TECHNICAL SPECIFICATION

ISO/TS 20791-2

First edition
2021-10

Photography — Photographic reflection prints —

Part 2: Evaluation of colour variation in printing

Photographie — Tirages photographiques par réflexion —

Partie 2: Évaluation de la variation de couleur dans l'impression

Reference number
ISO/TS 20791-2:2021(E)

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Published in Switzerland

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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 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).

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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.

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

A list of all parts in the ISO 20791 series can be found on the ISO website.

Introduction

In photographic reflection colour prints, density and colour are essential quality attributes of an image. However, the density and colour of prints can fluctuate during repeated continuous printing or vary between two printings done at different times or days, even if the same input data and printer settings are used. This is a critical issue, particularly in the following cases:

a) When the same photographic image is reprinted to make an extra copy and there is obvious difference in density and colour between the original and the reprint when they are compared side by side, the customer might be dissatisfied with this difference.

b) When a photo book is produced by binding up photographic prints into different pages in a book, and the difference in the density and colour between adjacent pages is easily noticeable, this difference might be considered unsatisfactory by the customer.

c) When a customer and a print shop agree to the image quality of prints based on a sample or a proof print, and the difference between the proof sample and the actual prints is discernible, this might lead to customer dissatisfaction.

Moreover, colour management for high quality printing is attainable only with a stable printing system. If the colour and density of the actual print differ from that of the designated proof print or sample used as the basis for the colour management, the quality of the actual print may be different from the desired image quality.

To improve the reproducibility of printing, or to select the appropriate printing system, the evaluation of colour variation in printing is crucial. Although the evaluation of colour variation in graphic printing is described in ISO/TS 15311-1, standardized evaluation methods and procedures for quantifying colour variation specific to photographic prints are also necessary.

— test target design for the print ranging from a small size to large size;

— sampling procedures (within a job and between jobs);

— measurements and evaluation of colour variation and

— reporting (evaluation results, parameter and mode of printing).

The objective of this document is to provide standard procedures to evaluate colour variation in photographic printing.

Photography — Photographic reflection prints —

Part 2:
Evaluation of colour variation in printing

1 Scope

This document describes the procedures for evaluation of colour variation in the printing of photographic reflection colour prints. The following procedures are described to evaluate colour variation in printing within a consecutive print job, between several print jobs, or between multiple photographic images printed in different areas of a large sheet:

a) test targets for small and large photographic prints;

b) printing procedures and conditions;

c) sampling in correspondence to the production scale;

d) measurement of colour;

e) calculation and analysis of colour variation and

f) reporting.

The procedures presented in this document are applicable for prints with a size of available picture area ranging from 35 cm^2 (e.g. 5 cm × 7 cm) to 5 400 cm^2 (e.g. 60 cm × 90 cm). This document is applicable to any of the photographic printing technologies, including inkjet, thermal dye transfer, electrophotography and silver halide (chromogenic) technologies.

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

ISO 11664-1, *Colorimetry - Part 1: CIE standard colorimetric observers*

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

ISO 18944, *Imaging materials — Reflection colour photographic prints — Test print construction and measurement*

ISO/TS 21139-1:2019, *Permanence and durability of commercial prints — Part 1: Definition of use profiles and guiding principles for specifications*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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 https://www.electropedia.org/

3.1 Terms

3.1.1
job
one sequence of printing initiated by the order from the print operation system

Note 1 to entry: Even if a pause is automatically inserted between printings, one sequence ordered from the operating system is considered as one job.

