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AMENDMENT 1
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Information technology — Office equipment — Measurement of image quality attributes for hardcopy output — Monochrome text and graphic images

AMENDMENT 1

Technologies de l'information — Équipement de bureau — Mesurage des attributs de qualité d'image — Texte monochrome et images graphiques

AMENDEMENT 1

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

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Information technology — Office equipment — Measurement of image quality attributes for hardcopy output — Monochrome text and graphic images

AMENDMENT 1

Clause 2

Add the following two references in Clause 2:

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

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

5.2.2

Replace the first paragraph as follows:

In order to determine the inner boundary, the maximum reflectance factor (R_{max}) is determined by averaging the R_v values measured in the area selected by the user as background area and the minimum reflectance factor (R_{min}) is determined by averaging the R_v values measured in the area selected by the user as image area, in which the visual reflectance R_v values can be obtained via OECF conversion of the measured data in G channel as specified in 6.2.1. Then, from R_{max} and R_{min}, R_{10} is computed and the inner boundary edge is determined.

5.2.3

Replace b) as follows:

b) Measure the the visual reflectance R_v (x, y) wholly within the ROI.

Replace $Y(x, y)$ in Fomula (1) to $R_v(x, y)$

5.2.4

Replace b) as follows:

b) Measure the the visual reflectance R_v (x, y) wholly within the ROI.

Replace $Y(x, y)$ in Fomula (2) to $R_v(x, y)$

5.2.5.2

Replace b), c), g) and j) as follows:

b) Measure scanner outputs in terms of $R_S(x, y)$, $G_S(x, y)$ and $B_S(x, y)$ of 360 000 (600×600) pixels, evenly-spaced and non-overlapping elements within the ROI, respectively. Then, convert those values in $R_S(x, y)$, $G_S(x, y)$ and $B_S(x, y)$ to the linearized values in $R_L(x, y)$, $G_L(x, y)$ and $B_L(x, y)$ as described in 6.2.3.

c) Convert the values in $R_L(x, y)$, $G_L(x, y)$ and $B_L(x, y)$ to the values in CIE Y (x, y) by using Formula (3), derived by converting the matrix in page 4 in "https://www.color.org/chardata/rgb/sRGB.pdf", and calculate the positive values of the square root of CIE Y (x, y) $(Y(x, y)^{0,5})$ as input data for the wavelet transform:

$$Y_{D50}(x,y) = 0{,}2224 R_L(x,y) + 0{,}7169 G_L(x,y) + 0{,}0606 B_L(x,y) \quad (3)$$

$$\text{when } Y_{D50}(x,y) \geq Y_{D50}(100\,\%\text{ patch of conformance chart}),$$

$$Y_{D50}(x,y) = Y_{D50}(100\,\%\text{ patch of conformance chart})$$

$$\text{when } Y_{D50}(x,y) < Y_{D50}(100\,\%\text{ patch of conformance chart}).$$

Mottle scores calculated by using the method in this document do not show a good agreement with subjective scores when test patches include noise with CIE Y values lower than the colourimetrically measured CIE Y value for the solid patch in the confomance test chart. A clipping procesure in Formula (6) to replace such low CIE Y values to the measured CIE Y value for the solid patch noticeably improved this issue. Considering consistency throughout this document, not only Formula (6) for mottle measurement, but also Formula (3) for graininess measurement and Formula (11) for banding measurement, adopt the same formula with this clipping procedure.

g) Apply the inverse wavelet transform to get the filtered image $Y'(x, y)^{0,5}$.

j) Compute the variance $v_{i,j}$ of each tile of i-th row and j-th column [Formula (4) assumes a total of 60×60 = 3 600 pixels per tile]:

$$v_{i,j} = \frac{1}{60\times 60-1}\sum_{x=1}^{60}\sum_{y=1}^{60}\left[Y'^{\,0,5}_{i,j}(x,y) - \overline{Y'^{\,0,5}_{i,j}}\right]^2 \quad (4)$$

5.2.6.2

Replace b), c), g) and j) as follows:

b) Measure scanner outputs in terms of $R_S(x, y)$, $G_S(x, y)$ and $B_S(x, y)$ of 14 400 (1 200×1 200) pixels, evenly-spaced and non-overlapping elements within the ROI, respectively. Then, convert those values in $R_S(x, y)$, $G_S(x, y)$ and $B_S(x, y)$ to the linearized values in $R_L(x, y)$, $G_L(x, y)$ and $B_L(x, y)$ as described in 6.2.3.

