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Office equipment — Print quality measurement methods for colour prints —

Part 3: Physical durability measurement methods

Équipements de bureau — Méthodes de mesure de la qualité d'impression en couleurs —

Partie 3: Méthodes de mesure de la durabilité physique

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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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Foreword

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This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 28, *Office equipment*.

A list of all parts in the ISO/IEC 22592 series can be found on the ISO and IEC websites.

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 and www.iec.ch/national-committees.

Introduction

There is a need for the standardization of measurement methods that quantitatively evaluate the physical durability attributes of duplex print sets, as most office documents are currently printed as duplex print sets comprising several sheets printed with colour images on both sides of substrates.

The measurement methods described in this document are used to assess the physical durability of a print set formed by a printing system on a substrate. When test results are compared among various printing systems, it is important to use the same product of substrates and to set the equivalent printing conditions under default printer settings among the printing systems.

Electrophotography, thermal inkjet or piezoelectric inkjet technologies are commonly used to form such prints. The main purpose of this document is to provide objective measurement methods for physical durability attributes of duplex print sets, however, some attributes are also applicable for a set of simplex prints.

This document specifies the following:

— digital test charts for the measurements;

— measurement methods for the following physical durability attributes:

  — thermal and humidity blocking caused by environmental stress;

  — water resistance;

  — abrasion resistance;

  — scratch resistance.

The above attributes are also applicable for a simplex print set comprising several sheets which are printed colour images on one side of a substrate and no image on the other side. In such case, test parameters are configured to conform with the print set. For example, in thermal and humidity blocking measurement, a print surface of an image area is contacted with an unimaged area of the same paper.

Long term durability affected by light exposure, ozone exposure or thermal storage as described in Annex A is important for long term preservation use cases but not essential for general office use cases.

In this document, colour codes for the test charts are defined in the sRGB colour space specified in IEC 61966-2-1 as is common in office documents, and colour measurements in terms of CIE 1976 L*a*b* (CIELAB) are based on ISO 13655:2017,5.3.

Office equipment — Print quality measurement methods for colour prints —

Part 3:
Physical durability measurement methods

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 test methods as well as test charts for measuring the physical durability attributes of duplex colour prints, typically used in office environment.

This document is applicable to duplex prints comprising several sheets with colour images printed on both sides of a substrate. A multifunction or single function printer is used to form the duplex prints.

This document is intended to be used to evaluate the durability of colour prints under environment and stress conditions assuming general office use, including transportation from the place of printing to where practically used. Permanence and durability in archival and storage environments are out of scope of this document and can be evaluated by the methods in ISO 11798.

The physical durability attributes included are thermal and humidity blocking, water resistance, abrasion resistance and scratch resistance.

All of these attributes are also applicable to a simplex print set comprising several sheets with colour images printed on one side of a substrate and no image on the other side.

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 13655:2017, *Graphic technology — Spectral measurement and colorimetric computation for graphic arts images*

ISO 15184, *Paints and varnishes — Determination of film hardness by pencil test*

ISO 18947-2:2021, *Imaging materials and prints — Abrasion resistance — Part 2: Rub testing of photographic prints*

ISO/IEC 24790:2017, *Information technology — Office equipment — Measurement of image quality attributes for hardcopy output — Monochrome text and graphic images*

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

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
process of wearing away or damaging the surface by friction

3.2
back side
print side (3.6) corresponding to an even page of input data in a duplex *print set* (3.5)

3.3
curl
deviation from a flat surface

Note 1 to entry: Its measurement has three major components:

— its magnitude;

— the angle of the curl axis in relation to the paper or board's machine direction;

— the side towards which the sheet curls.