3.2 Abbreviations

CIE International Commission on Illumination

CIELAB CIE 1976 ($L^*a^*b^*$) colour space

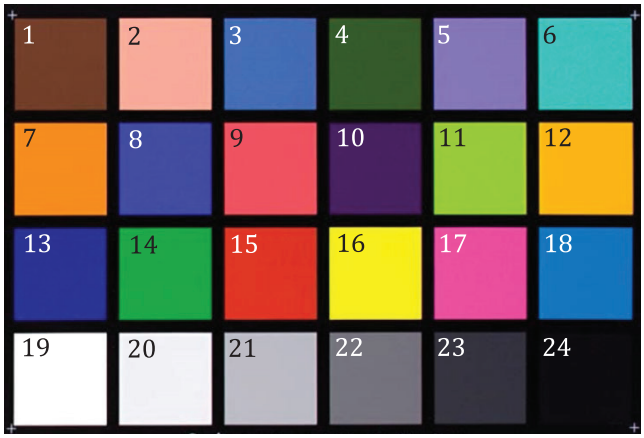
4 Test target

The test target shall be composed of the colour patches in Macbeth Color Checkers shown in Figure 1. The colour codes in sRGB as defined in IEC 61966-2-1[4] are shown in Table 1.

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.

Table 1 — Colour patch of the test target (RGB value in 8 bit)

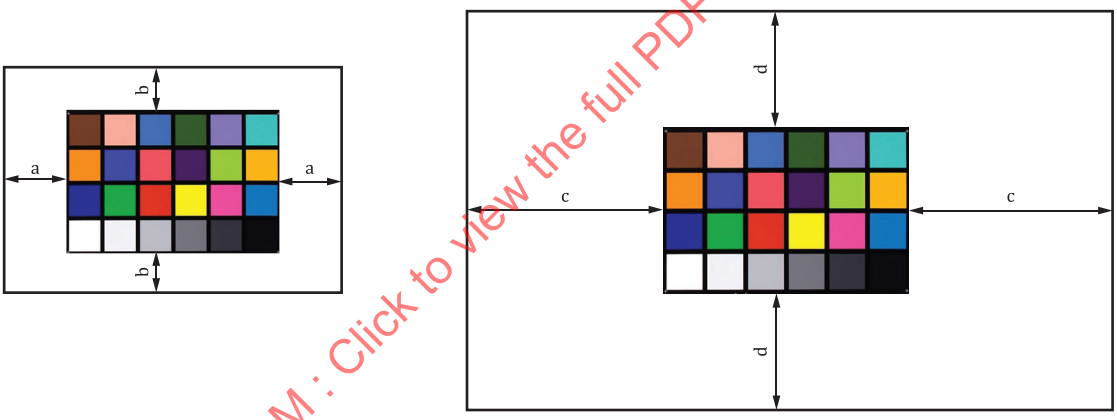
		R	G	B			R	G	B
1	Dark skin	115	82	68	13	Blue	56	61	150
2	Light skin	194	150	130	14	Green	70	148	73
3	Blue sky	98	122	157	15	Red	175	54	60
4	Foliage	87	108	67	16	Yellow	231	199	31
5	Blue flower	133	128	177	17	Magenta	187	86	149
6	Bluish green	103	189	170	18	Cyan	8	133	161
7	Orange	214	126	44	19	White	243	243	242
8	Purple blue	80	91	166	20	Neutral 8	200	200	200
9	Moderate red	193	90	99	21	Neutral 6.5	160	160	160
10	Purple	94	60	108	22	Neutral 5	122	122	121
11	Yellow green	157	188	64	23	Neutral 3.5	85	85	85
12	Orange yellow	224	163	46	24	Black	52	52	52



NOTE The numbers shown in the figure are only added here as reference and do not represent an integral part of the test target when printed.

Figure 1 — An example of the test target design

When the print size is larger than 35 cm^2 (e.g. 5 cm × 7 cm) and smaller than 2 600 cm^2 (e.g. 43 cm × 60 cm), the 24 solid patches shall be positioned at the centre of the print, as shown in Figure 2.

