stipulated endpoint is "yy years." The print life is "yy years or more" and no other value; the value calculated at the 1/2 or 1/3 endpoint cannot be doubled or tripled and reported as the print life. In addition, if at the time of preparing the report, the 1/3 endpoint has not been reached at all test temperatures, the test must be reported as "under test." However, as a proviso, it is permitted to add that the endpoint has not been reached under the specific test conditions (test temperature and test duration). For example: "Under test. However, after 120 days under thermal stability testing at the temperatures 55 °C, 50 °C, 45 °C, and 40 °C, the 1/3 endpoint has not been reached." This type of proviso shall be permissible only when the elapsed test time is at least 90 days. Specifically, if fewer than 90 days have elapsed, then only the statement "Under test" is allowed, and no proviso may be added.

10.1 Report on the Specimen Preparation Method

- Preparation date
- Person responsible for preparing the specimens
- Printer model number and individual identifying number (serial number, prototype number, etc.)
- Ink type and individual identifying number (serial number, prototype number, etc.)
- Paper type and individual identifying number (serial number, prototype number, etc.)
- Software
  - Operating system type and version
  - Application type and version
  - Printer driver version and its settings
- Drying and storage conditions of specimens after printing (temperature, humidity, days)
- Colors of the evaluative image and the starting densities

10.2 Report on the Light Stability in Years

10.2.1 Report on Results of Tests Conducted Under Standard Conditions

- Test dates
- Person responsible for the test
- Calculated value for the predicted print life in years
- Type of filter
- Illuminance of the test lamp
- Temperature and relative humidity of air inside the test chamber
- Chosen temperature of the black panel
- Color that first reached the endpoint and the starting reflection density
- Accumulated optical intensity at the endpoint

10.2.2 Report on Results of Tests Conducted Under Non-Standard Conditions

- Test dates
- Person responsible for the test
- Calculated value for the predicted print life in years
- Illuminance of the test lamp
- Type and spectrum characteristics of the filter
- Differences from the standard specimens
- Temperature and relative humidity of air inside the test chamber
- Chosen temperature of the black panel
- Color that first reached the endpoint and the starting reflection density
- Differences from the standard conditions
- Comments on the occasion and place the product will be used

10.3 Report on the Ozone Stability in Years

10.3.1 Report on Results of Tests Conducted Under Standard Conditions

- Test dates
- Person responsible for the test
- Calculated value for the predicted print life in years
- Ozone concentration and exposure time
- Type of ozone generator
- Temperature and humidity conditions and airflow (speed and recirculation rate) conditions
- Color that first reached the endpoint and the starting reflection density

10.3.2 Report on Results of Tests Conducted Under Non-Standard Conditions

- Test dates
- Person responsible for the test
- Calculated value for the predicted print life in years
- Color that first reached the endpoint and the starting reflection density
- Ozone concentration and exposure time
- Temperature and humidity conditions and airflow (speed and recirculation rate) conditions
- Differences in specimens from standard conditions
- Differences from the standard conditions
- Comments on the occasion and place the product will be used

10.4 Report on the Thermal Stability in Years

Reports can be made on thermal stability tests under four conditions: **ISO** compliant, **JEITA** compliant, print-life prediction method using intermediate values, and non-standard environment. Reports on non-standard environment tests are only permitted when reported together with **ISO** compliant or **JEITA** compliant tests, or print-life prediction method via intermediate values.

10.4.1 Report on Results of Tests Conducted Under Test Conditions (I) ISO Compliant

- Test dates
- Person responsible for the test
- Calculated value for the predicted print life in years
- Accelerated test temperatures
- Time to reach the endpoint at each temperature
- Color that first reached the endpoint and the starting reflection density
- Result and applicability of the Arrhenius print-life prediction

10.4.2 Report on Results of Tests Conducted Under Test Conditions (II) JEITA Compliant

- Test dates
- Person responsible for the test
- Calculated value for the predicted print life in years
- Accelerated test temperatures
- Any change to the endpoint and summary of changes
- Time to reach the endpoint at each temperature
- Color that first reached the endpoint and the starting reflection density
- Result and applicability of the Arrhenius print-life prediction

10.4.3 Reporting of Test Results for Print-life Prediction Using Intermediate Value of Test Conditions (I) and (II)

- Test dates
- Person responsible for the test
- Calculated value for the predicted print life in years
- Accelerated test temperatures
- Any change to the endpoint and summary of changes
- Time to reach the endpoint at each temperature
- Color that first reached the endpoint and the starting reflection density
- Result and applicability of the Arrhenius print-life prediction
- That these are print-life prediction values via intermediate values
- That the evaluation is ongoing

10.4.4 Report on Results of Tests Conducted Under Non-Standard Conditions

- Test dates
- Person responsible for the test
- Calculated value for the predicted print life in years
- Color that first reached the endpoint and the starting reflection density
- Temperature of the print-life conversion
- Accelerated test humidity
- Whether the sealed-bag or free-hanging method was used?
- Differences from the standard specimens
- Differences from the standard conditions
- Comments on the occasion and place the product will be used

Annex 1
(informative)
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Annex 2
(normative)
Test charts

1 Overview

This Annex provides a description of the print-life prediction charts data and the image charts used in image stability tests of digital color photo prints.

Figure 6: Print-life predictive chart data

Figures 7-A and 7-B: Image chart data

2 Format of the Print-Life Predictive Chart Data

The print-life predictive chart data is provided in the digital-camera Exif data format (JPEG formatted).

