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Graphic technology — Requirements for colour soft proofing systems

Technologie graphique — Exigences pour les systèmes d'épreuve à l'écran couleur

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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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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 meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 130, *Graphic technology.*

Introduction

The use of images displayed on a colour monitor is increasingly being used in the graphic arts industry for colour evaluation and colour acceptance (commonly referred to as “soft” proofing). This requires that the colour display and its associated viewing environment be able to simulate the appearance of the final printed image viewed under standard graphic arts viewing conditions. The major components required to accomplish this are assembled to create a soft proofing system which is usually comprised of a monitor, colour measurement device, driving software (for calibration, profiling the monitor, and displaying the data), and a viewing cabinet. The overall design and calibration has to control and take into account the influence of ambient lighting.

As the use of soft proofing increases, the need for an objective and vendor neutral assessment of soft proofing systems is steadily increasing. This International Standard specifies requirements for systems that are used to produce, from digital data, images on electronic displays that are intended to simulate a characterized printing condition defined by a set of characterization data and spot colours defined by a physical reference.

This International Standard builds on the monitor requirements defined in ISO 12646, the viewing cabinet defined in ISO 3664, and the requirements for contract hard copy proofing defined in ISO 12647-7.

Three common soft proof scenarios are typically encountered. In the first scenario, a soft proof is displayed on a monitor without an associated viewing cabinet. In the second scenario, a viewing cabinet is associated with the monitor. In the third, the monitor is a part of, and built-into, a viewing cabinet. To test how closely the displayed image simulates the encoded colorimetric data of the original, there is no need to differentiate between these three scenarios. However, to assess the similarity of the soft proof reproduction (as described in this standard) to a reference print, a viewing cabinet or controlled room lighting is required.

The objective assessment of a soft proofing display system is carried out in three steps. First, the monitor and the viewing cabinet are tested to ensure that these components are capable of achieving the results needed to produce a high quality soft proof. Second, the capability of the combination of the monitor and the display driving software is tested. Third, the simulation of an output condition, usually a characterized printing condition, is assessed.

With respect to the data handling and display driving software, a separation is made between the driving of the display and the simulation of a given colorimetric reference, termed simulation. The primary focus of the display driving software lies in the accurate characterization of the display. This is typically accomplished by a contact measurement device.

Once the display device itself is evaluated, the integration of the display and any associated viewing cabinet (or a room lighting setup to function as a viewing cabinet) and the effect of ambient lighting has to be evaluated. The simulation of an intended characterized printing condition represents the colorimetry of the display as seen from the viewer position. For that reason, telespectroradiometric readings are required at this stage of evaluation.

The use of a display and an associated viewing cabinet and/or the display integrated into a hard copy viewing cabinet often occurs in situations where a printed product, like a newspaper or offset print, is being evaluated with respect to the soft copy proof in the absence of a hard copy proof. In this case, there is active research as to how a concrete document can be shown reliably in order to facilitate it as a contract proof or reference in disputes of colour difference.

The use of a standalone display in uncontrolled ambient lighting is not subject of this International Standard because the final visual appearance of a soft proof on a display cannot be judged without taking into account the influence of the ambient light, even when the soft proof is viewed alone, without comparison to a physical object like a proof print, production print, or product sample.

Obtaining a good soft proof simulation of a reference is not simple and to be fully accurate requires careful control of many aspects of the process. The primary purpose of this International Standard is to establish the criteria and tolerances needed to evaluate a complete soft proofing system.

Graphic technology — Requirements for colour soft proofing systems

1 Scope

This International Standard specifies requirements for systems that are used to produce, from digital data, images on electronic displays that are intended to simulate a characterized printing condition defined by a set of characterization data and spot colours defined by a physical reference. Recommendations are provided with regard to equipment selection, setup, operating, and environmental conditions. Appropriate test methods associated with these requirements are specified.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3664, *Graphic technology and photography — Viewing conditions*

ISO 12639, *Graphic technology — Prepress digital data exchange — Tag image file format for image technology (TIFF/IT)*

ISO 12646, *Graphic technology — Displays for colour proofing — Characteristics and viewing conditions*

ISO 12647-7, *Graphic technology — Process control for the production of half-tone colour separations, proof and production prints — Part 7: Proofing processes working directly from digital data*

ISO 15930, *Graphic technology — Prepress digital data exchange using PDF*

3 Terms and definitions

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

3.1
display
electronic device capable of visibly communicating information

3.2
characterized printing condition
printing condition for which process control aims are defined and for which the relationship between input data (printing-tone values, usually CMYK) and the colorimetry of the printed image is documented

[SOURCE: ISO 15930-8:2010, 3.1]

3.3
power off
condition in which the *display* (3.1) is switched off

3.4
soft proof
visualization of colour image data using a *display* (3.1) with the intent of synthesizing the colour appearance under a defined illumination and viewing condition

3.5
soft proofing system
system of hardware and software components used to reproduce the colour appearance for a specific viewing condition

3.6
spectroradiometer
instrument for measuring radiometric quantities in narrow wavelength intervals over a given spectral region

[SOURCE: IEC 60050-845:1987 17.4]

3.7
telespectroradiometer
spectroradiometer (3.6) that uses an optical relay component to allow measurements to be made at a distance from the specimen

[SOURCE: ISO 13655:2009, 3.12]

Note 1 to entry: The measurement of spectral radiance is independent of the distance from the source, but the area that is imaged will not produce constant results unless the source is perfectly uniform. The surface of most *displays* (3.1) are not uniform enough for the radiance from a 25 mm diameter area to produce the same results as the radiance from a 10 mm diameter area. The distance to the display face and the cone half angle needs to be noted in the report.