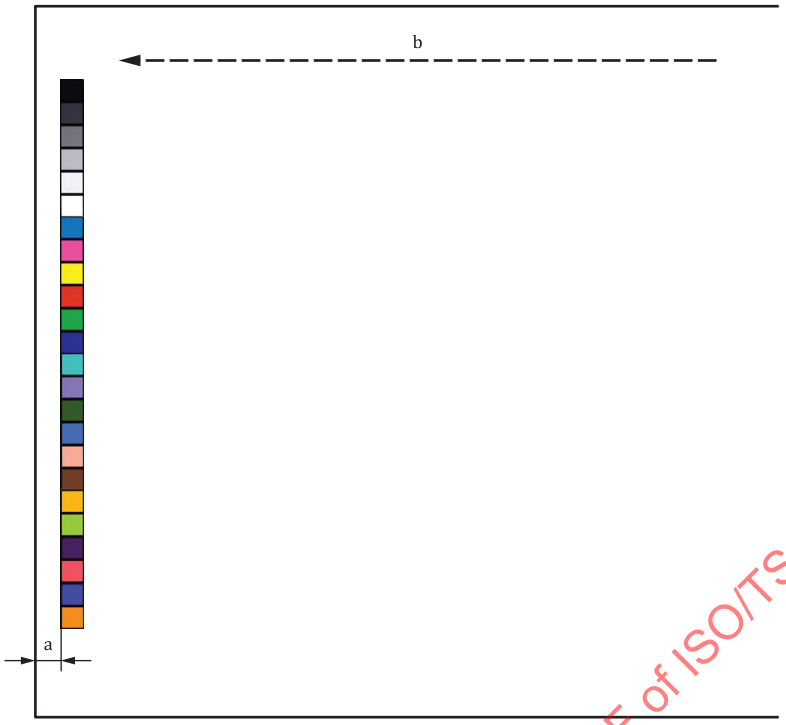


Key

a, b, c, d The distance between each edge of the print and the test target.

Figure 2 — An example of the test target arrangement for small (left) and medium (right) print

When the print size is equal to or larger than 2 600 cm^2 (e.g. 43 cm × 60 cm), and smaller than 5 400 cm^2 (e.g. 60 cm × 90 cm), the 24 solid patches shall be positioned at the leading edge of the print, as shown in Figure 3. Other layouts may be used, but the layout used shall be reported.



Key

a The distance between the edge and the patch, a = 25 mm.

b The printing direction.

Figure 3 — An example of the test target arrangement for large size print

When multiple photographic images (pages) need to be printed on one larger sheet described in the previous paragraph, the above test target shall be printed at the centre of each location corresponding to where each image (page) will be printed on the large sheet. When the locations of the images to be printed are not specified, the locations may be the centre and near each of the four corners of the large sheet.

ISO 18944 shall be referred to for more details concerning dimensions.

5 Printing

5.1 Environmental conditions

The standard ambient environmental conditions shall be the temperature of 23 °C ± 3 °C, relative humidity of 50 % RH ± 10 % RH and air pressure of 101 kPa ± 20 kPa.

The printing test shall be done under this standard ambient environmental condition. However, if it is not possible to conduct the test under the standard condition, the test may be done under uncontrolled environmental conditions. In this case, the temperature and relative humidity shall be measured regularly every 30 min and shall be reported.

In addition to the defined standard ambient environment, it is recommended that the test be performed under different temperature and relative humidity conditions, for example, at the higher end (e.g., 35 °C, 90 % RH) and the lower end (e.g., 5 °C, 10 % RH) of the "operating environment" specified for the printing system. The temperature and relative humidity conditions of the test shall be reported.

5.2 Procedures

The test target described in Clause 4 shall be printed consecutively. The number of sheets ranges from 10 to 100 sheets or more. However, the number of sheets will be determined based on the actual situation of normal printing work.

The default printing mode of the printing systems shall be applied. However, a particular printing mode can be used if a particular print mode other than the default mode is normally used for the application. In any case, the printer setting and printing mode shall be reported.

The printer should be in standard operating condition for printing of the test targets, which may require warming-up. According to the actual practice of the printing system, the printing state should be selected from 1-a) active state of on mode, 1-b) ready state of on mode, 2) off mode, 3) sleep mode, or 4) standby mode defined in Energy Star Programme Requirements for Imaging Equipment – Eligibility Criteria ver. 2.0 (2014)[5].

Furthermore, if the printing system has an automatic calibration function as the default mode, then the automatic calibration shall be applied. Nevertheless, any additional setting shall be reported. If the calibration of the printing system is carried out manually, the calibration shall be done in the same manner based on common practice. The manual implementation of the calibration shall be reported.