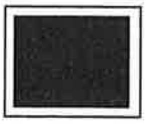
Pixel layout: 2,432 x 1,664 pixels (horizontal x vertical) (~4 million pixels) (areas outside the patches given below are left blank)

Patches : Consists of gradated patches for C, M, Y, K, R, G, and B in 16 levels of density (112 patches in total), and the Dmin patch

Table 8

NO	W	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16
R	255	240	224	208	192	176	160	144	128	112	96	80	64	48	32	16	0
G	255	240	224	208	192	176	160	144	128	112	96	80	64	48	32	16	0
B	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
NO	–	G1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16
R	–	240	224	208	192	176	160	144	128	112	96	80	64	48	32	16	0
G	–	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
B	–	240	224	208	192	176	160	144	128	112	96	80	64	48	32	16	0
NO	–	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16
R	–	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
G	–	240	224	208	192	176	160	144	128	112	96	80	64	48	32	16	0
B	–	240	224	208	192	176	160	144	128	112	96	80	64	48	32	16	0
NO	–	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16
R	–	240	224	208	192	176	160	144	128	112	96	80	64	48	32	16	0
G	–	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
B	–	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
NO	–	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16
R	–	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
G	–	240	224	208	192	176	160	144	128	112	96	80	64	48	32	16	0
B	–	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
NO	–	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Y15	Y16
R	–	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
G	–	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
B	–	240	224	208	192	176	160	144	128	112	96	80	64	48	32	16	0
NO	–	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11	K12	K13	K14	K15	K16
R	–	240	224	208	192	176	160	144	128	112	96	80	64	48	32	16	0
G	–	240	224	208	192	176	160	144	128	112	96	80	64	48	32	16	0
B	–	240	224	208	192	176	160	144	128	112	96	80	64	48	32	16	0

K16	K8	Y16	Y8	M16	M8	C16	C8		B8	G16	G8	R16	R8
K15	K7	Y15	Y7	M15	M7	C15	C7	B15	B7	G15	G7	R15	R7
K14	K6	Y14	Y6	M14	M6	C14	C6	B14	B6	G14	G6	R14	R6
K13	K5	Y13	Y5	M13	M5	C13	C5	B13	B5	G13	G5	R13	R5
K12	K4	Y12	Y4	M12	M4	C12	C4	B12	B4	G12	G4	R12	R4
K11	K3	Y11	Y3	M11	M3	C11	C3	B11	B3	G11	G3	R11	R3
K10	K2	Y10	Y2	M10	M2	C10	C2	B10	B2	G10	G2	R10	R2
K9	K1	Y9	Y1	M9	M1	C9	C1	B9	B1	G9	G1	R9	R1
													W



Outer: 160 × 160
Inner : 152 × 152

Figure 6

3 Image Chart Data Format

The image chart data is provided in the digital-camera Exif data format (JPEG formatted).

Pixel layout: 2,432 x 1,664 pixels (horizontal x vertical) (~4 million pixels)

3.1 Compression

Minimum (quantization table consists of ones only)

3.2 Header

The chart includes a natural image in the center.

3.3 Image Chart Data Layout

The image chart data consists of a natural image surrounded by patches.

3.3.1 Natural Image

The natural image is a picture taken with a digital camera.

Pixel layout: 1,536 × 1,152 pixels (horizontal × vertical) (~1.6 million pixels)

Design : Children, fruit (**Figure 7-A**); night view, scenery (**Figure 7-B**)

3.3.2 Patches

The charts consist of 113 patches as given below, with 96 color patches and 17 neutral patches (including a white patch).

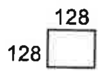
Color patches : A 48-segment color wheel; each segment consisting of a maximum saturated color patch and a patch that increases the brightness of the same hue (**Figure 7-A**) A 48-segment color wheel; each segment consisting of a maximum saturated color patch and a patch that reduces the brightness of the same hue (**Figure 7-B**)

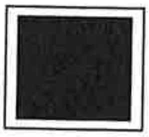
Neutral patches: Representative colors set at equal intervals across the brightness range

NO	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
R	255	255	255	255	255	255	255	255	255	224	192	160	128	96	64	32	0	0	0	0	0	0	0	0
G	0	32	64	96	128	160	192	224	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	64	96	128	160	192	224
R	255	255	255	255	255	255	255	255	255	248	240	232	224	216	208	200	192	192	192	192	192	192	192	192
G	192	200	208	216	224	232	240	248	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
B	192	192	192	192	192	192	192	192	192	192	192	192	192	192	192	192	192	200	208	216	224	232	240	248

NO	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
R	0	0	0	0	0	0	0	0	0	32	64	96	128	160	192	224	255	255	255	255	255	255	255	255
G	255	224	192	160	128	96	64	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	224	192	160	128	96	64	32
R	192	192	192	192	192	192	192	192	192	200	208	216	224	232	240	248	255	255	255	255	255	255	255	255
G	255	248	240	232	224	216	208	200	192	192	192	192	192	192	192	192	192	192	192	192	192	192	192	192
B	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	248	240	232	224	216	208	200

NO	W	B16	B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1
R	255	240	224	208	192	176	160	144	128	112	96	80	64	48	32	16	0
G	255	240	224	208	192	176	160	144	128	112	96	80	64	48	32	16	0
B	255	240	224	208	192	176	160	144	128	112	96	80	64	48	32	16	0





Outer: 128 × 128
Inner : 120 × 120

B1	B1	42	43	44	45	46	47	48		2	3	4	5	6	7	8	W	W
B1	B1	42	43	44	45	46	47	48	1	2	3	4	5	6	7	8	W	W
41	41	W														B8	9	9
40	40	B16														B7	10	10
39	39	B15														B6	11	11
38	38	B14							Natural Image (Child, fruit)							B5	12	12
37	37	B13														B4	13	13
36	36	B12														B3	14	14
35	35	B11														B2	15	15
34	34	B10														B1	16	16
	33	B9														W	17	17
W	W	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	B1	B1
W	W	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	B1	B1

Figure 7-A

NO	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
R	255	255	255	255	255	255	255	255	255	224	192	160	128	96	64	32	0	0	0	0	0	0	0	0
G	0	32	64	96	128	160	192	224	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	64	96	128	160	192	224
R	128	128	128	128	128	128	128	128	128	112	96	80	64	48	32	16	0	0	0	0	0	0	0	0
G	0	16	32	48	64	80	96	112	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128
B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	32	48	64	80	96	112

NO	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
R	0	0	0	0	0	0	0	0	0	32	64	96	128	160	192	224	255	255	255	255	255	255	255	255
G	255	224	192	160	128	96	64	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	224	192	160	128	96	64	32
R	0	0	0	0	0	0	0	0	0	16	32	48	64	80	96	112	128	128	128	128	128	128	128	128
G	128	112	96	80	64	48	32	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	128	112	96	80	64	48	32	16

NO	W	B16	B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1
R	255	240	224	208	192	176	160	144	128	112	96	80	64	48	32	16	0
G	255	240	224	208	192	176	160	144	128	112	96	80	64	48	32	16	0
B	255	240	224	208	192	176	160	144	128	112	96	80	64	48	32	16	0

