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Information and documentation — Permanence and durability of writing, printing and copying on paper — Requirements and test methods

Information et documentation — Permanence et durabilité de l'écriture, de l'impression et de la reprographie sur des documents papier — Prescriptions et méthodes d'essai

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Contents

Page

Foreword

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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 document 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).

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This document was prepared by Technical Committee ISO/TC 46, *Information and documentation*, Subcommittee SC 10, *Requirements for document storage and conditions for preservation*.

This second edition cancels and replaces the first edition (ISO 11798:1999), which has been technically revised.

The main changes are as follows.

— The reference material used for the testing of mechanical properties is defined and shall, prior to testing, be handled according to 4.5.

— CIELAB measurements replaces optical density measurements, i.e. evaluation of monocoloured printing shall be performed by CIELAB measurements. Accordingly, microdensitometers or densitometers are no longer needed.

— Testing of colour fastness (5.2 and 6.2) shall be followed to evaluate recording (monocoloured and multicoloured) for lightfastness (6.4), water resistance (6.5) and resistance to heat (6.8).

— Table 1 (see 5.1) presents, for printing devices, elaborated CIELAB lightness and colour shift requirements ΔL^*, Δa^*, Δb^* and, in addition, a new requirement of ΔE^*_{ab} (Euclidean distance between two CIELAB coordinates).

— Table 2 (see 5.1) presents, for pens and stamps, requirement of maximum CIELAB lightness change ΔL^*.

— Abrasion resistance (formerly referred to as *resistance to wear*) shall be evaluated by the degree of abrasion (6.7) and is determined by CIELAB measurements prior to, and after, abrasion.

— Detailed descriptions of specimen preparation for pens and stamps, three printout templates for specimen preparation from printers and copying machines and reporting forms are given in Annexes.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

It is of great importance that recording of images on paper which, during long-term storage in libraries, archives, and other protected environments, undergo little or no change in properties that affects its use. The documents must preserve their information content and, thus, enable information storage and information supply for the future. Accordingly, it is important to study the permanence and durability of recording on paper.

Writing materials and printing equipment meeting the requirements given in this document can be used in the preparation of paper documents intended for long-term storage and recurrent use. Such documents contain permanent and durable images, i.e. images likely to be stable and thus undergo little or no change in properties that influence legibility and the possibility of copying or converting the paper documents to other data carriers.

Permanent paper and archival paper, used in the preparation of documents, may differ widely in properties of importance for the quality and permanence of the image. Some properties of an image, such as abrasion resistance, depend on the combination of the image and the paper. The testing conditions of this document are chosen so that results, representative of most papers on the market to be used for a particular imaging process, shall be obtained.

In this document, the requirements are given in the following attributes:

— visual image colour strength and appearance;

— lightfastness;

— water resistance;

— transfer of recorded image;

— abrasion resistance;

— resistance to heat;

— effect of recording on the mechanical strength of the paper.

Experience has shown that images written with carbon black ink as well as printed images using commercial printing inks have proved to be consistently reliable. There are, however, many documents where acidic inks have affected the paper to such an extent that the paper has degraded. Images produced from dry or liquid toner are also susceptible to ageing problems.

Images printed with modern material and machinery are often completely different from old images with respect to composition and properties. The rapid development of new printing techniques makes this testing very important. One printing technology may be replaced by a newer technology within a few years on the market. Therefore, conclusions based on studies of old documents in libraries and archives are of limited use when discussing the permanence of modern documents.

Strictly speaking, the only way to test the permanence and durability of documents is to handle them and to store them under the relevant conditions for long periods of time. In practice, one can only rely on the observations made on documents kept for a few decades and evaluate the effect of factors known to influence the permanence and durability of the image. Therefore, the testing according to this document does not correlate to lifetime of documents, but rather the documents that satisfy the requirements can be stored for a long time in the future in archives and protected environments, probably for several hundred years.

Information and documentation — Permanence and durability of writing, printing and copying on paper — Requirements and test methods

1 Scope

This document specifies requirements and test methods for evaluation of the permanence and durability of writing, printing and copying on paper stored in libraries, archives, and other protected environments for long periods of time, in which the information recorded on paper must be retained but not necessarily the full artistic quality.

