
**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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Contents

	Page
Foreword.....	iv
Introduction.....	v
1 Scope	1
2 Normative references	1
3 Terms, definitions and symbols	1
3.1 Terms and definitions.....	1
3.2 Symbols.....	2
4 Requirements	2
5 Digital file preparation	2
5.1 Digital test file usage situations.....	2
5.2 Digital test file general requirements.....	3
5.3 Preparing the digital test file.....	3
5.3.1 Constructing the digital file.....	3
5.3.2 Adapting the digital file.....	4
5.4 Target print uniformity.....	4
6 Generating the target prints	4
6.1 Digital print preparation.....	4
6.2 Source preparation for conventional silver gelatine photographic materials.....	4
6.3 Configuring the printing system and generating the target prints.....	4
6.4 Conditioning the prints after printing.....	5
7 Target print holding and measurement conditions	5
7.1 Measurement timing.....	5
7.2 Holding and measurement conditions.....	5
8 Measurement of test patches	6
8.1 Measured attributes.....	6
8.1.1 General.....	6
8.1.2 Density attributes to be measured.....	7
8.1.3 Colorimetry values to be measured.....	7
9 Calculation of colour changes	7
9.1 General.....	7
9.2 Percent density change in primary colour patches.....	7
9.3 Percent density change in secondary (mixed) colour patches.....	8
9.4 Percent density change in composite neutral patch.....	8
9.5 Colour balance shift in composite neutral patch.....	8
9.6 Colour balance shift in secondary (mixed) colour patches.....	8
9.7 Colour balance in D_{\min} patches by colorimetry.....	9
10 Reporting	9
10.1 General.....	9
10.2 Test report.....	9
Annex A (normative) Required sRGB encoded patch values for test targets, tolerance in optical density (OD) and patch selection process	10
Annex B (informative) Method of interpolation for step wedge exposures	19
Bibliography	20

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html. (standards.iteh.ai)

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

This third edition cancels and replaces the second edition (ISO 18944:2014), which has been technically revised.

The main changes compared to the previous edition are as follows:

- the document structure has been simplified in order to be better understood by users;
- definitions for measurement condition, colour attributes measured and calculations of colour changes have been included.

Introduction

This document is one of a family of International Standards on the physical properties, stability and permanence of imaging materials.

This document 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 document 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:

- digital file preparation;
- digital test file usage;
- target print uniformity;
- printing system configuration and control;
- test print conditioning;
- measurement timing and measurement conditions;
- sRGB encoded patch value for test targets and the corresponding patch selection process;
- densitometric and colorimetric calculations for colour changes.

Test target design and test print preparation are important elements in the characterization of image stability of prints, namely changes in colour attributes such as discoloration of D_{\min} as well as lightness, hue and chroma changes in colour and neutral patches.

A test target realizes a specific sampling of colours from colour space that is representative for characterization of image stability in the envisaged use case. Other important elements in that characterization process are the definition of colour attributes the changes of which are evaluated and the construction of a metric as well as the choice of the statistical assessment of data analysis, such as choice of average, median or maximum changes of either individual colours or all colours. Unless a psychovisual correlation with observer judgments have been implemented, measured changes have *ad hoc* character.

In this document, the definition and the calculation of changes in colour attributes of colour and neutral patches are expressed in terms of densitometry, whereas discoloration of D_{\min} is characterized colorimetrically. Changes in colour attributes evaluated with the target and definition of colour attributes in this document are intended to feed an end point system that can be used in image life specification under development in the series of print life specification standards. Previously, the definitions of colour attributes were included in the various test methods which are now consolidated into this document.

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

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

1 Scope

This document specifies requirements and recommendations for the digital test file content, 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.

Furthermore, this document defines measurement procedures of the test patches as well as how changes of colour attributes are calculated in the course of a given image stability test.

Definition of the statistical procedure for data reduction and the translation of those changes into psychophysical end point levels does not belong to the scope of this document, but results obtained with the methods defined in this document can feed into the appropriate statistical evaluation and end point systems of a print life specification defined in other documents.