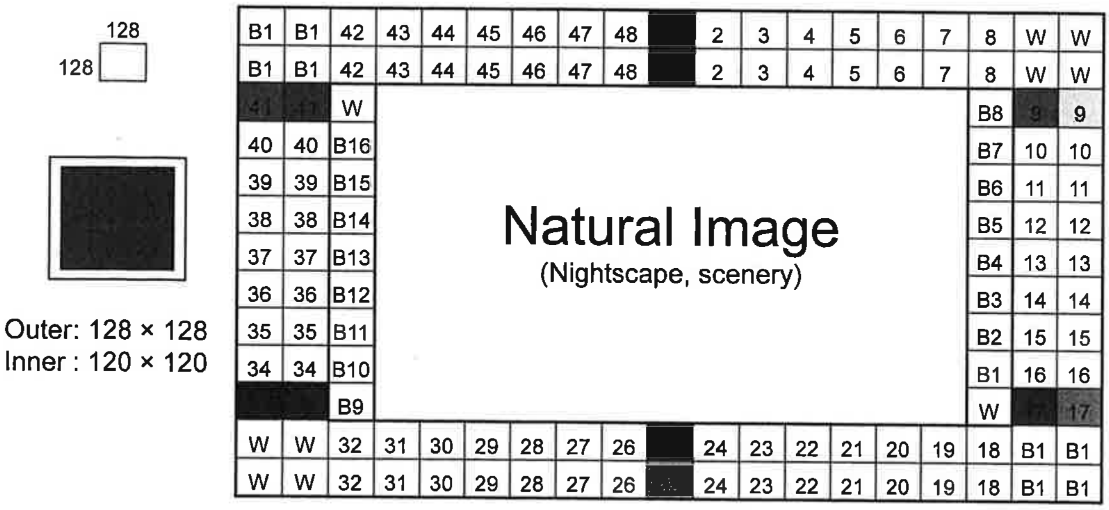


Figure 7-B

4 Sample Measurements

Below are the measurement results from an indoor ozone stability test, for use as a reference. (**Figures 8-A**, **B**, and **C**) The legends in the figures indicate the printer types.