It is applicable to:

— images on white permanent paper according to ISO 9706 or ISO 11108;

— recording obtained from pens, stamps, copying machines and printers (that can produce monocoloured and/or multicoloured images).

It does not apply to:

— documents stored under harmful conditions, such as high humidity that promotes microbiological attack, excessive heat, radiation (e.g. light), high levels of pollutants, or the risk of water damage (or water contact). Since documents might be kept in non-protected environments before being transferred to protected environments, resistance to water and light is, however, of importance;

— legal documents, e.g. banking documents, where the authenticity is of primary interest;

— documents where the information contents are influenced by small colour changes;

— documents within the scope of ISO/TC 42, *Photography*.

2 Normative references

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 536, *Paper and board — Determination of grammage*

ISO 1924-2, *Paper and board — Determination of tensile properties — Part 2: Constant rate of elongation method (20 mm/min)*

ISO 2470-1, *Paper, board and pulps — Measurement of diffuse blue reflectance factor — Part 1: Indoor daylight conditions (ISO brightness)*

ISO 4892-2, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps*

ISO 5626, *Paper — Determination of folding endurance*

ISO 9352, *Plastics — Determination of resistance to wear by abrasive wheels*

ISO 9706, *Information and documentation — Paper for documents — Requirements for permanence*

ISO 11108, *Information and documentation — Archival paper — Requirements for permanence and durability*

ISO 12757-1, *Ball point pens and refills — Part 1: General use*

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

ISO 14145-1, *Roller ball pens and refills — Part 1: General use*

ISO 27668-1, *Gel ink ball pens and refills — Part 1: General use*

3 Terms and definitions

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

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
abrasion resistance
rub resistance
characteristic of a document with *recording* (3.14) against losses of image or text from the action of abrasion (i.e. the ability of materials and structures to withstand mechanical wear or rubbing by means of friction)

Note 1 to entry: Abrasion resistance is measured in this standard as the *degree of abrasion resistance,* R_a (3.4).

3.2
archival paper
paper of high *permanence* (3.11) and high *durability* (3.6)

[SOURCE: ISO 11108:1996, 3.1]

3.3
CIELAB colour shift
lightness and colour change (ΔL^*, Δa^*, Δb^* and ΔE^*_{ab}) measured between two coordinates in the CIELAB colour space

Note 1 to entry: CIELAB colour space is a three-dimensional, approximately uniform colour space, produced by plotting, in rectangular coordinates L*, a*, b*. It was defined by the International Commission on Illumination (CIE) in 1976 (Synonymously referred to as CIE 1976 L*a*b*. CIELAB colour space or CIELAB values.).

Note 2 to entry: The quantity L* is a measure of the lightness, where L* = 0 corresponds to black and L* = 100 corresponds to the perfect reflecting diffuser. Visually, the quantities a* and b* represent respectively the red-green and yellow-blue axes in colour space, such that:

— +a* is a measure of the degree of redness;

— −a* is a measure of the degree of greenness;

— +b* is a measure of the degree of yellowness;

— −b* is a measure of the degree of blueness.

If both a* and b* are equal to zero, the test piece is grey

Note 3 to entry: Synonymously referred to as CIE 1976 *L*a*b**, CIELAB colour space or CIELAB values.

Note 4 to entry: Adapted from ISO/TS 21331:2020, 3.3.5.

3.4
degree of abrasion resistance
R_a
measure of the magnitude of retain of recorded image (or text) on paper because of abrasion (or wear, or rubbing)

Note 1 to entry: Degree of abrasion resistance is evaluated by measuring the % of changes in *L** of a printed image or text prior to and after the abrasion test, according to ISO 13655, and is calculated according to Formula (5) in 6.7.

3.5
document
recorded information which can be treated as a unit in a documentation process

[SOURCE: ISO 5127:2017, 3.1.1.38, modified — "material object" and Notes to entry have been deleted from the definition.]