It is worth noting that colour variation of printing may occur depending on the time within a day, from day to day, and between different seasons (from the coldest winter period to the hottest summer).

"Consecutive printing" is referred to here as one consecutive printing initiated with an order from the operating system. Even if a pause is automatically inserted between printings, it is recognised as one consecutive printing job in this document.

6 Sampling

6.1 Reproducibility within a job

During continuous printing within a job, all sheets shall be sampled. For simple testing, for example, the sampling shown in Table 2 may be performed. However, the details of the sampling shall be reported. Sampling can be varied depending the objective of the test. An example of other protocol is described in ISO 15311-1[3].

Table 2 — Example of sampling for simple testing

	Total number of sheets	Sheets to be sampled
a	10	1st, 2nd, 3rd, 4th, 5th, 6th, 7th, 8th, 9th, 10th
b	50	1st, 2nd, 3rd, 5th, 10th, 20th, 30th, 40th, 50th
c	100	1st, 2nd, 3rd, 5th, 10th, 20th, 40th, 60th, 80th, 100th

6.2 Colour variation between jobs

Sampling for evaluating variation between jobs (in a day or different days) shall be determined based on 6.1.

6.3 Colour variation between printed images located in different areas on a large sheet

When multiple images will be printed on different locations within a large sheet, each location shall be sampled. The test target shown in Table 1 and Figure 1 shall be printed at the centre of each location on the sheet corresponding to where each image will be printed. The layout of the test target for each location is shown in Figure 2. The layout of individual images (sampling locations) in a large sheet should be determined according to the actual job using the printing system. When the locations of the

images to be printed are not specified, the locations may be the centre and near each of the four corners of the large sheet. For more additional details, ISO 12647-8[1] can be referred.

7 Measurement

7.1 Measurement device

For colorimetric evaluation, all the 24 patches of the printed test target described in Clause 4 shall be measured using a spectrophotometer.

Densitometry measurement described in ISO 5-4 may also be used.

The same measurement equipment shall be used throughout the test.

7.2 Timing of measurement

The measurement can be done at any time within 30 days after printing. For inkjet prints, the measurement shall be done at the earliest after a 14-day conditioning period, and within 30 days of printing.

7.3 Measurement conditions

The colour of the samples shall be measured based on ISO 11664-1 and ISO 11664-4. The geometry of the spectrophotometer shall be 45°/0° or 0°/45°. The colour value shall be computed using the CIE 1931 with a 2° observer for the detector and the illuminant shall be CIE standard illuminant D50.

When different printers or printing systems are tested, all measurements shall be done with the same measurement conditions.

For colour evaluation, the measurement condition M0 described in ISO 13655[2] should be applied. The other condition, M1 or M2, may be used but the measurement condition shall be the same as employed during calibration of the device.

NOTE ISO 13655 notes that M0 measurement conditions are sufficient for process control. This provision helps ensure that the existing population of instruments is not immediately called into question, and can continue to be used in many workflows. Use of M0 is the most common practice today.

8 Calculation

8.1 General

The colour components, L^*, a^* and b^*, for all of the 24 colour patches in all of the test targets shall be measured, and the simple average across all printed targets (within a job, or within a set of jobs) shall be calculated for each individual colour patch Q (Q = 1, 2, 3, …, 24) and be noted as: $L^*_{Q\text{-ave}}$, $a^*_{Q\text{-ave}}$ and $b^*_{Q\text{-ave}}$, where, Q represents the ID of a specific colour patch among the 24 patches.

The measured results and their calculated average shall be recorded in a data table, similar to the example shown in Table 3.