c) Convert the three optical reflectance factors to a single CIE Y (x,y), using Formula (6), and calculate the positive values of the square root of CIE Y (x, y) $(Y(x, y)^{0,5})$ as input data for the wavelet transform:

$$Y_{D50}(x,y) = 0{,}2224 R_L(x,y) + 0{,}7169 G_L(x,y) + 0{,}0606 B_L(x,y) \quad (6)$$

$$\text{when },Y_{D50}(x,y) \geq Y_{D50}(100\,\%\text{ patch of conformance chart}),$$

$$Y_{D50}(x,y) = Y_{D50}(100\,\%\text{ patch of conformance chart})$$

$$\text{when } Y_{D50}(x,y) < Y_{D50}(100\,\%\text{ patch of conformance chart})$$

g) Apply the inverse wavelet transform to get the filtered image $Y'(x, y)^{0,5}$.

j) Compute the variance $v_{i,j}$ of each tile of i-th row and j-th column [Formula (7) assumes a total of 120×120 = 14 400 pixels per tile]:

$$v_{i,j} = \frac{1}{120 \times 120 - 1} \sum_{x=1}^{120} \sum_{y=1}^{120} \left[{Y'_{i,j}}^{0,5}(x,y) - \overline{{Y'_{i,j}}^{0,5}} \right]^2 \quad (7)$$

5.2.9

Replace b), c) and d) as follows:

b) Measure scanner outputs in terms of $R_S(x, y)$, $G_S(x, y)$ and $B_S(x, y)$ within ROI at a minimum of 600 dpi, and convert those values in $R_S(x, y)$, $G_S(x, y)$ and $B_S(x, y)$ to the linearized values in $R_L(x, y)$, $G_L(x, y)$ and $B_L(x, y)$ as described in 6.2.3.

c) Calculate one-dimensional reflectance profiles of $R_L(x)$, $G_L(x)$ and $B_L(x)$ by averaging in the y-direction. Where inclination of an image to the scanner geometry should be 0,2° or less.

d) Convert the reflectance profiles in $R_L(x)$, $G_L(x)$ and $B_L(x)$ to a single profile in terms of CIE Y (x), using Formula (11):

$$Y_{D50}(x,y) = 0{,}2224 R_L(x,y) + 0{,}7169 G_L(x,y) + 0{,}0606 B_L(x,y) \quad (11)$$

$$\text{when } Y_{D50}(x,y) \geq Y_{D50}(100\,\%\text{ patch of conformance chart}),$$

$$Y_{D50}(x,y) = Y_{D50}(100\,\%\text{ patch of conformance chart})$$

$$\text{when } Y_{D50}(x,y) < Y_{D50}(100\,\%\text{ patch of conformance chart}).$$

5.3.4

Replace c) as follows:

Compute the line image density (LID), the average optical density of the area within the R_{25} boundary, equivalent to the negative value of the base 10 logarithm of the average reflectance factor of the area.

6.2.1

Replace the 1st paragraph as follows:

An OECF created with the following procedures as specified in ISO 14524 is used for measurement of image quality attributes except mottle, graininess and banding using the large area darkness pattern of system conformance test chart specified in 6.3.2.6, only G channel is used to obtain visual reflectance R_{vi}.

In mottle, graininess and banding measurements, measure scanner outputs in terms of $R_S(x, y)$, $G_S(x, y)$ and $B_S(x, y)$ within ROI at a minimum of 600 dpi, and convert the values in $R_S(x, y)$, $G_S(x, y)$ and $B_S(x, y)$ to the linearized values in $R_L(x, y)$, $G_L(x, y)$ and $B_L(x, y)$ as described in 6.2.3.

Remove f).

6.2.3

Create subclause 6.2.3 "sRGB conversion" as follows:

6.2.3 sRGB conversion

Colourimetric measurement shall be carried out under the D50 illuminant with 2-degree observer condition as defined in ISO 13655. Either M1 or M2 illuminant can be used, while the illuminant condition shall be maintained consistently throughout measurements. The conversion from scanner RGB to linearized sRGB shall be performed as follows.

a) Measure the CIE $X_{D50}Y_{D50}Z_{D50}$ values of 13 patches of the large area darkness pattern contained in the ISO/IEC 24790 system conformance test chart.

