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**Imaging materials — Reflection colour  
photographic prints — Test print  
construction and measurement**

*Matériaux pour l'image — Réflexion des impressions photographiques  
en couleurs — Mesurage et construction d'une impression d'essai*

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 18944 was prepared by Technical Committee ISO/TC 42, *Photography*.

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## Introduction

This International Standard is one of a series of International Standards prepared by ISO/TC 42 on the physical properties, stability and permanence of imaging materials.

This International Standard provides constraints on factors pertaining to target print preparation and resulting target print measurement which can cause a confounding test-process-induced variation in measured colour values and densities.

The requirements in this International Standard are intended to be used with test methods that produce test data to be shared publicly, with the aim that test results can be duplicated in an alternate test facility.

Topics addressed include:

- description of test types (image print stability testing versus image forming materials testing);
- digital file preparation;
- digital test file usage;
- addressing target print uniformity;
- managing test equipment non-uniformity;
- print system configuration and control;
- test print conditioning;
- measurement timing and measurement conditions;
- required sRGB encoded patch set for image print stability test target and the corresponding patch selection process;
- informative guidance for test file construction and use;
- informative guidance on statistical approaches to minimize measurement error.

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# Imaging materials — Reflection colour photographic prints — Test print construction and measurement

**IMPORTANT** — The electronic file of this International Standard contains colours which are considered to be useful for the correct understanding of this International Standard. Users should therefore consider printing with a colour printer.

## 1 Scope

This International Standard specifies requirements and recommendations for the digital test file content, number of print replicates, printer setups and printing procedures that are used to generate target prints for test method standards and specifications for image stability in the context of reflection colour photographic prints.

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 5-3, *Photography and graphic technology — Density measurements — Part 3: Spectral conditions*

ISO 5-4, *Photography and graphic technology — Density measurements — Part 4: Geometric conditions for reflection density*

ISO 2471:2008 *Paper and board — Determination of opacity (paper backing) — Diffuse reflectance method*

ISO 11664-4, *Colorimetry — Part 4: CIE 1976 L\*a\*b\* Colour space*

ISO 12640-3, *Graphic technology — Prepress digital data exchange — Part 3: CIELAB standard colour image data (CIELAB/SCID)*

ISO 13655, *Graphic technology — Spectral measurement and colorimetric computation for graphic arts images*

ISO 18941, *Imaging materials — Colour reflection prints — Test method for ozone gas fading stability*

IEC 61966-2-1, *Multimedia systems and equipment — Colour measurement and management — Part 2-1: Colour management — Default RGB colour space — sRGB*

TIFF, Revision 6.0. Adobe Systems Incorporated 1992  
<http://partners.adobe.com/public/developer/en/tiff/TIFF6.pdf>

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

### 3.1

#### **CMYK printer**

printer configured to accept digital files with colours encoded for CMYK printer colourants and print without further colour conversion

### 3.2

#### **image forming materials stability test**

test to evaluate the print stability of the component materials that comprise image prints, intended for manufacturers who are designing new colourants or for customers who are specifying colourant characteristics

**3.3**  
**image print stability test**

test to evaluate the print stability of images printed in end-user-typical fashion

**3.4**  
**operational control point**

set point for equilibrium conditions measured at sensor location(s) in an exposure device

NOTE Adapted from ASTM G 113.

**3.5**  
**operational fluctuations**

positive and negative deviations from the setting of the sensor at the operational control set point during equilibrium conditions in a laboratory-accelerated weathering device

NOTE 1 The operational fluctuations are the result of unavoidable machine variables and do not include measurement uncertainty. The operational fluctuations apply only at the location of the control sensor and do not imply uniformity of conditions throughout the test chamber.

NOTE 2 Adapted from ASTM G 113.

**3.6**  
**operational uniformity**

range around the operational control point for measured parameters within the intended exposure area within the limits of intended operational range

NOTE 1 Operational uniformity evaluates the measured parameters throughout the volume of a test chamber so that regions of the test chamber volume can be determined to comply within the required stated limits of the measured parameter operating aim.

NOTE 2 Adapted from ASTM G 113.