[SOURCE: ISO 11556:2005, 3.1]

3.4
front side
print side (3.6) corresponding to an odd page of input data in a duplex *print set* (3.5)

3.5
print set
set of sheets printed in a print operation

3.6
print side
one of the duplex print surfaces, either *front side* (3.4) or *back side* (3.2)

3.7
scratch resistance
resistance against plastic deformations of a print surface or wearing of print surface materials caused by an action of a sharp-pointed tip pushed across the surface

3.8
thermal and humidity blocking
undesired adhesion between sheets of printed material that occurs under moderate pressure, high temperature, or high humidity, while in storage or in use, that leads to undesirable effects

3.9
water resistance
ability of a print to resist fading or bleeding upon exposure to water or high humidity

4 Print preparation procedures

4.1 Printing environment

Printers shall be installed in an environment with a temperature range of (23 ± 5) °C and a relative humidity (RH) of (50 ± 10) % at least 2 h prior to print operations. Print operations shall be completed in the same environment range. The substrate shall be placed in a paper tray when the printers are installed. Prior to the installation of printers, additional conditioning of papers is recommended under the same temperature

and humidity conditions for more than 24 h, in order to stabilize the water content of the papers which often affects image quality of prints.

If a printer has not been used for a long period or if the environmental difference between storage and the evaluation area is large, installation should be done 12 h prior to the test and 10 or more sheets should be printed before the test to warm it up.

4.2 Printing materials

Plain papers shall be used, in order to simulate typical use of office prints. Coated papers for inkjet or lithography can be used in specific cases as long as a rational explanation is included in the report. The grammage of the paper shall be from 60 g/m^2 to 90 g/m^2. Any other grammage for paper can be used for a specific usage case with a rational explanation in reporting. The name, grammage and supplier of the paper shall be reported.

The printer manufacturer's instructions regarding the toner or ink materials shall be used. Any other materials provided by third party suppliers may be used as long as product name and supplier are included in the report.

Any other printing materials, such as photoreceptors in an electrophotographic printer, print heads in an ink jet printer, shall be in accordance with the printer manufacturer's instructions. Printing materials provided by third party suppliers may be used if the product name and supplier are included in the report.

4.3 Printer settings

Modifications in colour and tone reproduction, sharpness enhancement, or noise reduction in the printer settings shall not be used. No reduction or enlargement in printed size shall be made.

Test prints shall be formed using driver and printer settings that are appropriate for typical office use, except the settings relating to the optional conditions for papers described in 4.2. Initial settings for each substrate when a printer shipped out should be used for evaluations. When printing systems are compared, the default settings for each printing system shall be selected. The driver and printer settings used shall be described in the test report.

Colorant compositions in each printed colour patch depend on printer setting and cannot be controlled by users. On the other hand, colorant compositions, especially for black colorant depending on under colour removal (UCR, as described in Reference [11]) policy with printer settings, can affect test results. It is difficult for users to specify colorant compositions in a printed colour patch. Colorant compositions should be reported for each printed colour patch if specified.

Caution is advised, users should check if the size and position in a substrate are consistent. In some application viewers or printer settings for PDF files, settings related to size modification or printed position in a substrate at the previous print operation remain unchanged.

4.4 Printing operations

Printing can be initiated under any operational mode, for example, that defined in “ENERGY STAR® Product Specification for Imaging Equipment - Eligibility Criteria Version 3.2 (2021)”, i.e. "Active State", "Ready State", "Off Mode" or "Sleep Mode". In order to compare test results, it shall be used the same operational mode among the tests. In order to evaluate overall performance of a printing system, the tests should be carried out under multiple operational modes. When performances of printing systems are compared, the same operational mode shall be used. The operational mode selected shall be included in the report.

A duplicated print set should be prepared for each measurement for backup and measurement noise reduction.

4.5 Conditioning the prints after printing

Prior to measurements, each print set shall be conditioned in a controlled environment for at least 24 h after printing to stabilize the dimension of sheet comprising the print set in addition to mitigate colour changes

caused by the exposure of environmental factors, such as light, high temperature and humidity during the conditioning. The controlled environment shall be of a RH between 30 % to 70 % and temperature between 15 °C to 28 °C, with average ambient illuminance on the print surface less than 1 000 lx.

5 General requirements for measurements

5.1 Measurement environmental conditions

All measurements in this document shall be completed in a controlled environment of RH between 30 % to 70 % and temperature between 15 °C to 28 °C. It is recommended to complete a series of measurements continuously in a shorter duration to prevent from the change in colour reproductions with environmental factors.

5.2 Colour measurement

The CIELAB colour space values shall be obtained from measurements using measurement conditions specified in ISO 13655:2017, 5.3.