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2 Normative references (standards.iteh.ai)

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 11664-4, *Colorimetry — Part 4: CIE 1976 L*a*b* Colour space*

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

ISO 18913, *Imaging materials — Permanence — Vocabulary*

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*

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 18913 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1.1

printing system

system to generate reflection colour photographic prints, including printing colorants, printing equipment hardware and software, and typically the print media

3.1.2

RGB printer

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

3.2 Symbols

Symbol	Definition
D_{\min}	optical density of the unprinted substrate
D_{\max}	maximum optical density aim chosen for the test

4 Requirements

This document 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 document shall be applied in image stability test methods that are used to characterize changes of a print material due to a specific failure mode, or 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 analysis of colour changes in the course of image stability testing requires the following.

- a) A definition of how test colours are sampled in colour space in a way representative for the use case. This results in a specific design of a test target as given in this document.
- b) A definition of how colour changes are determined, which represents a specific colour distance metrics. In this document, changes in colour and neutral patches are measured densitometrically and discoloration of D_{\min} is characterized with colorimetry.
- c) A definition of the statistics that is applied to translate the calculated colour changes into end point levels, e.g. average, media or maximum colour change for a selection of starting density values over all colours or per colour. The statistics are not defined in this document but are given by appropriate specifications of print life or characterizations of single failure mode.
- d) A correlation of end point levels to visual perception. The necessary establishment of (potentially different) tolerance sets for each colour is an important limitation. Such end point levels system is not defined in this document but is given by an appropriate specification of print life.

5 Digital file preparation

5.1 Digital test file usage situations

For general testing purposes, users of this document 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 is likely to require the use of specific targets and starting densities.

The digital test file is designed to assess 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.

5.2 Digital test file general requirements

Printing systems can be configured to accept digital files with colours encoded for the printer colourants, 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”. The file preparation process below describes the necessary file treatment for RGB.

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 large enough to cover measured area plus positioning error. The appropriate size depends on the equipment used. Aperture size requirement shall comply with the geometric conditions in ISO 5-4.

The digital test file shall incorporate target print patch areas of minimum density.

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 patch pair” tolerance limits, according to the requirements of [Annex A](#). In the case of a set of bracketing pair patches, the targeted optical density value shall be obtained using interpolation of measured values of the pair patches as described in [Annex B](#).

No lossy image or file compression shall be applied to the target file. Digital file shall be prepared to fit the native resolution of the printer or by scaling to size with integer numbers.

NOTE 1 A 120 dpi test file is a good starting point, as it can be scaled by integer factors to current printer resolutions such as 600 dpi, 720 dpi and 1 440 dpi.

NOTE 2 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 publication of this document, the tiff file format provides the means to carry raster image content in digital files with minimal host application and operating system dependence.

NOTE 3 The digital test file can be zipped using lossless compression to minimize file size for storage.

Digital test files defined in compliance with this document can be designed and adapted for particular printing systems in any of the available image programs [such as Adobe Photoshop®¹⁾].

5.3 Preparing the digital test file

5.3.1 Constructing the digital file

The digital test file shall be encoded in sRGB as defined in IEC 61966-2-1 and use a data format that enables control of individual pixel RGB values with the sRGB ICC profile embedded and without image or file compression, such as TIFF.

Colourant proportions in a printed image are recognized as system-specific, dependent on image processing, ICC profiles, halftoning, and other physical printer characteristics.

The digital test file is required to include target prints with selected optical densities in:

- a) neutral patches;

NOTE Patches that are treated as neutral include white (no colourant printed), black and all values of grey produced from $R = G = B$ sRGB encoded patch values. Such sRGB values correspond to CIELAB values with $L^* \geq 0$, and a^* and b^* both equal to zero.

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

1) Adobe Photoshop® is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

- c) red, green, and blue-coloured patches;
- d) D_{\min} patch area (used to evaluate substrate discolouration).

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

5.3.2 Adapting the digital file

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.

5.4 Target print uniformity

The impact of the density non-uniformity in a target print or print-to-print, which is likely to affect the accuracies of density change measurement caused by exposure of the light, ozone, thermal, etc. should be minimized. Replicate prints should be printed and duplicate patches can be included within a single target print page.

6 Generating the target prints

6.1 Digital print preparation

If the printing system under test cannot accept the digital file created with the procedure described in [5.3](#), convert the digital file to the highest quality (e.g. least compressed) file format that the printing system can accept just prior to printing. Ensure that the required patch size is maintained in the converted printable file.

6.2 Source preparation for conventional silver gelatine photographic materials

Conventional silver gelatine photographic materials can be tested. Exposures can be controlled to produce desired print density values. Specific proportions of colourants cannot be directly controlled.