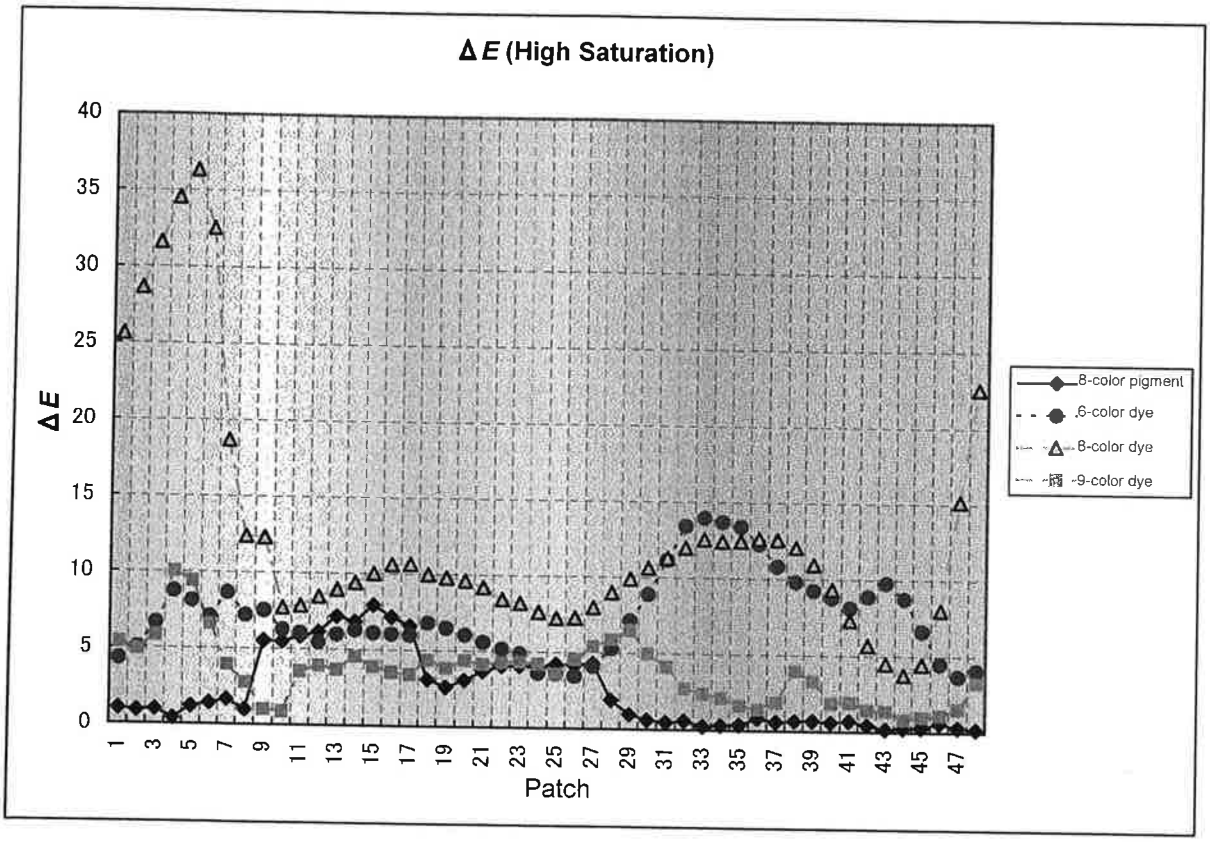


Figure 8-A

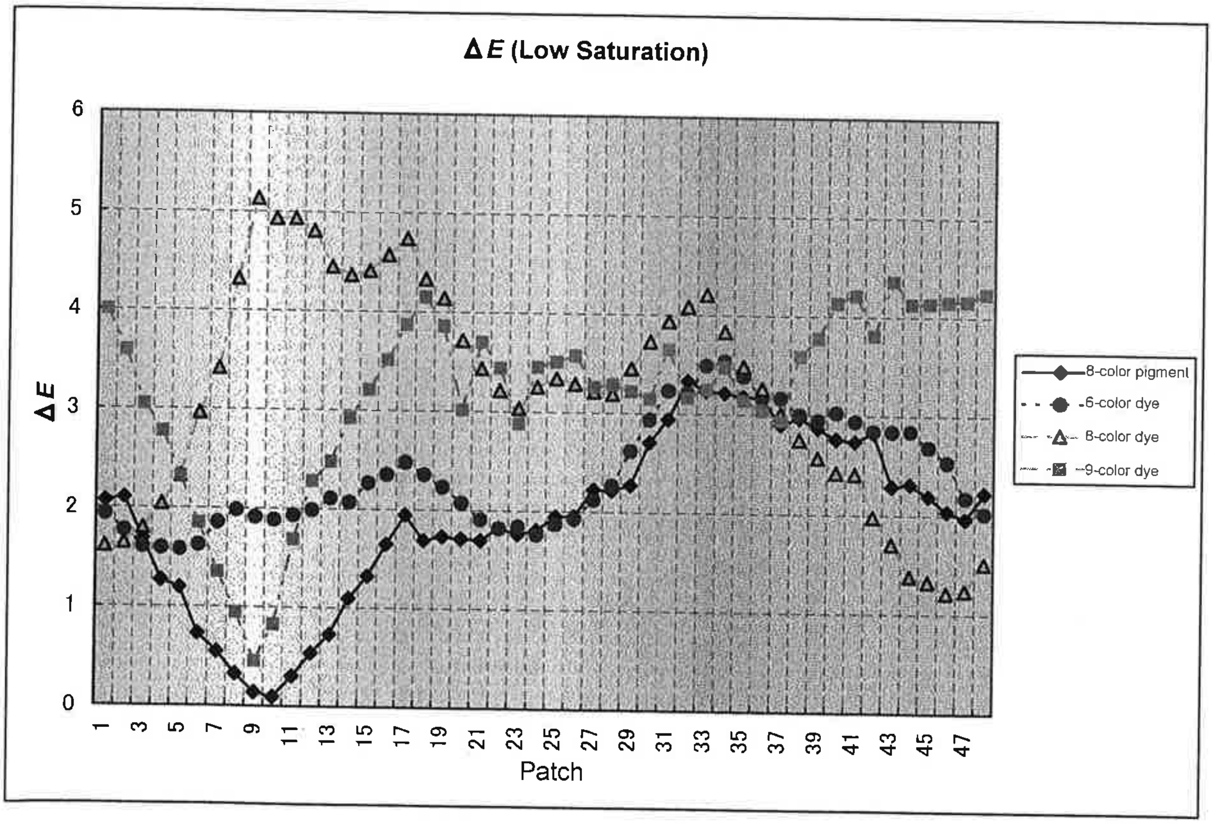


Figure 8-B

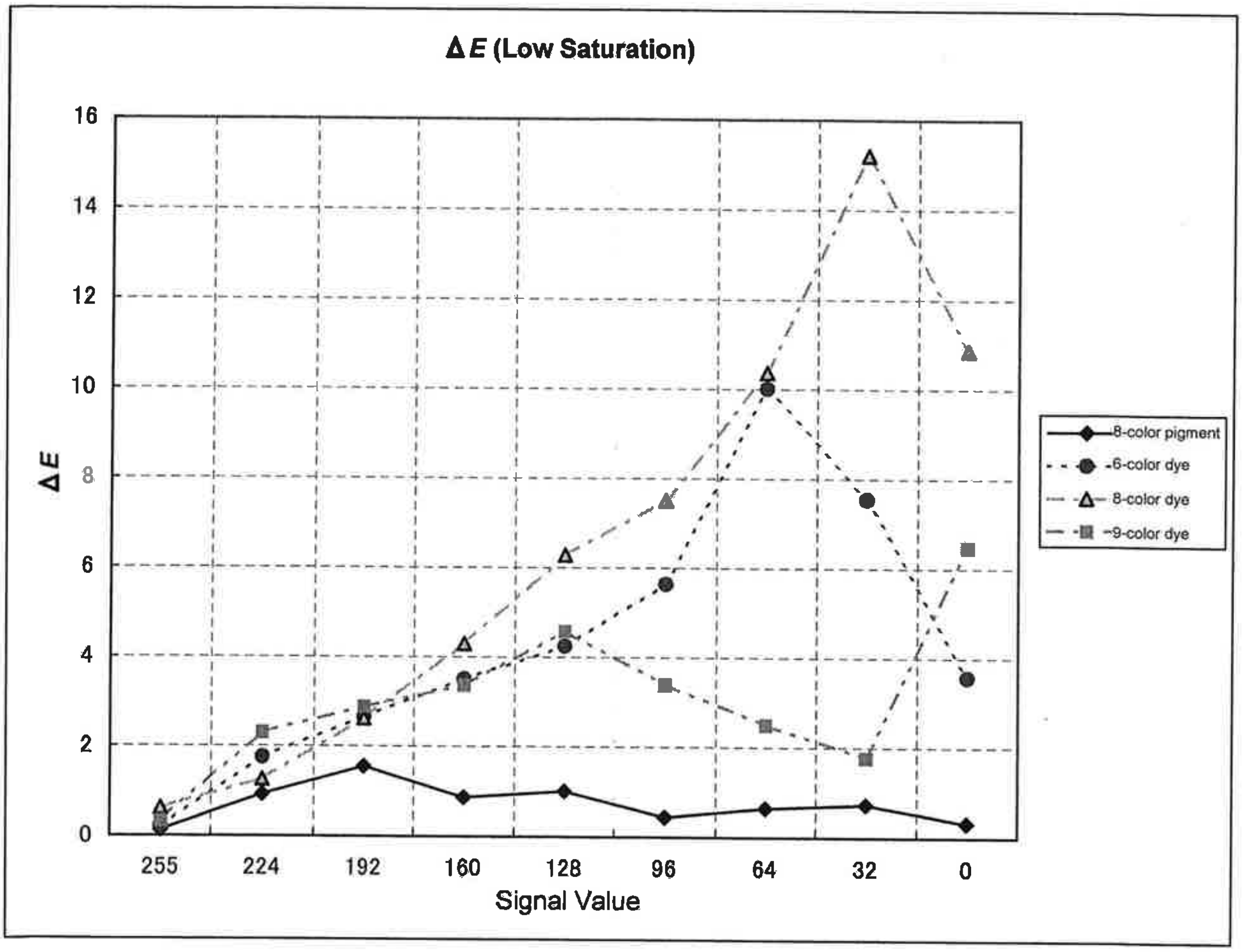

ΔE (Low Saturation)
16
14
12
10
8
6
4
2
0
ΔE
255
224
192
160
128
96
64
32
0
Signal Value
8-color pigment
6-color dye
8-color dye
9-color dye