In accordance with ISO 13655:2017, calculated tristimulus values and corresponding CIELAB coordinates of the colorimetry shall be computed using CIE standard illuminant D50 and the CIE 1931 standard colorimetric observer (often referred to as the 2° standard observer). “Self-backing” or “white-backing” is recommended with respect to a typical office document composed of several sheets of a low area coverage print. The same measurement condition, either M0, M1 or M2, shall be maintained for a series of colour measurements. It is recommended to apply M2, which is insensitive to the variation of optical brightener in papers when the colour variations originated by the performance of print equipment are evaluated.

Measurement instruments shall be calibrated in accordance with manufacturer’s instructions. The same measurement instrument is recommended to be used for all of the same kind of measurements.

5.3 Scanner conformance for line quality measurement

5.3.1 General

In case a scanning system is used for the line quality measurements, the scanning system shall meet the requirements described in ISO/IEC 24790:2017, Clause 6.

A scanning system used for the measurements in this document shall be tested using the test charts and procedures specified in ISO/IEC 24790:2017, Clause 6.

The scanning system is calibrated suitably if it can obtain a value within acceptable tolerances of the goal values given in ISO/IEC 24790:2017, 6.4. The conformance test shall be completed at least within six months prior to evaluations.

5.3.2 Equipment and setting

The measurements of line qualities in this document shall be carried out with a scanning system that has a minimum of 1 200 spots per inch (spi) and 8 bits per pixel (256 grey levels), with a scanning field equal to or larger than A4 area.

The scanner settings shall be as follows:

— scanning resolution: 1 200 spi;

— number of bits: 8 bit;

— colour mode: RGB;

— scanning speed: default;

— no spatial filter applied;

— no colour or tone correction applied.

Under the settings specified in 5.3.2, the scanning system shall be demonstrated to conform to the requirements in ISO/IEC 24790:2017, Clause 6.

5.4 Reporting

The following items shall be reported:

— date, place, temperature and humidity when the scanner conformance measurements carried out;

— settings of measurement systems;

— conformance of the scanner for the goal values in ISO/IEC 24790:2017, 6.4.

6 Thermal and humidity blocking

6.1 General

The primary objective of this test method is to assess the durability of a print set in a closed condition. The use cases to be simulated with blocking tests are:

a) long term storage, such as a file stored in a bookshelf or stacked on a table;

b) short term transport in a vehicle interior.

A similar test method is standardized in ISO 18948:2018, Clause 6 to evaluate the thermal and humidity blocking for photo book applications. Test conditions are modified with respect to typical uses of office colour prints.

6.2 Test conditions

There are two substantially different use cases for print set storage:

a) long term storage under moderate environmental conditions;

b) short term transport under more extreme environmental conditions.

In both cases, the primary stress factors are temperature, humidity and pressure. Tests are often referred to as blocking tests, and the primary response factors are:

— physically sticking or binding of pages together;

— ink transfer to an adjacent facing page;

— degradation of image quality (colorimetric changes, changes in gloss, etc.).

For the long-term storage cases, prints are stored in a book shelf as filed print sheets or stacked on a table, under two typical temperature and humidity conditions simulating either hot and dry or warm and moist storage. The hot and dry condition is reasonably simulated by running the test at 40 °C and 20 % RH, and that the warm and moist condition is reasonably simulated by running the test at 25 °C and 85 % RH. A fixed pressure of 1 kPa shall be used for either of these two environmental conditions, and the test duration shall be seven days.

NOTE The pressure of 1,0 kPa corresponds to the approximate pressure at the bottom of a stack of seven files, each containing 200 pages of standard substrate (with a grammage of 75 g/m^2). It also corresponds to the approximate pressure experienced in a tightly packed book shelf.

For short-term transport, several print sets can be stored for a shorter duration under a somewhat hotter environment. Because the hot air in a closed car interior typically has a comparable dew point to the ambient

exterior environment, the RH shall be scaled appropriately to the temperature of the test. An illustrative example is to assume that the exterior atmosphere on a typical hot summer day is 35 °C/80 % RH, then the RH of that same air heated to 50 °C will be 30 % RH. In this case, a treatment condition of 50 °C and 30 % RH for 8 h applies for short term transport. Because a print set being transported in a car is not likely to experience the same pressures as one in a stack or in a tightly packed bookshelf, a reduced pressure of 0,5 kPa shall be used for this test condition.