Table 3 — An example of blank table of colour data

Colour patch Q (Q = 1 to 24)	Sampled sheet 1 (The 1st sheet)			→ (Sheet 2 to Sheet s-1)			Sampled sheet s (The last sheet)			Average of all sampled sheets i = 1 to s		
	L^*_1	a^*_1	b^*_1	L^*_i	a^*_i	b^*_i	L^*_s	a^*_s	b^*_s	L^*_{ave}	a^*_{ave}	b^*_{ave}
1	$L^*_{1\text{-}1}$	$a^*_{1\text{-}1}$	b^*_1	$L^*_{1\text{-}i}$	$a^*_{1\text{-}i}$	$b^*_{1\text{-}i}$	$L^*_{1\text{-}s}$	$a^*_{1\text{-}s}$	$b^*_{1\text{-}s}$	$L^*_{1\text{-}ave}$	$a^*_{1\text{-}ave}$	$b^*_{1\text{-}ave}$
2	$L^*_{2\text{-}1}$	$a^*_{2\text{-}1}$	$b^*_{2\text{-}1}$	$L^*_{2\text{-}i}$	$a^*_{2\text{-}i}$	$b^*_{2\text{-}i}$	$L^*_{2\text{-}s}$	$a^*_{2\text{-}s}$	$b^*_{2\text{-}s}$	$L^*_{2\text{-}ave}$	$a^*_{2\text{-}ave}$	$b^*_{2\text{-}ave}$
3	$L^*_{3\text{-}1}$	$a^*_{3\text{-}1}$	$b^*_{3\text{-}1}$	$L^*_{3\text{-}i}$	$a^*_{3\text{-}i}$	$b^*_{3\text{-}i}$	$L^*_{3\text{-}s}$	$a^*_{3\text{-}s}$	$b^*_{3\text{-}s}$	$L^*_{3\text{-}ave}$	$a^*_{3\text{-}ave}$	$b^*_{3\text{-}ave}$
↓												
23	$L^*_{23\text{-}1}$	$a^*_{23\text{-}1}$	$b^*_{23\text{-}1}$	$L^*_{23\text{-}i}$	$a^*_{23\text{-}i}$	$b^*_{23\text{-}i}$	$L^*_{23\text{-}s}$	$a^*_{23\text{-}s}$	$b^*_{23\text{-}s}$	$L^*_{23\text{-}ave}$	$a^*_{23\text{-}ave}$	$b^*_{23\text{-}ave}$
24	$L^*_{24\text{-}1}$	$a^*_{24\text{-}1}$	$b^*_{24\text{-}1}$	$L^*_{24\text{-}i}$	$a^*_{24\text{-}i}$	$b^*_{24\text{-}i}$	$L^*_{24\text{-}s}$	$a^*_{24\text{-}s}$	$b^*_{24\text{-}s}$	$L^*_{24\text{-}ave}$	$a^*_{24\text{-}ave}$	$b^*_{24\text{-}ave}$
$L^*_{Q\text{-}i}$: L^* of colour patch Q of i^{th} sheet,				$L^*_{Q\text{-}ave}$: Average L^* of colour patch Q across all sheet 1 to s.								
$a^*_{Q\text{-}i}$: a^* of colour patch Q of i^{th} sheet,				$a^*_{Q\text{-}ave}$: Average a^* of colour patch Q across all sheet 1 to s.								
$b^*_{Q\text{-}i}$: b^* of colour patch Q of i^{th} sheet,				$b^*_{Q\text{-}ave}$: Average b^* of colour patch Q across all sheet 1 to s.								

The standard deviation and the difference between maximum and minimum of L^*, a^*, b^* of each colour patch (Q = 1 to 24) of all sampled sheets can be calculated to look at the variation of the L^*, a^*, b^*.

8.2 Calculation of colour difference

For each sampled sheet, i, the colour difference of a specific colour patch Q from the average colour value of the same colour patch Q across the entire test target set, $\Delta E_{Q\text{-}i}$, is calculated using Formula (1) below:

$$\Delta E_{Q\text{-}i} = \sqrt{\left(L^*_{Q\text{-}i} - L^*_{Q\text{-ave}}\right)^2 + \left(a^*_{Q\text{-}i} - a^*_{Q\text{-ave}}\right)^2 + \left(b^*_{Q\text{-}i} - b^*_{Q\text{-ave}}\right)^2} \quad (1)$$

where, $L^*_{Q\text{-}i}$, $a^*_{Q\text{-}i}$ and $b^*_{Q\text{-}i}$ are the measured colour component values on the colour patch Q in sample, i, and $L^*_{Q\text{-ave}}$, $a^*_{Q\text{-ave}}$ and $b^*_{Q\text{-ave}}$ are the calculated average colour component values of the same colour patch Q across all the samples of the printed test target set (recorded in the three columns on right in Table 3).