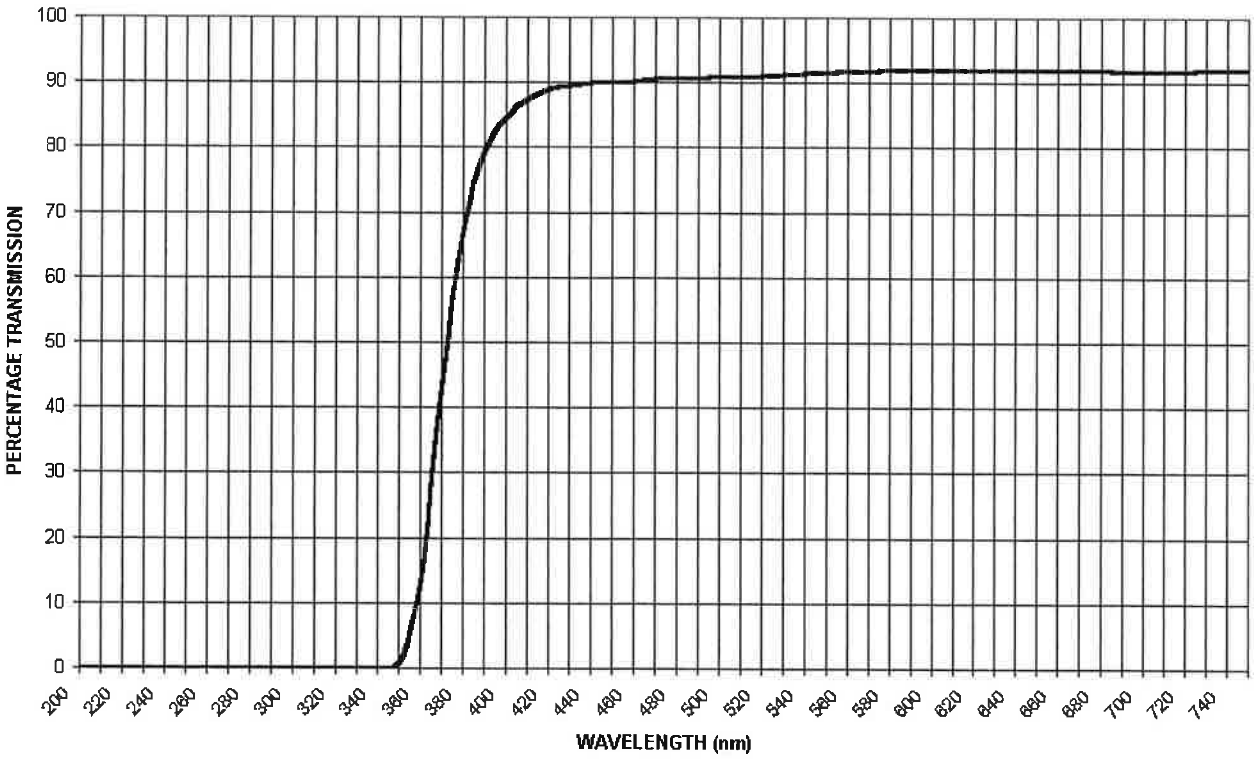
Figure 8-C

Annex 3
(informative)
Specifications of filters used in light stability tests

1 Transmission Spectrum Distribution of UV Blocking Sharp Cut Filter

For reference, the transmission spectrum distribution of the HOYA L-37 is shown.

HOYA L-37 (200 - 750 nm)



Annex 4
(informative)
Stability test methods for digital color print photos

1 Overview of Scope

As a reference, we show some evaluation methods for testing the water resistance, sebum resistance, and oil resistance in digital color photo prints output on household-use printers. These testing methods cannot be used as substitutes for calculating print life.

2 Testing Water Resistance for Indoor Use

This testing method is based on **ISO 18935**.

3 Testing Sebum Resistance

(This standard is based on the testing method described in the **EIAJ**'s Video Print Image Durability Report (March 2000).)

3.1 Scope

This standard describes tests to measure sebum resistance in printed digital images. This standard can be applied to digital printing.

3.2 Definitions of Terms

For the purposes of this standard, the following terminology is used.

3.2.1 Surrounding Conditions

Ambient conditions of (23 ± 1) °C and (50 ± 5) %RH

3.3 Sebum Resistance Categories

3.3.1 General Provisions

Sebum resistance in printed materials is classified into ① of ⑤ categories, as defined below.

① Uplift of sebum is recognized

② Significant change in density is recognized

③ Slight change in density is recognized

④ No change is recognized with fingerprints only

⑤ No fingerprints are recognized

3.4 Procedure for Evaluating Sebum Resistance

3.4.1 General Precautions

Sebum resistance testing is a method of testing the degree to which printed materials are affected by human sebum (e.g. excretions (sweat, moisture, etc.) and body temperature).

3.4.2 Comparative Samples

In order to evaluate the test results based on the qualitative criteria for sebum resistance defined in **Section 3.3**, it is necessary to use comparative samples that will not be tested, in order to compare with the test specimen.

3.5 Test Methods

3.5.1 General Provisions

There is one test method.

3.5.2 Test Methods

In the test environment indicated in **Section 3.2.1**, apply sebum to the tester's fingers, press them against the print surface, and make a determination via sensory test.

4 Testing Oil Resistance

(This standard is based on the testing method described in the **EIAJ**'s Video Print Image Durability Report (March 2000).)

4.1 Scope

This standard describes tests to measure oil resistance in printed digital images. This standard can be applied to digital printing.

Although the use of artificial sebum is possible for simulating the sebum resistance of print media, there is no absolute artificial sebum, and each manufacturer has its own formulation, making reproducibility and interchangeability challenges. For this reason, cooking oil, which is easily obtaining from commercial channels, is used as a substitute. Although the resulting discoloration or color changes may be different due to different constituents from human sebum, this is currently used as the best method.

4.2 Definitions of Terms

For the purposes of this standard, the following terminology is used.

4.2.1 Surrounding Conditions

Ambient conditions of (23 ± 1) °C and (50 ± 5) %RH

4.3 Oil Resistance Categories

4.3.1 General Provisions

Oil resistance in printed materials is classified into ① of ⑩ categories, as defined below.