Table 1 — Summary of test conditions used for the closed book blocking test

Use case	Temperature	Relative humidity	Pressure	Duration
Long-term storage	40 °C	20 %	1 kPa	7 days
	25 °C	85 %	1 kPa	7 days
Short-term storage	50 °C	30 %	0,5 kPa	8 h

6.3 Sample settings

Solid patches of cyan (0,255,255), magenta (255,0,255), yellow (255,255,0) and black (0,0,0) in the sRGB colour code defined in IEC 61966-2-1 shall be printed under the printing conditions specified in Clause 4. Each patch size shall be equal to or larger than (2,0 × 2,0) cm^2.

One of either of the graphics modes “vector graphics” or “raster graphics” appropriate for the usage case assumed, may be selected for input data of all colour patches if the mode selected is described in the report.

For the measurements evaluating a duplex print set, blocking both for colorant-to-colorant and colorant-to-substrate for each colour shall be evaluated. Therefore, the two patches of the same colour as well as a colour patch and a blank patch without a colorant layer shall be placed face-to-face under the appropriate weight to achieve the specified pressure for each of the test conditions.

For the measurements evaluating a simplex print set, blocking for colorant-to-substrate for each colour shall be evaluated. Therefore, the two patches of a colour patch and a blank patch without a colorant layer shall be placed face-to-face under the appropriate weight to achieve the specified pressure for each of the test conditions.

6.4 Test methods

6.4.1 General

The test methods described in 6.4.1 comprise a stack of print sets that are sandwiched between top and bottom plates, upon which a weight or load is applied, the pressures produced by which are summarized in Table 1. An example of a test jig which can be used for the closed book test is described in Reference [9].

At least two replicate print sets shall be tested at each test condition.

In order to achieve the required pressure for each of the test conditions, a weight, with the same area dimensions as the stacked test patch, should be chosen to produce the required pressure.

NOTE The mass needed to achieve the required pressure can be determined using the formula below.

$$m = 10{,}2 \times p \times (L_p \times l_p)$$

where

m is the mass needed in gram;

p is the required pressure for each of the test conditions shown in Table 1;

L_p is the patch length of a print measured in centimetre;

l_p is the patch width of a print measured in centimetre;

Coefficient of 10,2 is a factor coming from the conversion of 1 kPa = 10,197 gram- weight/cm^2.

Other test conditions are permitted in addition to the required conditions, if such conditions correspond to a particular use case. In such case, the specific combinations of temperature, humidity, pressure, and test duration, and the rationale for choosing such conditions, shall be included in the report.

6.4.2 Equipment and calibration

Test chambers which can control temperature and humidity to within the specifications described in 6.4.3 shall be used.

Each test chamber shall be calibrated for RH control and measurement accuracy by using a chilled mirror hygrometer or other type of measurement device. The calibration shall include the temperature and RH ranges that will be used in the ensuing test processes.

6.4.3 Test environment control

The RH shall be maintained and controlled throughout testing with an operational fluctuation within ±5 % RH of target (regardless of the place in the chamber where test patches are) excluding the transit time within 30 min when samples are installed.

Regions of the test chamber for use shall meet the required operational uniformity conditions. If the operational fluctuation does not meet the requirement, it shall be documented and explained.

The air temperature inside the chamber shall be maintained and controlled throughout testing with an operational fluctuation within ±3,0 °C of the target temperature (regardless of the location within the test chamber) excluding the transit time within 30 min after samples are installed. The operational uniformity of the equipment under test conditions should be evaluated prior to the start of the test. If the operational fluctuation does not meet the requirement, it shall be documented and explained.

The air flow shall be sufficiently high to ensure uniform temperature and humidity conditions within the chamber.

6.4.4 Long term storage (hot and dry) test

An environmental chamber shall be equilibrated and controlled to a nominal set point of 40 °C and 20 % RH. The test prints stacked with applied loads of 1,0 kPa shall be placed in the chamber with sufficient space between them to allow for air circulation.