$\Delta E_{Q\text{-}i}$, which corresponds to the CIELAB ΔE_{ab}, shall be the standard parameter of this document. However, the CIELAB ΔE_{00} also can be used, when the value is compared to the other information which uses the CIELAB ΔE_{00}.

NOTE The ΔE_{ab} is selected as the standard parameter in this document. The reason is that, compared to ΔE_{00}, ΔE_{ab} is comparable to, or even better, when correlating it to the results from visual assessment. This has been reported in the literature[6][7].

In addition to the colour difference $\Delta E_{Q\text{-}i}$ the difference in the lightness, L^*, and the chroma, C^*, may be reported in an analogous way.

The calculated value of $\Delta E_{Q\text{-}i}$ of the colour patch (Q = 1 to 24) of the sampled sheets (i = 1 to s) are recorded as shown in Table 4.

For each colour patch, Q, the average ΔE of all sampled sheets (i = 1 to s), $\Delta E_{Q\text{-ave}}$, shall be calculated using Formula (2), from which, the maximum ΔE among all sampled sheets (i = 1 to s), $\Delta E_{Q\text{-max}}$, shall be determined.

$$\Delta E_{Q\text{-ave}} = \sum_{i=1}^{s} \Delta E_{Q\text{-}i} \,/\, \mathrm{s} \tag{2}$$

For each sampled sheet, i (i = 1 to s), the average ΔE of all 24 colour patches (Q = 1 to 24), $\Delta E_{\text{ave-}i}$, shall be calculated using Formula (3), from which, the maximum ΔE among all 24 colour patches (Q = 1 to 24), $\Delta E_{\text{max-}i}$ shall be determined.

$$\Delta E_{\text{ave-}i} = \sum_{Q=1}^{24} \Delta E_{Q\text{-}i} \,/\, 24 \tag{3}$$

Further, the average ΔE of all colour patches (Q = 1 to 24) and all sampled sheets (i = 1 to 24), $\Delta E_{\text{ave-all}}$ shall be calculated using Formula (4), from which, the maximum ΔE among all colour patches (Q = 1 to 24) and all sampled sheets (i = 1 to 24), $\Delta E_{\text{max-max}}$ shall be determined.

$$\Delta E_{\text{ave-all}} = \sum_{Q=1}^{24} \Delta E_{Q\text{-ave}} \,/\, 24 \tag{4}$$

The colour difference of the 95$^{\text{th}}$ percentile of all 24 patches of all sampled sheets, $\Delta E_{95\ \%\text{-tile}}$, shall be calculated according to ISO/TS 21139-1:2019, Annex G.

These results shall be recorded in the three boxes at the lower-right corner in Table 4.

Table 4 — Example of a blank table of colour of difference, $\Delta E_{Q\text{-}i}$, data