**3.7**  
**RGB printer**

printer configured to accept digital files with RGB printer-independent encoded colours and apply a conversion to obtain printer colourant code values

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**3.8**  
**uncertainty (of measurement)**

parameter associated with the result of a measurement that characterizes the dispersion of the values that could be reasonably attributed to the measurand

NOTE 1 The parameter may be, for example, a standard deviation (or a given multiple of it), or the half-width of an interval having a stated confidence level. Uncertainty of measurement comprises, in general, many components. Some of these components may be evaluated from statistical distribution of the results of series of measurements and can be characterized by experimental standard deviations. The other components, which can also be characterized by standard deviations, are evaluated from assumed probability distributions based on experience or other information. It is understood that the result of the measurement is the best estimate of the value of the measurand, and that all components of uncertainty, including those arising from systematic effects, such as components associated with corrections and reference standards, contribute to the dispersion.

NOTE 2 Adapted from ASTM G 113.

**4 Requirements**

This International Standard specifies constraints on factors pertaining to target print preparation and resulting target print measurement which can cause confounding test-process-induced variation of measured colour values and densities. The requirements of this International Standard shall be applied in test methods that are used to make life expectancy claims, such as time-based print lifetime claims, either comparative or absolute, in accordance with the applicable International Standard(s) for specification of print life.



The requirements of this International Standard should be applied with image stability test methods when those test methods are used to report stand-alone absolute or comparative stability of image materials with respect to the specific failure mode of the test method standard.

In alternative test situations, when the conditions and constraints set forth in this International Standard are not followed, then the test report of that test method result shall include a statement of each condition that differs from the requirements of this International Standard. Caution shall be used when comparing test results for different materials and for different target print preparation and measurement conditions. Comparisons shall only be made when using equipment with matching specifications, under matching test conditions.

## 5 Digital file preparation

### 5.1 Digital test file usage situations

For general testing purposes, users of this International Standard are free to choose whatever target patches and starting densities they feel are appropriate for their testing needs. Applicable International Standard(s) for specification of print life may require the use of specific targets and starting densities.

Reference target prints should be included in every exposure test to track consistency of the test procedures, as well as to detect unintended changes in test conditions.

NOTE 1 See ASTM G156.

The target prints of this International Standard can be used for two kinds of image stability testing:

- 1) a printing system test for image print stability, including substrate discolouration, or
- 2) a materials test for image forming materials stability (colourant stability and substrate discolouration).

The digital test file is adapted and the target prints are generated differently for these two cases. After the digital test file is printed, when subjected to the test method standards, the target prints are treated identically.

The *image print stability test* assesses the stability of images printed in end-user-typical fashion. The test file in this case is encoded in standard sRGB, as defined in IEC 61966-2-1.

NOTE 2 The sRGB colour encoding is widely used in digital photography. This is a particular RGB encoding that has a standardized visual colour meaning for each RGB code value. The standardized colour meaning for each sRGB code value means that “sky blue” and “grass green”, etc. are represented by certain RGB code values. Because the sRGB colour encoding is well known, printers that print digital photographs can be configured to print sRGB encoded images. Printing sRGB code values that have standardized colour meanings of cyan, magenta, yellow, red, green, blue and neutral will result in target print patches that have colourant proportions similar to consumer image prints of those colours produced through the specific print system.

Real world image print stability is a function of combinations of colourants in real images. Colourant proportion significantly impacts the results of the stability tests. Using colourant proportions similar to those in consumer prints for specific well defined colours improves estimation of consumer image stability. The print colourant proportions in the image stability target print will be slightly different for different print systems, however in each case the target print is a realistic representation of the colourant proportions in real photos printed via those printers.

Printing the primaries and secondaries and neutrals does not cover all possible kinds of inks that a printer may contain. Testing for additional colourants is a recommended extension for both the image print and image forming materials.

The *image forming materials stability test* assesses the stability of the component materials that comprise the prints. Care is taken to isolate the materials from influences of the print system as far as is possible.

NOTE 3 This test is intended for manufacturers who are designing new inks or for customers who are specifying ink characteristics, and require testing on individual components.

## 5.2 Digital test file general requirements

Print systems can be configured either to accept digital files with colours encoded for the printer colourants, such as CMYK, or to accept digital files with colours defined using a printer-independent encoding, such as sRGB. Printers that are configured to accept an RGB printer-independent encoding can process the conversion from the input RGB to the printer colourant encoding in a proprietary manner. These printers can be referred to as “RGB printers”. Printers that can be configured to accept (and print without further colour conversion) digital files with colours encoded for CMYK printer colourants can be referred to as “CMYK printers”. The file preparation process below describes the necessary file treatment for RGB and CMYK printers.