The test prints shall be incubated for seven days under these conditions. At the end of the test duration, the test prints shall be removed from the chamber and re-equilibrated to (23 ± 2) °C and (50 ± 5) % RH until the sample temperature is reduced to (23 ± 2) °C. The assembled stack of test prints, including the applied load, shall be maintained until re-equilibration is complete.

6.4.5 Long term storage (warm and humid) test

An environmental chamber shall be equilibrated and controlled to a nominal set point of 25 °C and 85 % RH. The test prints stacked with applied loads of 1,0 kPa shall be placed in the chamber with sufficient space between them to allow for air circulation.

The test prints shall be incubated for seven days under these conditions. At the end of the test duration, the test prints shall be removed from the chamber and re-equilibrated to (23 ± 2) °C and (50 ± 5) % RH until the sample temperature is reduced to (23 ± 2) °C. The assembled stack of test prints, including the applied load, shall be maintained until re-equilibration is complete.

If necessary to avoid condensation, it is suggested that:

— the chamber be prewarmed to 25 °C and RH below 50 %,

— the test prints then be moved into the chamber and allowed to warm up for approximately 15 min before raising the chamber set point to 85 % RH,

— the 48 h ageing test time begin once the chamber reaches the 85 % RH.

6.4.6 Short term transport test

An environmental chamber shall be equilibrated and controlled to a nominal set point of 50 °C and 30 % RH. The test prints stacked with applied loads of 0,50 kPa shall be placed in the chamber with sufficient space between them to allow for air circulation.

The test prints shall be incubated for 8 h under these conditions. At the end of the test duration, the test prints shall be removed from the chamber and re-equilibrated to (23 ± 2) °C and (50 ± 5) % RH until the sample temperature is reduced to (23 ± 2) °C. The assembled stack of test prints, including the applied load, shall be maintained until re-equilibration is complete.

6.5 Evaluation

The primary response factor of test prints when subjected to a combination of either heat, humidity, or pressure, or all three, is adhesion or blocking. The other possible response factors are the migration of colorants from one page to another and change in gloss due to break of a clear substance, such as a release agent in electrophotography, gloss optimizing agent in inkjet, etc. Less likely to occur, but worth noting, is any evidence of delamination of any of the layers of the substrate.

After the test prints have been re-equilibrated, the surface of test print shall be visually inspected. Typical evaluation items are as follows:

— pages stick together, but no surface change;

— changes in gloss;

— colorant migration from one surface to another;

— delamination of a layer.

6.6 Reporting

Observed phenomena in 6.5 shall be reported.

In addition to the inspection items listed in 6.5, any other evidence of degradation shall be noted. Optionally, changes in density, colorimetric values and gloss may be reported for the printed patch and any of the facing sheets.

7 Water resistance

7.1 General

The water resistance of colour prints evaluated in this document pertains to the stability of image quality, i.e. changes in colour and line reproduction. Such changes are mainly caused by the migration of colorants when prints are subjected to direct contact with water or aqueous clear liquids and are wiped with tissue or

cloth to remove the liquid. Physical changes such as curl, waviness and dimension changes are not taken into consideration.

Deionized or distilled water shall be used for all of the tests. The pH of this water is not controlled (although it will have an initial pH value of 7, which will decrease over time mainly due to the absorption of ambient CO_2), but an initial pH value has little effect on the tests. This is because any water-soluble components in the substrates dissolve into the water and rapidly change the pH, and the final value of pH mostly depends on the substrate used.

7.2 Test chart for water resistance

Two test charts shall be prepared. One shall comprise a checkerboard pattern of test patches, without back side images, to measure colour changes caused by colorant bleeding and an unimaged area with a solid patch on the back side to measure colour changes caused by the penetration of the colorant in the solid patch through a substrate. The other shall comprise solid line patterns to measure changes in line reproduction caused by colorant bleeding.