① Hue change of 4.5 or greater
② Hue change of 4.0 or greater, and less than 4.5
③ Hue change of 3.5 or greater, and less than 4.0
④ Hue change of 3.0 or greater, and less than 3.5
⑤ Hue change of 2.5 or greater, and less than 3.0
⑥ Hue change of 2.0 or greater, and less than 2.5
⑦ Hue change of 1.5 or greater, and less than 2.0
⑧ Hue change of 1.0 or greater, and less than 1.5
⑨ Hue change of 0.5 or greater, and less than 1.0
⑩ Hue change of less than 0.5

4.4 Procedure for Evaluating Oil Resistance

4.4.1 General Precautions

The purpose of testing oil resistance is to determine the resistance to oil as a simulation of print media's resistance to sebum.

4.5 Test Methods

4.5.1 General Provisions

There is one test method.

4.5.2 Test Method

① Measure the density and hue of the test sample before the oil-resistance test.

② Place an appropriate amount of commercially available salad oil, which has been brought to room temperature, into the test container (a plastic cup was used in this case), and immerse the printed material in the oil for 10 minutes. When doing so, take care that the test sample does not float out of the oil (in this case, one edge of the sample was clipped in place)

③ After 10 minutes, remove the sample, and wipe of the oil thoroughly. Use an oil-absorbent cloth, such as a kim towel, to wipe off the sample. Wipe the sample by pressing on both sides with the cloth. Never rub the sample.

④ After the test, the density and hue of the sample were measured, and the huge change $\Delta E^{()}$ as defined by the following formula was calculated.

$$\Delta E^{()} = \sqrt{\Delta a^{*2} + \Delta b^{*2}}$$

4.5.3 Accelerated Test

Leave the sample in a 50 °C / 80 % and 60 °C / 80 % environment for 3 days and 1 week, and measure the density and CIE LAB* values.

4.6 Materials Used

4.6.1 Oil Used

Commercially available salad (light cooking) oil (canola or soy)

4.6.2 Measuring Instruments

Density measurement : Macbeth TR-924 reflection densitometer (filter: visual type)

CIE LAB color measurement: Gretag SPM100-II spectral reflectometer (view angle: 2°; D65 light source)

Digital Color Photo Print Stability Evaluation Discussion

This Discussion does not constitute part of **JEITA CP-3901**. The explanation that follows provides a description of matters detailed in the Standard body or the Annex, matters detailed in the references to this Standard, and other related matters.

1 Objective and Intent of Establishing and Amending This Standard

1.1 Background and intent of this Standard's establishment

The image quality and print stability of household-use printers have improved remarkably since such printers first appeared on the market. Manufacturers today compete on the performance of their printers in these areas, which they publish in catalogs and other sales promotion materials. At the same time, the **ISO** has been conducting an ongoing study of methods by which to evaluate the print stability of photo prints, but there is, as yet, no timeframe for establishing a standard. In this context, the Print Media Stability Evaluation Study Group, the precursor to this PG, proposed, as the result of its investigations, that given the recent improvements in the photo print stability of household-use printers, given the fact that all companies now promote the print stability performance of their printers, and given the advisability of unifying the print stability terms used in promotion materials and defining test methods for each performance aspect, it is necessary to create criteria upon which users can readily make product comparisons. In receipt of this recommendation the Digital Print Media Stability Evaluation PG was inaugurated on August 25, 2003. The work of this PG has led to the establishment of methods to evaluate the print stability and to calculate the print life of digital color photo prints produced by household-use printers.

2 Problems Addressed During Deliberations on This Standard

2.1 Ozone stability tests versus mixed-gas stability tests

As described in the background to this Standard's formulation, one of the most time-consuming issues faced in the **JEITA** standardization process was discussing whether an ozone stability test method or a mixed-gas stability test method was valid as **JEITA**'s gas stability test method. The following points were raised while studying this issue.

- The mechanisms governing gas fading are not established. All that is clear at the present time is that ozone gas is a primary factor in fading.
- Since no test method perfectly conforms to all recording methods, all we can do is seek a method that more closely simulates natural exposure.
- Sunlight is modeled by xenon lamps in light stability tests. Similarly, modeling gas fading with ozone gas alone may be a valid approach.
- We closely investigated Fujifilm's ozone gas test results and Canon's mixed-gas test results obtained in round robin testing. The two sets of results were found to be well correlated; no particular advantage to the mixed-gas test was discovered. Consequently, the ozone gas test was thought to be valid for our purposes, as it involves less expense in terms of equipment. It is hoped that the results of the round robin tests and the preamble to the selection of the ozone gas test will be noted in the Annex or Introduction of the **JEITA** standard document.

After further debate on the positions given above, adoption of the ozone gas method as the gas test method in the **JEITA** standard was approved by vote.

2.2 Thermal stability testing

This PG considered how to handle digital color photo prints produced by sublimation transfer methods; prints that, because of their inherent characteristics, cannot be evaluated with the Arrhenius method at high temperatures. The PG decided to propose the following test method governed by **JEITA** conditions, as described below. The specific difficulty with some photo print specimens of this type is due to their low glass transition temperature (Tg); they demonstrate aging factors when exposed at actual room temperatures that are significantly different from the aging factors seen in accelerated tests performed at higher temperatures. As a result, accurate print life calculations cannot be made. Furthermore, the deterioration rate of some specimens is very slow, requiring considerable time to reach the stipulated endpoint and making print life predictions impractical.

In consideration of these aspects, a choice from the following test conditions and print-life calculation methods was permitted.