The digital test file of encoded colour values shall be constructed so that the target print contains areas of uniform colour (i.e. patches) corresponding to each selected optical density (recommended 0,5; 1,0; and 1,5). The size of each square colour patch area shall be at least 2 mm greater in length and width than the measurement instrument aperture, plus twice the measurement instrument positioning accuracy specification, according to the following equation:

$$S = 2 + (2 * A) + D$$

where:

*S* is the minimum size of each square colour patch area, in millimetres;

*A* is the measurement instrument “measurement positioning accuracy” specified by the instrument manufacturer, in millimetres;

*D* is the measurement instrument “measurement aperture diameter” specified by the instrument manufacturer, in millimetres.

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For example, with a measurement positioning accuracy of  $\pm 0,25$  mm and a measurement aperture diameter of 4,5 mm, the minimum allowed patch size =  $(2,0 + 0,50 + 4,5)$  mm, which is 7 mm<sup>2</sup>. Spacing between patches shall be adjusted to minimize degrading influence between patches during the testing and measurement processes. The appropriate inter-patch spacing depends on the materials and the equipment used.

The digital test file shall produce target print patch areas of minimum density (i.e. paper white).

The digital test file shall produce target print patches of selected optical densities utilizing cyan, magenta, yellow and black printer colourant primaries, and utilizing red, green and blue printer secondaries.

The digital test file shall produce target prints with individual patches having the selected optical densities within the required “single patch” tolerance limits, or with pairs of “bracketing patches” having the selected optical densities within the required “bracketing pair” tolerance limits, according to the requirements of Annex A. In the case of bracketing patch pairs, the selected optical density values shall be obtained using interpolation as described in Annex B.

The digital test file shall be created and maintained continuously in the tiff file format. No lossy image or file compression shall be applied to the target file. The digital image file resolution shall be 600 dpi.

NOTE 1 Various lossy compression methods can result in slight changes to colour values, particularly at patch edges. This in turn can result in additional undesirable mixing of colourants. At the time of writing of this International Standard, the tiff file format provides the means to carry raster image content in digital files with minimal host application and operating system dependence.

NOTE 2 The digital test file can be zipped using lossless compression to minimize file size for storage.

Digital test files defined in compliance with this International Standard can be designed and adapted for particular printing systems in any of the available image programs (such as Adobe Photoshop®<sup>1)</sup>). Ensure that the image resolution is 600 dpi after editing.

### 5.3 Preparing the digital test file for an image print stability test

#### 5.3.1 Constructing the digital file for an image print stability test

The image print stability digital test file shall be encoded in sRGB as defined in IEC 61966-2-1 and saved in the tiff format with the sRGB ICC profile embedded.

NOTE 1 Even though sRGB is a standard, the ICC profiles for sRGB can differ. Retaining the original sRGB ICC profile with the file contributes to test repeatability.

For image print stability testing, the encoded colour values of the patches in the digital test file shall not be manipulated to control the colourant proportions in the patches of the target print. Rather, the objective is to obtain cyan, magenta, yellow, red, green, and blue coloured patches in the target print that are typical in a pleasing pictorial image. Pure primary colourant patches and two-colourant secondary patches may or may not occur in the print. When subjected to an image print stability test method, the measurable target print patch density changes can be compared to image print changes that a user would experience. See Annex A and Annex C.

Colourant proportions in the image print stability target print are recognized as system-specific, dependent on image processing, ICC profiles, halftoning, and other physical printer characteristics.

The image print stability test requires target prints with selected optical densities in:

- a) neutral patches;

NOTE 2 Patches that are treated as neutral are produced from sRGB encoded patch values that equate to CIELAB values with  $L^* > \text{zero}$ ,  $a^*$  and  $b^*$  zero, i.e.  $R=G=B$ .

- b) cyan, magenta, and yellow-coloured patches;

- c) red, green, and blue-coloured patches;

- d)  $D_{\text{min}}$  patch (i.e. paper white) area (used to evaluate substrate discolouration).

NOTE 3 Additional coloured patches, e.g. black, orange, and flesh tones, can also be tested, although such test patches are not within the scope of this International Standard.

In certain cases, the printer driver software may provide an option to assign neutral code values exclusively to the black ink. Composite neutral black printed with cyan, magenta and yellow colourants shall be used.