The first test chart shall be composed of checkerboard pattern patches of cyan/white (0,255,255)/(255,255,255), magenta/white (255,0,255)/(255,255,255), yellow/white (255,255,0)/(255,255,255), red/white (255,0,0)/(255,255,255), green/white (0,255,0) /(255,255,255), blue/white (0,0,255) /(255,255,255) and black/white (0,0,0)/(255,255,255) in sRGB colour code in accordance with IEC 61966-2-1. The spatial cycle of each checkerboard is 30 cycles/inch. Each patch size shall be equal to or larger than (2,0 × 2,0) cm^2. The back side of each patch shall have no images, in order to prevent the colour change caused by the penetrated colorants through a substrate in the evaluations of duplex print of two print sides. Patch arrangements on the front side and back side that are appropriate to measure the colour changes only caused by colorant bleeding in a checkerboard image shall be taken into account for duplex print sets.

The first test chart shall also be composed of uniform solid colour patches of cyan (0,255,255), magenta (255,0,255), yellow (255,255,0), red (255,0,0), green (0,255,0), blue (0,0,255) and black (0,0,0) in sRGB colour code when the colour changes caused by the penetrated colorants through a substrate in duplex print sets are evaluated. The back side of those patches shall have no images. Appropriate patch arrangements on the front side and back side to measure colour changes only caused by colorant penetrations from a back side solid image through the substrate shall be taken into account for duplex print sets.

The second test chart shall be composed of a set of line patterns of different line angles of vertical and horizontal for four input colours of cyan, magenta, and yellow and black, each composed of two different line widths specified in the input file to be 0,24 pt (85 µm) and 0,60 pt (212 µm), corresponding to 2 dots and 5 dots at 600 dpi resolution. The file format shall be PDF in sRGB colour code in accordance with IEC 61966-2-1. The back side of each line area shall have no images, in order to prevent the colour change caused by the penetrated colorants through a substrate in the evaluation of duplex print sets. Appropriate arrangements of line components for the front side and back side to measure colour changes only caused by colorant bleeding of line images shall be taken into account for duplex print sets.

"Vector graphics" shall be selected for input data of all colour patches and line components. A sample test chart can be downloaded via the following ISO website: https://standards.iso.org/iso-iec/22592/-3/ed-1/en.

7.3 Water resistance test method

Test prints shall be prepared under the print preparation procedures specified in Clause 4. A sheet of duplex print using the first and second test charts described in 7.2 for both sides shall be printed to measure colour changes for the patches. Another sheet of duplex print using the latter test chart described in 7.2 for both sides shall be printed to measure the change in line reproduction.

NOTE The test results for a front side and back side are not always the same due to the effect of the difference in the surface property of a substrate, fusing or drying conditions of colorants, etc.

A droplet of 0,1 ml deionized or distilled water shall be applied to each colour patch of checkerboard pattern placed on a flat plate at ambient temperature. After allowing this drop to stand for 60 s, the droplet on the patch shall be removed by placing a piece of laboratory tissue backed by a rigid support of larger than (2,0 × 2,0) cm^2. Total of 50 gram-weight/cm^2 including the support is further applied on the tissue

immediately after the tissue is placed. The weight and tissue shall be removed from the patch after 60 s. The patch shall be maintained for another 24 h in a laboratory condition until the water droplet is sufficiently dried. The laboratory condition shall be between 20 °C and 30 °C and between 30 % RH to 60 % RH. Colour measurement shall be carried out around the centre of the area where a droplet was permeated.

7.4 Evaluation

Colour reproduction shall be measured in terms of CIELAB L^*, a^* and b^* under the conditions in 5.2. Changes in the colour reproductions caused by the water exposure shall be evaluated in terms of the CIEDE2000 colour difference, ΔE_{00} as defined in ISO 13655:2017 Annex K, both for simplex and duplex print sets.

For evaluations of a duplex print set, colour changes in the blank image on the back side caused by penetrated colorant from front side to back side shall be evaluated visually.

Line reproductions for the 2 dot and 5 dot lines for the horizontal and vertical directions of primary colour of K shall be evaluated in terms of the line width and blurriness defined in ISO/IEC 24790:2017 5.3.3 and 5.3.5, respectively. Difference in the line width and blurriness values after water exposure shall be evaluated both for simplex and duplex print sets. Change in the line reproductions for the primary colours of C, M and Y shall be evaluated visually.