Colour patch Q	$\Delta E_{Q\text{-}i}$				
	Sampled sheet 1 (1st sheet) $\Delta E_{Q\text{-}1}$	→ **(2nd to s-1 sheet)** $\Delta E_{Q\text{-}i}$	**Sampled sheet s (the last sheet)** $\Delta E_{Q\text{-}s}$	**Average value of $\Delta E_{Q\text{-}i}$ of all samples** 1 to s $\Delta E_{Q\text{-ave}}$	**Maximum value of $\Delta E_{Q\text{-}i}$ in samples** 1 to s $\Delta E_{Q\text{-max}}$
1	$\Delta E_{1\text{-}1}$	$\Delta E_{1\text{-}i}$	$\Delta E_{1\text{-}s}$	$\Delta E_{1\text{-ave}}$	$\Delta E_{1\text{-max}}$
2	$\Delta E_{2\text{-}1}$	$\Delta E_{2\text{-}i}$	$\Delta E_{2\text{-}s}$	$\Delta E_{2\text{-ave}}$	$\Delta E_{2\text{-max}}$
3	$\Delta E_{3\text{-}1}$	$\Delta E_{3\text{-}i}$	$\Delta E_{3\text{-}s}$	$\Delta E_{32\text{-ave}}$	$\Delta E_{3\text{-max}}$
↓					
23	$\Delta E_{23\text{-}1}$	$\Delta E_{23\text{-}i}$	$\Delta E_{23\text{-}s}$	$\Delta E_{23\text{-ave}}$	$\Delta E_{23\text{-max}}$
24	$\Delta E_{24\text{-}1}$	$\Delta E_{24\text{-}i}$	$\Delta E_{24\text{-}s}$	$\Delta E_{24\text{-ave}}$	$\Delta E_{24\text{-max}}$
Average ΔE of 24 colour patches $\Delta E_{\text{ave-}i}$	$\Delta E_{\text{ave-}1}$	$\Delta E_{\text{ave-}i}$	$\Delta E_{\text{ave-}s}$	$\Delta E_{\text{ave-all}}$	

$\Delta E_{Q\text{-}i}$: Colour difference of colour patch Q of the i^{th} sheet from the average across all sampled sheets.

$\Delta E_{Q\text{-ave}}$: Average ΔE of colour patch Q across all sampled sheets.

$\Delta E_{Q\text{-max}}$: Maximum ΔE of colour patch Q among all sampled sheets.

$\Delta E_{\text{ave-}i}$: Average ΔE of i^{th} sampled sheet across all colour patches Q (1 to 24).

$\Delta E_{\text{max-}i}$: Maximum ΔE of i^{th} sampled sheet among all colour patches Q (1 to 24).

$\Delta E_{\text{ave-all}}$: Average ΔE across all colour patches Q (1 to 24) of all sampled sheet.

$\Delta E_{\text{max-max}}$: Maximum ΔE among of all colour patches Q (1 to 24) of all sampled sheet.

Table 4 *(continued)*

Colour patch Q	$\Delta E_{Q\text{-}i}$				
	Sampled sheet 1 (1st sheet) $\Delta E_{Q\text{-}1}$	→ **(2nd to s-1 sheet)** $\Delta E_{Q\text{-}i}$	**Sampled sheet s (the last sheet)** $\Delta E_{Q\text{-}s}$	**Average value of $\Delta E_{Q\text{-}i}$ of all samples** 1 to s $\Delta E_{Q\text{-ave}}$	**Maximum value of $\Delta E_{Q\text{-}i}$ in samples** 1 to s $\Delta E_{Q\text{-max}}$
Maximum ΔE among the 24 colour patches $\Delta E_{\text{max-}i}$	$\Delta E_{\text{max-1}}$	$\Delta E_{\text{max-}i}$	$\Delta E_{\text{max-}s}$		$\Delta E_{\text{max-max}}$
ΔE of 95 %-tile of samples $\Delta E_{\text{i95 \%-tile}}$					$\Delta E_{95\ \%\text{-tile}}$

$\Delta E_{Q\text{-}i}$: Colour difference of colour patch Q of the i^{th} sheet from the average across all sampled sheets.

$\Delta E_{Q\text{-ave}}$: Average ΔE of colour patch Q across all sampled sheets.

$\Delta E_{Q\text{-max}}$: Maximum ΔE of colour patch Q among all sampled sheets.