b) Convert the values in CIE $X_{D50}Y_{D50}Z_{D50}$ to those in the linearized $R_L G_L B_L$, in the sRGB colour space as defined in IEC 61966 2-1, using the following formula (30), derived as the inverse matrix of the matrix in page 4 in "https://www.color.org/chardata/rgb/sRGB.pdf":

$$\begin{bmatrix} R_L \\ G_L \\ B_L \end{bmatrix} = \begin{bmatrix} 3{,}133923646 & -1{,}616922939 & -0{,}490733723 \\ -0{,}978421052 & 1{,}915842665 & 0{,}033399127 \\ 0{,}072035534 & -0{,}229032035 & 1{,}405716158 \end{bmatrix} \begin{bmatrix} X_{D50} \\ Y_{D50} \\ Z_{D50} \end{bmatrix} \quad (30)$$

c) Scan the 13 patches of the gray scale with a scanner in RGB mode and calculate the average $R_s G_s B_s$ values of each gray scale step.

d) Perform a 4th-order regression analysis between the liner sRGB($R_L G_L B_L$) and scanner RGB($R_s G_s B_s$) to determine the coefficient values of a_R, b_R, c_R, a_G, b_G, c_G, a_B, b_B and c_B in the following conversion functions.

$$R_L = a_R \times R_S{}^4 + b\mathrm{R} \times R_S{}^2 + c_R \quad (31)$$

$$G_L = a_G \times G_S{}^4 + b_G \times G_S{}^2 + c\mathrm{G} \quad (32)$$

$$B_L = a_B \times B_S{}^4 + b_B \times B_S{}^2 + c_B \quad (33)$$

In case converted sRGB values by those formulae are less than zero, replace them with zero.

6.4

Add the following Note after the first paragraph:

NOTE The goal values for each attribute were specified with respect to the variations in the measured results in the various scanners when the test objects of the confomance test chart in Annex E are used. In the mottle conformance test, as the measured results varied depending on ROI in the test object, the goal values were determined based on the measured results when ROI sets the center of the object. A mottle conformance test sometime shows a value outside the goal value range when ROI is not arranged the centre of the test object correctly.

Replace Table 10 as follows:

Table 10 — Goal values for system conformance test of background darkness, mottle, graininess and banding

Attribute	Range		
Background darkness	0,128	–	0,140
Mottle	3,457	–	3,745
Graininess	2,379	–	2.630
Banding	3,326	–	3,531

B.4.1

Replace the subclause with the following text and footnotes:

The tool for the system conformance test "TS24790_Tool_Ver.1.6.exe" can be obtained from the Japanese Business Machine and Information System Association (JBMIA) website[1].

To use this tool the following programs will need to be installed:

a) "LabVIEW2020 SP1 Runtime Engine 32bit"[2];

b) "MATLAB Compiler Runtime 2012a"[3];

c) "Visual C++2010 redistributable"[4].

1) Available at: https://iso.jbmia.or.jp/test_c_new.html. This tool is given for the convenience of users of this document and does not constitute an endorsement by ISO or IEC of these product(s).

2) Available at: https://www.ni.com/en-us/support/downloads/software-products/download.labview-runtime.html#346222. LabVIEW Runtime is the trade name of a product supplied by NI This information is given for the convenience of users of this document and does not constitute an endorsement by ISO or IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

3) Available at: https://www.mathworks.com/products/compiler/mcr/index.html. MATLAB Compiler is the trade name of a product supplied by MathWorks This information is given for the convenience of users of this document and does not constitute an endorsement by ISO or IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

4) Available at: https://www.microsoft.com/en-us/download/details.aspx?id=26999. Visual C++ is the trade name of a product supplied by Microsoft This information is given for the convenience of users of this document and does not constitute an endorsement by ISO or IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

E.3

Replace the first paragraph and Table E.1 as follows:

The OECF characteristic employed in the measurement methods specified in this document can be produced using the procedure specified in 6.2.1 using the large area darkness patterns of the conformance test chart. Visual density and CIE Y of these patterns on 32 prints sampled from the production run are summarized in Table E.1.

Table E.1 — Measurement values of large area darkness pattern for system conformance test

Coverage (%)	Visual density		CIE_Y	
	Average of	Standard deviation	Average of	Standard deviation
0	0,091	0,005	81,171	0,941
5	0,147	0,007	71,365	1,069
10	0,203	0,005	62,692	0,656
20	0,336	0,006	47,839	9,540
30	0,472	0,005	33,741	0,415
40	0,629	0,008	23,513	0,406
50	0,786	0,008	16,366	0,303
60	0,957	0,009	11,038	0,226
70	1,131	0,010	7,394	0,172
80	1,322	0,012	4,764	0,130
90	1,503	0,008	3,145	0,058
95	1,617	0,009	2,417	0,050
100	1,792	0,011	1,616	0,039