7.5 Reporting

Values of ΔE_{00} for all the colour patches, changes in the line width and blurriness values for K line elements and visual changes in the line reproduction for the line elements of C, M and Y shall be reported.

8 Abrasion resistance

8.1 Test chart for abrasion resistance

Solid patches of cyan (0,255,255), magenta (255,0,255), yellow (255,255,0) and black (0,0,0) in sRGB colour code specified in IEC 61966-2-1 shall be printed either on the front side or back side of a sheet of substrate under the print preparation procedures specified in Clause 4 of this document. Users may design any patch layout if the patch size for each colour meets the requirement for their test equipment.

Either “vector” or “raster” graphics mode, as appropriate for the usage case assumed, may be selected for input data of all colour patches if the mode selected is described in the report.

The opposite side of each patch shall have no images to prevent the colour change caused by show-through from back side.

8.2 Test equipment and settings

The test equipment described in ISO 18947-2:2021, Clause 5 shall be used. Test procedure shall follow the requirements in ISO 18947-2:2021, Clause 7.

The test conditions for FR-2 shall be as follows:

— force on contact line: 2 N;

— reciprocal frequency: 30 cycle/min;

— line speed: 12 cm/s;

— number of rubbing cycles: 50 cycles.

The test conditions for the Sutherland rub-tester shall be as follows:

— pressure: 0,69 N/cm^2;

— reciprocal frequency: 43 cycle/min;

— line speed: 8,2 cm/s;

— number of rubbing cycles: 50 cycles.

8.3 Test sample and arrangement

The solid patches of cyan, magenta, yellow, black on both front and back sides shall be evaluated.

Abrasion between a colour patch and a colour patch as well as a colour patch and a blank substrate shall be evaluated for each solid colour patch in a duplex print set. In the former case, the same solid colour patch as that subjected to the evaluation shall be used as a receiving layer. In the latter case, a blank substrate of the same material shall be used as a receiving layer. Only the latter case shall be measured for a simplex print set.

Colour changes caused by the abrasion test shall be evaluated in terms of ΔE_{00}.

A minimum of two measurements shall be carried out under each condition. The average value of the measurements shall be calculated.

It can be difficult to accurately measure the colour change of the abraded target due to non-uniform abrasion or smudge patterns. To reduce the variability of the measurement, the largest aperture available for the densitometer or colorimeter shall be used. An average of multiple measurements at various locations within the abraded area shall be used.

8.4 Reporting

Colour changes in terms of ΔE_{00} shall be reported for all colour patches under the two kinds of receiving layers.

9 Scratch resistance

9.1 Test chart for scratch resistance and test samples

Solid patches of cyan (0,255,255), magenta (255,0,255), yellow (255,255,0) and black (0,0,0) in sRGB colour code defined in IEC 61966-2-1 shall be printed on the both sides of a sheet of substrate under the printing conditions specified in Clause 4. Users may design any patch layout if the patch size for each colour meets the requirement for their test equipment.

Either the “vector graphics” or “raster graphics” graphics modes, whichever is appropriate for the usage case assumed, may be selected for input data of all colour patches if the mode selected is described in the report.

The opposite side of each patch shall have no images, in order to prevent the colour change caused by show-through from back side.

The solid patches of cyan (0,255,255), magenta (255,0,255), yellow (255,255,0), black (0,0,0) on both front and back sides shall be evaluated both for simplex and duplex print sets.

9.2 Test equipment and settings

The test equipment described in ISO 15184 shall be used, employing a pencil with a hardness varying from 9B to 9H. The load of (7,35 ± 0,15) N or (4,0 ± 0,1) N shall be applied as specified in ISO 15184. The speed of the pencil on the sample surface shall be from 0,5 mm/s to 1 mm/s. At least 7 mm shall linearly be drawn along the surface of the sample by the pencil.

In the case of the heavy load of (7,35 ± 0,15) N, some substrates are not durable enough for the scratch resistance test described in this document. In such samples, a lighter load of (4,0 ± 0,1) N can be used. Comparisons shall only be made among the test results with the same loads. The load used in a measurement shall be described in its test report.