Sensitometrically-exposed specimens designed to achieve the selected optical densities in the target prints shall be processed using the processing system of primary interest and in accordance with the manufacturer's recommendations.

Processing chemicals and procedures can have a significant effect on the dark-keeping and light-keeping stability of conventional silver gelatine photographic materials. For example, a chromogenic colour negative print paper processed in a "washless" or "non-plumbed" system with a stabilizer rinse bath instead of a water wash is likely to have stability characteristics that are different from the same colour paper processed in chemicals requiring a final water wash or using a final water wash. Therefore, the specific processing chemicals and procedure shall be reported, along with the name of the colour product in any reference to the test results.

Stability data obtained from a colour material processed in certain processing chemicals shall not be assigned as belonging to colour material processed in different chemicals, or using a different processing procedure. Likewise, data obtained from colour materials that have been subjected to post-processing treatments (e.g. application of lacquers, plastic laminates, or retouching colours) shall not be assigned as belonging to colour material that has not been similarly treated, and vice versa.

6.3 Configuring the printing system and generating the target prints

When printing a test target, target prints shall be produced using driver and printer settings that are appropriate for photo printing. The printer manufacturer recommended print mode for photo printing

shall be used with each printer. When multiple print mode options are available for use with the selected photo paper, the print mode selection used shall be included in the test report.

If the colourant and substrate under test are not an OEM combination, then the closest matching media setup provided in the driver and printer settings (e.g. “generic glossy photo paper”) shall be chosen. As appropriate in the typical use of the printing system, ICC profiles provided by the printing system manufacturer for the test paper and test print conditions can be used in generating target prints. In such a case using ICC profiles, do not turn off colour management when initiating the print.

Photographic material shall be printed in accordance with the manufacturer’s recommendations. The manufacturer’s requirements regarding colourant and print media storage and pre-conditioning and print device operating environment shall be followed. Printed images used for test specimen shall be collected after the printing system reaches a steady-state.

The specific printing system configuration used to generate the target print, as far as it can be determined by the test operator, shall be reported with the test results. The digital test file, as used to generate the digital target prints, shall be included in the test report, and the measurement plan (e.g. single or bracketing patch measurements, use of duplicate patch pairs, and number of replicate prints) shall be described.

6.4 Conditioning the prints after printing

Aqueous and solvent inkjet prints, and prints of any types that require curing/stabilization/dry-down shall be conditioned for two weeks after printing, in an environment with a temperature of $(23 \pm 2) ^\circ\text{C}$, with a relative humidity (RH) of $(50 \pm 5) \%$. The print conditioning environment shall be ozone-free (≤ 2 nl/l average concentration over any 24 h period) for ozone-sensitive target prints, as determined in accordance with ISO 18941. During the conditioning period, the prints shall be maintained with unrestricted airflow. Prints of any types that do not require curing/stabilization/dry-down shall be held for 24 h. Measurements shall be conducted after conditioning or print hold. The required target densities shall be assessed after conditioning.

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7 Target print holding and measurement conditions

7.1 Measurement timing

After the required conditioning and before being subjected to image stability testing, the target prints are measured to determine initial patch density values.

7.2 Holding and measurement conditions

The measurement environment and target print holding environment can influence measured densities. Measurements and target print holding for measurement and next test phase preparation shall be conducted in a controlled environment with no time constraint, or can be conducted in a less controlled environment with a time constraint.

NOTE 1 Target print holding environment refers to the environment in which target prints are held in between test phases, such as before and after measurement, while the target prints are not in the active test environment.

The controlled environment, in which target prints can be measured and held with no time constraint, shall meet the following set of conditions: target prints shall be kept in dark for target print holding and in ambient illuminance on the target print surface no greater than 200 lx for measurement process, $(23 \pm 2) ^\circ\text{C}$, $(50 \pm 10) \%$ RH conditions, and ozone-free (≤ 2 nl/l average concentration over any 24 h period) for ozone-sensitive target prints.

Ozone sensitivity shall be determined in accordance with ISO 18941 and this document. A material that is not sensitive to ozone shall have demonstrated no measurable D_{\min} or printed patch colour change at ambient ozone exposure levels and measurement condition temperature and humidity, over time periods consistent with measurement and test staging time periods.