3.6
durability
ability to resist the effect of physical stress, such as wear and tear, pressure, or damage during recurrent use

3.7
image
visual representation with colourants (such as dyes or pigments) distributed on paper as text characters, lines, colour patches or other visually identifiable patterns

3.8
monochromatic image
image (3.7) with *recording* (3.14) uniformly in one colour

Note 1 to entry: Images produced in one colour from a black and white printer, or any colour from a printer that can produce other colours, such as black, cyan, magenta and yellow.

3.9
multicoloured image
image (3.7) composed of *recording* (3.14) in more than one colour, where the colours constitute part of the information contents

Note 1 to entry: It can be separated into different base colours (e.g. black, cyan magenta and yellow).

Note 2 to entry: Not to be confused with a coloured image. A coloured image is in this standard referred to as an image recorded in any colour as a *monochromatic image* (3.8).

3.10
performance testing paper
permanent paper (3.13) or *archival paper* (3.2) used for sample preparation

Note 1 to entry: The performance testing paper shall be handled according to clause 4.1 and meet the requirements of Annex A.

3.11
permanence
ability to remain chemically and physically stable over long periods of time

3.12
permanent image
image (3.7) which, during long-term storage in libraries, archives and other protected environments will undergo little or no change in properties that affect its use

3.13
permanent paper
paper of high *permanence* (3.11) in accordance with ISO 9706

3.14
recording
process of performing writing, printing and copying on paper

3.15
spot colour image
specialized ink mixes to create a specific predetermined uniform colour in commercial printing

3.16
sample
aggregate of all the *specimens* (3.17) taken to be representative of a lot

[SOURCE: ISO 4046-5:2016, 5.100]

3.17
specimen
portion of a paper or board sample (in this context performance testing paper with recording from the tested writing, printing, or copying material) sufficient in size so that *test pieces* (3.18) can be obtained from it

[SOURCE: ISO 4046-5:2016, 5.106, modified — text in brackets has been added.]

3.18
test piece
piece or pieces of paper or board on which the measurement is carried out in accordance with the stipulations of the method of test

[SOURCE: ISO 4046-5:2016, 5.118, modified — Note to entry has been omitted.]

4 Preparation of specimens

4.1 Performance testing paper

Paper used for production of specimens shall meet the requirements of Annex A.

For the use of archival paper (in accordance with ISO 11108) as performance testing paper, watermarks may be present on various spots throughout the specimens. Such imprints are basically attenuations of the paper and indicate authenticity. To avoid misleading testing results, the watermarks shall be avoided for the test piece preparation when tested according to 6.2, 6.4, 6.5, 6.7, 6.8 and 6.9.

4.2 Conditioning of document substrates and recording atmosphere

Preferably, material (including paper) should be conditioned for at least 15 h at (23 ± 1) °C and (50 ± 2) % RH before recording. The recording should be performed in the same atmosphere. If this is not possible, instructions from the manufacturer of the recording equipment to be tested shall be followed.

4.3 Guidance for sample preparation

Specimens for testing purposes shall be prepared as described in an International Standard dealing with the specific type of recording equipment. If no such standard is available, the preparation of specimens shall be performed according to the instructions of the manufacturer of the recording equipment.

The test patterns shall be recorded to conform with Clause 6 using the same printing/writing method, ink, and paper combination, identical to the intended application or user case. Characters, spacing, etc.

shall represent normal use of the recording equipment intended for testing. Specimen preparation shall also meet the requirements of Annex B.

Three printout templates and the number of specimens that shall be used for sample preparation are given in Table C.1 of Annex C.

For printers and other recording devices, in addition to their manufacturer/brand, model number and serial number, note the print adjustment settings (such as paper setting, driver setting, colour mode and printing speed used), if specific print adjustments are to be made.

NOTE Print adjustments and other settings on a printer may have major impact on the permanence of the printed images. Accordingly, the print adjustments and print settings are two very important parameters to report, because different settings can drastically change the quality of the recorded information and thus impact its permanence.

4.4 Conditioning of specimens

Printed specimens shall be dried or cured and conditioned to the level of the intended use prior to testing. The specimens shall be kept at (23 ± 1) °C and (50 ± 2) % RH for at least 24 h (depending on the type of printing method) prior to further test piece preparation and testing. Inks that must evaporate or cure, such as water-based inkjet-printed specimens, shall be conditioned at least 7 days prior to the testing. When testing the mechanical strength of the paper (see 6.9), the preparation of test pieces, conditioning and testing atmosphere shall be in accordance with ISO 1924-2 and ISO 5626.