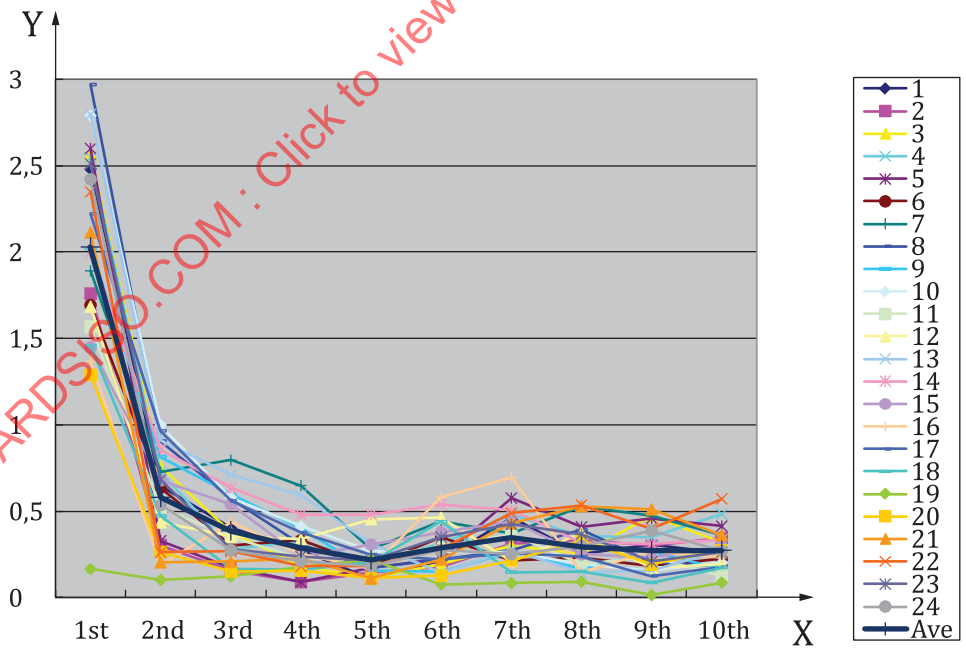
$\Delta E_{\text{ave-}i}$: Average ΔE of i^{th} sampled sheet across all colour patches Q (1 to 24).

$\Delta E_{\text{max-}i}$: Maximum ΔE of i^{th} sampled sheet among all colour patches Q (1 to 24).

$\Delta E_{\text{ave-all}}$: Average ΔE across all colour patches Q (1 to 24) of all sampled sheet.

$\Delta E_{\text{max-max}}$: Maximum ΔE among of all colour patches Q (1 to 24) of all sampled sheet.

The colour variation averaged over all 24 colour patches on the i^{th} sampled sheet, $\Delta E_{\text{ave-}i}$, shall be plotted on the graph. An example of the graph is shown in Figure 4.



Key

X sampled sheets

Y $\Delta E_{Q\text{-}i}$

Figure 4 — Example of colour variation, $\Delta E_{Q\text{-}i}$, of 24 colour patches (Q = 1 to 24) within a job

8.3 Colour variation between jobs

For evaluation of colour variation between jobs, the same calculation shall be applied for each job.

The difference between jobs can be shown using the graph of the each job, as shown in the comparison of Figure 4.

Alternatively, the variation between jobs can be shown by plotting $\Delta E_{\text{ave-all}}$ and $\Delta E_{\text{max-max}}$ described in 8.2, which shows the difference between each job.

9 Test report

9.1 In laboratory notebook

The following should be recorded in the laboratory notebook:

a) a reference to this document, i.e. ISO/TS 20791-2:2021;

b) printing system:

   1) printer: model name, manufacturing number, manufacturing date;

   2) printer driver: driver setting, printer driver version;

   3) materials (media and ink/toner/ribbon or chemicals, others): product name, manufacturing number, manufacturing date;

c) printing contents:

   1) print size, layout;

   2) test target design (input colour values);

   3) colour values of each patch [output colour values];

d) environmental conditions: temperature, humidity and air pressure at every 30 min during the printing tests;

e) printing procedures

   1) date and time, place;

   2) name of the operator;

   3) operation details, such as warm up, printing state, calibration (e.g., non/automatic/manual);

   4) number of prints;

   5) sampling details;

   6) conditioning, such as stacking or spreading, and environmental conditions;

f) Measurements:

   1) date and time (time from printing to measurement), place;

   2) name of the operator;

   3) measurement device, e.g. product type, geometry, UV cut filter, and other settings;