#### 5.3.2 Adapting the digital file for an image print stability test — RGB printers

The image content shall be encoded in sRGB as defined in IEC 61966-2-1. An sRGB digital test file shall be constructed using the required sRGB patch values provided in Annex A, or a selected subset of those required sRGB patch values. Whether used in whole or in part, the sRGB code values of the patches given in Annex A shall not be changed prior to printing.

#### 5.3.3 Adapting the digital file for an image print stability test — CMYK printers

The image content shall be encoded in “device CMYK” that is specific to the printer under test. The device CMYK digital test file for the specific printer under test shall be obtained from an sRGB digital test file constructed using the required sRGB patch values provided in Annex A, or a selected subset of those required sRGB patch values. The CMYK encoded digital test file shall be obtained for the specific printer under test using the photo print colour management transformation method that is appropriate for consumer users of the printer. For

1) Photoshop is the trade name of a product supplied by Adobe. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

example, an ICC profile provided by the printing system manufacturer and matched to the print conditions and media of the test can be used. Whether used in whole or in part, the sRGB code values of the patches given in Annex A shall not be changed prior to conversion to CMYK for the printer under test; and the resulting printer-specific CMYK code values shall not be changed prior to printing.

When the image print stability of a specialized configuration of a printing system is being tested, e.g. prints produced using a specialized configuration in a professional or commercial print environment, a customized ICC profile may be used. Such a customized ICC profile shall be appropriate to produce end-customer quality printing in the configuration under test. The use of any such ICC profile shall be reported in the test results.

## 5.4 Preparing the digital test file for an image forming materials stability test

### 5.4.1 Constructing the digital file for an image forming materials stability test

For digital print systems, the image forming materials stability test is used to test the stability of the component materials that comprise digital prints. For example, one cyan dye may exhibit greater resistance to light fade than another. When testing for primary colourant stability (e.g. C, M, Y, K colourants), it is ideal that each colourant be printed in a pure form isolated from other colourants. Colourant interactions can produce catalytic fading effects, whereby a primary colourant in a multi-colourant patch will fade at a different rate than would be observed had the colourant been printed alone. Additionally for image forming materials stability tests, secondary (mixed) colour patches (e.g. a red patch comprised of magenta and yellow colourant) are ideally comprised of equal amounts of two respective primary colourants, as it is known that any variance in these proportions can result in differing rates of catalytic change. In the image forming materials stability test, “test ready” target prints shall be produced after careful manipulation of the digital test file colour code values so that pure printer colourant primaries and correctly proportioned printer colourant secondaries are produced in the target print for each of the selected optical densities. Evaluation of preliminary printer assessment prints, using, for example drop count measurements and high resolution inspection, can be useful to determine the colour code values that produce pure (or closest to pure) colourant primaries and correctly proportioned colourant secondaries through a given system (see Annex D). Target print generation can also include such steps as selectively removing and replacing ink cartridges or tanks, cutting and splicing the thermal donor, etc., to achieve a desired effect in isolating specific colourants.

The image forming materials stability test requires target prints with selected optical densities in:

- a) neutral patches containing equal proportions of the printer primary colourants cyan, magenta, and yellow;
- b) patches containing isolated primary (pure) printer colourants (e.g. pure cyan, magenta, yellow and black colourants);
- c) patches containing isolated secondary (two equally proportioned primary colourants) printer colours (e.g. red, green and blue colour patches, each comprised of equal proportions of two printer primary colourants).

As far as is achievable in the printing system under test, isolated C, M, Y, K colourant primaries shall be tested. As far as is achievable in the printing system under test, secondaries of R, G, B, each comprised of equal parts of two colourant primaries, shall be tested. The colourant proportion is required, whereas exact colour hue and colourfulness are not. Additional primary and secondary colourant patches (e.g. red and green primaries and their associated secondaries) can be tested as needed to address specific system capabilities, understanding that these capabilities may or may not apply to all or any other printing systems (see Annex D).

### 5.4.2 Adapting the digital file for an image forming materials stability test — RGB printers

The RGB image forming materials stability digital test file shall be encoded in sRGB as defined in IEC 61966-2-1 and saved in the tiff format with the sRGB ICC profile embedded.

NOTE Even though sRGB is a standard, the ICC profiles for sRGB can differ. Retaining the ICC profile with the file contributes to test repeatability.

The image content shall be encoded in sRGB as defined in IEC 61966-2-1. The RGB printer case presents challenges for the image forming materials stability test due to the lack of direct control over the printer colourants. Adapt and evaluate the digital test file and the resulting assessment print using the print system