The specimens shall not be touched with bare hands.

4.5 Reference material used for testing of mechanical properties

Tensile energy absorption (see 6.9.2) and folding endurance (see 6.9.3) are both comparative tests between test specimens (performance testing paper with recording) and reference specimens (performance testing paper without recording). Accordingly, for a reliable comparison, all the performance testing paper used, for both test and reference specimens, shall be ensured to come from the same batch and also from the same section of the paper roll (i.e. sorted paper). In addition, paper is a sensitive material and is strongly affected by the surrounding climate, so the reference specimens shall be handled and stored in a similar manner as the test specimens prior to testing. Due to such unique handling, the reference specimens are restricted to the corresponding test specimens and cannot be used for other comparative tests.

EXAMPLE If test specimens are prepared for, such as a printer outside the laboratory, the reference specimens are brought to all environments where test specimens are produced and are stored together, preferably in the same box, prior to preparation of test pieces in the laboratory.

5 Required characteristics

5.1 General

Paper documents conforming to this document shall meet the following requirements. Specimens for testing shall be prepared as described in Clause 4 and tested according to Clause 6.

5.2 Colour fastness

The colour fastness is evaluated as CIELAB colour shift between before and after each test when tested according to 6.4, 6.5 and 6.8, and measured according to 6.2.

The colour change of monochromatic images obtained from printing devices shall not exceed the maximum CIELAB lightness and colour differences specified in Table 1.

For printing equipment that can produce multicoloured images (from e.g. toners or inks), all the base colours such as cyan, magenta, yellow and black (CMYK), shall be tested individually to cover all sets of

chemical compositions of the multicolour. For spot colour images, each spot colour shall individually be tested. The colour change (for each base colour or spot colour) shall not exceed the maximum CIELAB lightness and colour differences specified in Table 1.

The colour tone of the image may change visually but it shall still be recognizable as being of the same colour as before the treatment.

Table 1 — Maximum CIELAB lightness and colour changes for printers and other machines

Test property	ΔL^*	Δa^*	Δb^*	ΔE^*_{ab}
5.4[a], 5.5[b] and 5.8[c] All colours except yellow	±8	±8	±8	≤10
5.4[a], 5.5[b] and 5.8[c] Yellow	±8	±8	±15	≤15

[a] Lightfastness.

[b] Water resistance.

[c] Resistance to heat.

NOTE 1 ΔL^* is lightness difference and Δa^*, Δb^* and ΔE^*_{ab} are colour differences.

NOTE 2 The presented maximum changes are valid for uniform colours, such as cyan, magenta, yellow and black (CMYK).

The lightness change of images obtained from pens and stamps shall not exceed the maximum CIELAB lightness changes specified in Table 2. For pen writing with blue ink, the colour may change from blue to green when testing lightfastness and resistance to heat. This is acceptable if the requirement in Table 2 is met.

Table 2 — Maximum CIELAB lightness changes for pens and stamps

Test property	ΔL^*
5.4[a]	±15
5.5[b] and 5.8[c]	±10

[a] Lightfastness.

[b] Water resistance.

[c] Resistance to heat.

NOTE Multicoloured images (where colours constitute parts of the information content) are not possible to produce from pens and stamps, and thus, only lightness difference ΔL^* is required to measure.

5.3 Visual appearance

5.3.1 Each element of the specimen images shall be clearly defined and easily legible when inspected as described in 6.3. The colour strength shall be even, and the print density and colour intensity shall be satisfactory by eye for each colour that is tested. Text characters shall be easily legible. Feathering or strikethrough shall not be visible without magnification.

5.3.2 For printing or copying on paper, if traces of characters are detected outside the intended area on the paper specimens, anywhere on the white sections of the paper, and the assessment is that this appearance can interfere with the information content of the document, those specimens shall be regarded as failed. Such incident is referred to as ghost printing.

5.3.3 For printing devices that can produce multicolours, this visual appearance requirement shall be met for each base colour.