(I) **ISO conditions** (**ISO 18909** compliant, test temperature range: 20 °C or more, endpoint is as specified)

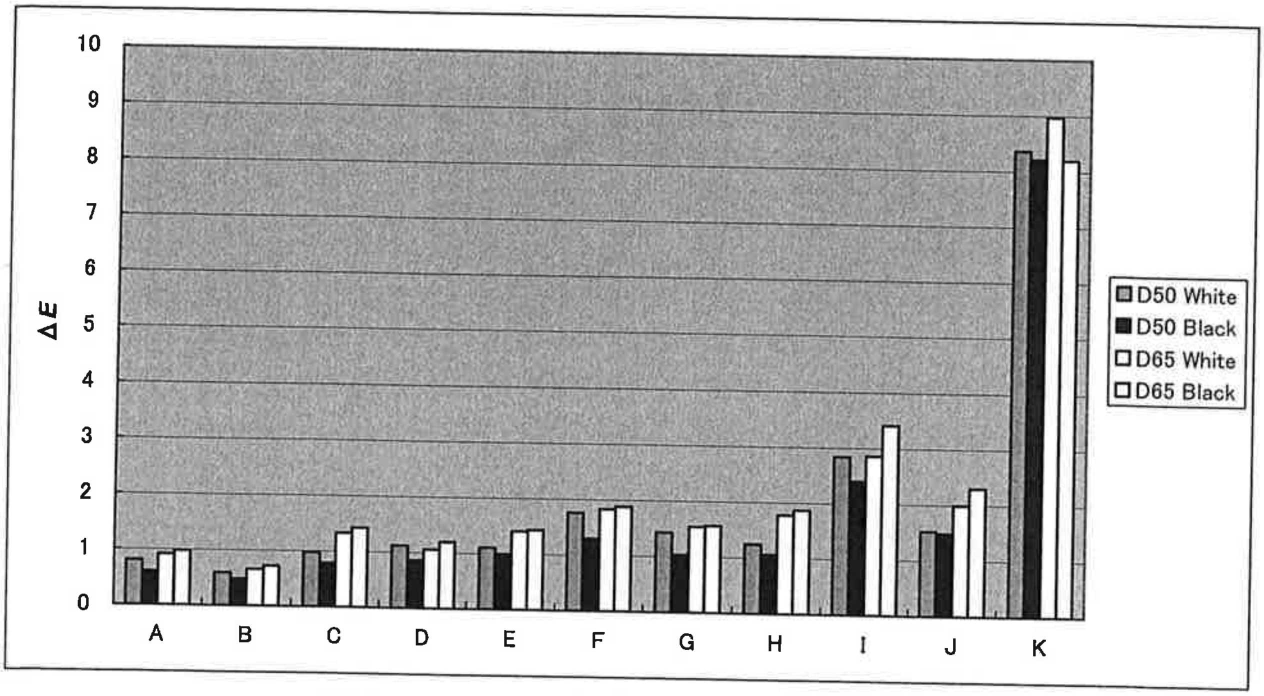
(II) **JEITA conditions** (test temperature range: 15 °C or more, endpoint: either as specified, at 1/2 the specification, or at 1/3 the specification)

2.3 Study of backing materials in color measurements

The PG investigated color measurement conditions since it decided to measure the yellow discoloration of white patches in indoor thermal stability tests as a color change (color differential) instead of as a density change. It was permitted for each company to use different conditions for light source and backing. We thus prepared prints before and after thermal deterioration, and measured color combining white and black backing on the non-image portions, and D50 and D65 light source color temperatures. **Discussion Figure 1** shows the difference before and after deterioration due to the color measurement conditions of ΔE. Based on these results, the PG concluded the following:

- The combination of D50 and a black baking tends to give lower measurement values for ΔE, while the combination of D65 and a black backing tends to give higher measurement values. Nevertheless, the differences low (1 or less), and are within the variation tolerance (the three-point average).
- Print life is expressed in years, and there is no absolute value for color difference. It is therefore not necessary to restrict the light source or backing.

After this discussion, the PG decided to allow a color temperature of either D50 or D65 as the light source, and either white or black backing in color measurements.



Discussion Figure 1 – Comparison of Δ*E* values

2.4 Scope of the Standard

Opinions on the Standard's scope — What is the definition of a household-use printer? Are A3 printers included? Are all digital color photo prints covered or just some? Is there a need to limit paper types, sizes, thicknesses, or media? — were divided throughout the standardization process, from initial deliberations to the final stages. The current scope stipulated in the Standard was arrived at after concluding it was best not to have strict limits since the Standard concerns testing methods.

After this standard was created, some companies stated that they wished to use it for evaluating digital color photo prints output with other than household-use printers (e.g. inkjet printers larger than A3 Extra), and the Digital Photo Print Stability Standardization G discussed the issue again. The group reached an agreement that companies could use this standard as a reference at their discretion for printers capable of printing sizes enjoyed in the home (e.g. A4), using the printing technologies described in the scope.

2.5 Direction of ISO Standardization

Discussion Table 1 summarizes the main differences between the trends in **ISO** standards currently being drafted, and this **JEITA** Standard. The description of the **ISO** standard in **Discussion Table 1** is current as of the Washington meeting held on May 17, 2007, and also reflects the status as of the Tokyo meeting held on October 6, 2009, immediately before the standard was amended. In particular, the method for determining the print life was reopened for discussion, and it is expected that debate over this topic, including whether to allow conversion of print life, will continue for some time.

Discussion Table 1 – Summary of main differences between the JEITA Standard and planned descriptions in the ISO working draft/committee draft

Item	JEITA Standard	ISO Working Draft/ Committee Draft (As per Tokyo meeting on Oct. 16, 2009)	ISO Working Draft (As per Washington meeting on May 17, 2007)
Print-life conversion method			
Print-life endpoint (color)	30 % OD loss	To be determined	40 % OD loss
Print-life endpoint (imbalance)	15 % difference in OD loss	To be determined	20 % difference in OD loss
Print-life determination areas	YMCK	To be determined	YMCK, RGB
Light stability calculation conditions	1 level: 250 lux × 12 hours	To be determined	2 levels: 125 lux × 12 hours and 500 lux × 12 hours
Ozone stability calculation conditions	40 ppm/*hr/year	To be determined	50 ppm*hr/year
Testing methods			
Light stability test conditions	UV filter required	UV filter required	UV filter optional
	IR filter optional	IR filter optional	The predominant opinion is that an IR filter is required in practice
	Test chamber temperature: 20 ± 5 °C	Being examined (prescribing temperature at surface of sample rather than chamber temperature being considered)	Test chamber temperature: 23 ± 2 °C
	Black panel temperature: no more than 40 °C	Can select from BPT or WPT. Specific numbers being considered.	BPT 23 ± 2 °C
Ozone stability test conditions	Gas concentration: 1 - 5 ppm ± 10 %	Gas concentration: 1 ppm ± 10 %. If reciprocity failure is confirmed, however, can be set up to 5 ppm.	Gas concentration: 1 - 5 ppm ± 0.1 ppm (however, examining the use of a 5 % tolerance at ± 5 ppm)
	Test chamber temperature: 23 ± 2 °C	Test chamber temperature setting: 23 ± 2 °C	Test chamber temperature setting: 23 - 27 ± 2 °C
Thermal stability test conditions	Possible to calculate a provisional print life at one-half and one-third of the Dmin endpoint	If color change is detected, the endpoint is user-defined.	Examining the possibility of using the **JEITA** condition given on the left
	A minimum temperature interval of 15 °C is permitted	Minimum temperature interval: no less than 20 °C	Minimum temperature interval: no less than 20 °C
Test humidity	50 %RH	50 %RH	Provisionally 50 %RH (some manufacturers have suggested 65 %RH, but 50 %RH is the leading opinion)
Sample preparation			
Targets	Format: JPEG Number of steps: 16 Initial density fluctuation tolerance: 10 % Profile: not used Driver: set as recommended by the manufacturer	Format: Tiff, sRGB Number of steps: 48 Initial density fluctuation tolerance: 10 % if there is no interpolation, 20 - 30 % otherwise Profile: used Driver: Photo best mode	Format: Tiff Number of steps: TBD Initial density fluctuation tolerance: Gray: 0.05, YMCK RGB: 0.10 Profile: used Driver: setting that gives the reproduction that is the closest to the original file

3 Objective and Intent of Amendments

3.1 Background and Intent of Amendments

When **JEITA CP-3901** was drafted, when drafting **Section 9 (test method — indoor thermal stability)**, consideration was given to such issues as Tg of dye-sublimation printers, and the fact that it takes a long time to reach an endpoint because recent inkjet printers have low wear. It was thus decided to introduce certain methods not originally in **ISO**, such as “test temperature range of 15 °C”; “1/2 endpoint method”; and “1/3 endpoint method”.

Nevertheless, after **JEITA CP-3901** was issued, when various parties began to consider the implementation and adoption of the standard, it was noted that even if the “1/2 endpoint method” or “1/3 endpoint method” is selected in compliance with **Section 9.4 (Test Condition (II) JEITA compliant)**, the test time is too long (e.g. one year or more). In light of the fact that the commercialization cycle of new products today is quite short, sometimes less than one year, users will be disadvantaged by not being able to obtain any information about the indoor thermal stability of their products, unless conditions are provided enabling evaluation over a shorter time span.

In light of the above circumstances, a supplementary version was created enabling the selection of a print-life calculation method using data from ongoing tests (intermediate values); this was approved by the Technical Standardization Committee on AV & IT Devices in August 2008 and published.

As described above, **JEITA CP-3901** was created in November 2007, and a supplementary edition was published within one year of that. This supplementary edition, however, was identified as having significant importance as an evaluation method, and when it was approved by the Technical Standardization Committee on AV & IT Devices, it was noted that there was a need to incorporate it into the main text as early as possible; this amendment to the standard is a result. In addition to incorporating the supplementary edition into the main text, the present amendment also contains amendments to bring it in line with the current situation, based on records of testing performed by various companies (e.g. changing the use of UV-blocking filters from recommended to mandatory), and **Discussion Table 1** was also updated to bring it into line with progress in **ISO**.

JEITA CP-3901 was originally created as a Japanese standard until an **ISO** standard could be created. As summarized in **Discussion Section 2.5** (Direction of **ISO** Standardization), however, **ISO** continues to debate the method for converting print life, and no date has been determined for the conclusion of this discussion. For this reason, companies are expected to continue to make effective use of **JEITA CP-3901** for some time to come.

4 Discussion of the Annexes

Annex 1 (informative): Bibliography
Annex 2 (normative) : Test charts
Annex 3 (informative): Specifications of filters used in light stability evaluations
Annex 4 (informative): Stability test methods for digital color print photos

5 Conformance with Corresponding International Standards

None

6 Organization of the Standard Drafting Committee

This standard has been prepared by the Digital Print Media Stability Evaluation PG under the Digital Camera Standardization G. The standard was approved by the Technical Standardization Committee on AV & IT Devices in November 2007.

<AV&IT Appliance Standardization Sub-committee>

Chairperson	Toshimitsu Umezawa	Toshiba Corporation

<Digital Camera Standardization Group>

Chief examiner	Takashi Sakaguchi	Matsushita Electric Industrial Co., Ltd.

<Digital Color Photo Print Media Stability Evaluation Method Studying Project Group>

Leader	Hiroko Hayashi	Seiko Epson Corporation
Group members	Yoshiro Udagawa	Canon Inc.
	Kazuo Kato	Konica Minolta Technology Center, Inc.
	Hideki Sekiguchi	Sony Corporation
	Minoru Ariyama	Dai Nippon Printing Co., Ltd.
	Takahito Kabai	Toshiba Tec Corporation
	Masami Nakagawa	Panasonic Communications Co., Ltd.
	Osamu Ide	Fuji Xerox Co., Ltd.
	Yukihiko Kanazawa	Fujifilm Corporation
	Masaya Fujioka	Brother Industries, Ltd.
	Nobuzumi Kurihara	Mitsubishi Electric Co.
	Shigeaki Kimura	Ricoh Company Ltd.
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	Ryuichi Arai	Canon Inc.
	Hirofumi Ichinose	Canon Inc.
	Kumiko Taguchi	Konica Minolta Technology Center, Inc.
	Kishio Tamura	Konica Minolta Technology Center, Inc.
	Shinichi Kato	Seiko Epson Corporation
	Hitoshi Saito	Dai Nippon Printing Co., Ltd.
	Takanori Kitagawa	Panasonic Communications Co., Ltd.
	Hiroshi Goto	Ricoh Company Ltd.

7 Organization of the Standard Revising Committee

This standard has been revised by the Digital Photo Print Stability Standardization G under the Digital Camera Standardization G (shown below). The standard was approved by the Technical Standardization Committee on AV & IT Devices in February 2009.

<AV&IT Appliance Standardization Sub-committee>		
Chairperson	Satoshi Kageyama	Panasonic Co., Ltd.
<Digital Camera Standardization Group>		
Chief examiner	Takashi Sakaguchi	Panasonic Co., Ltd.
<Digital Photo Print Stability Standardization G>		
Chief examiner	Shinichi Kato	Seiko Epson Corporation
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