Note 2 to entry: While some instruments of this type have obvious external input optics such as lenses and apertures (telescopic optics), many simpler, portable instruments used in graphic reproduction have such input optics inside the instrument housing and may have the ability to be used as a non-contact spectroradiometer with full conformance with this definition.

3.8
surround
area adjacent to the border of an image which, upon viewing the image, can affect the local state of adaptation of the eye

3.9
viewing cabinet
area of controlled illumination (usually enclosed on the sides and back) intended to provide a specified intensity and spectral power distribution to allow consistency viewing of a specimen

4 Requirements

4.1 Data delivery

Soft copy proofing systems shall accept digital data delivered as PDF/X data files as defined in ISO 15930 or shall accept digital data delivered as TIFF/IT files as defined in ISO 12639. Where TIFF/IT files are used, colour information shall be included using tag 34675 or tag 34029 as defined in ISO 12639.

NOTE PDF/X-1a requires that the intended printing condition be indicated. Where the intended printing condition is included in the registry of characterizations maintained by the International Color Consortium (ICC) and the digital data are cyan-magenta-yellow-key (black) (CMYK), the name used in the ICC registry is usually used for identification in lieu of including an ICC output profile. If the intended printing condition is not included in the said registry, PDF/X-1a requires that an ICC output profile be included.

4.2 Display requirements

The displays used for soft proofing shall meet either the class A or class B requirements of ISO 12646.

4.3 Viewing condition requirements

4.3.1 General

The visual environment should be designed to minimize interference with the viewing task. It is important to eliminate extraneous conditions that affect the appraisal of images on the display and prints in the viewing cabinet. There are many potential variations possible in soft proofing setups. To minimize variations, specific requirements are needed. In this International Standard, the final colour stimulus will be judged by instrumental measurements with specific requirements. For this reason, no additional normative requirements are provided for the position of the display.

Principally, there are two different setups. The first environment consists of a display situated next to (but not inside) a dedicated viewing cabinet. Here, the ambient shall be controlled so that stray light is not having a significant impact on the displayed image or its surround. In this situation, the illuminance level inside the viewing cabinet can be adjusted with the aid of a telespectrophotometer so that the reflected luminance from a sheet of paper (possibly containing a simulation of the intended paper) will match the displayed simulation of the intended paper. If an illuminance level is needed that differs from P1 or P2, this level should be used in the ISO 3664 evaluation test (in addition to the defined levels P1 or P2).

The second environment includes setups where illumination upon the display is intended or unavoidable. This is the case, for example, when a display is placed in a viewing cabinet next to a printing press. Here, the view booth illumination upon the display screen should be minimized as much as possible using display hoods, for example. For such systems, the cabinet illuminance, again, may not be within the limits specified in ISO 3664 when compensation is provided to achieve a match in luminance level and uniformity match between print and display.

When there is no dedicated viewing cabinet to be tested by the manufacturer in a dark room, all criteria defined in ISO 3664 shall be applied (of the objects to be soft proofed).

4.3.2 Displays to be used alone

The following guidelines should be used for cases where a display is used independently of a viewing cabinet:

a) the luminance of a perfectly reflecting diffuser placed at the position of the faceplate of the display (and behind any anti-reflection shields) with the display switched off (power off) should not be greater than 1/4 of the display white point luminance (R = G = B = 255 for 8-bit displays);

   NOTE This correlates to a colour change due to the added display reflection of about DE00 = 1 for a typical current flat panel display.

b) the display frame, the surround of the display, desks, walls, and everything in the field of view should be near neutral to ensure that no saturated chromatic elements affect the chromatic adaptation of the observer. For the display frame, grey would be the best colour, but black or white can also be used. Silver or aluminium display frames are not suited because of the glare. For walls and desks, a neutral grey would also be best, but white can also be used;

c) display hoods should be used to minimize the influence by surrounding illumination reflecting on the display surface. The hood should cover the display face from top and both sides;

d) the desktop and the keyboard should be neutral coloured and have a low reflectance. The top hood should be reasonably deep, from display face to the front edge, but not be oppressive.

The colorimetric difference between the characterization printing condition and the measured display by using patches compliant to ISO 12647-7 control strip shall be within the tolerances stipulated in Table 3.

4.4 Display driving and simulation requirements

4.4.1 General

First, a calibration shall be conducted in accordance with the manufacturer's requirements. A visual fine-tuning of the soft proofing system may be applied.

For each characterization printing condition to be tested, only the patches listed in Annex B, in addition to any desired spot colour patches, shall be printed. These patches shall be printed with a minimal patch size of 10 cm by 10 cm. These prints are subject for sequential presentation and measurement in the centre of the intended viewing plane for the scrutiny of the simulation accuracy. In case spot colours are to be reproduced, they shall be defined by uniform print samples. They will be presented and measured the same way as the prints before.

Printed patches shall meet a tighter tolerance than that specified in ISO 12647-7, i.e. patches simulating a characterization print conditions shall have ΔE_{00}avg ≤ 2, ΔE_{00}max ≤ 3 with respect to the reference characterization data and each spot colour patch shall have $\Delta E_{00} \leq 1{,}5$.

NOTE For many soft proofing systems, an A4 sheet size is practical and easy to handle for the measurements.

4.4.2 Testing of display driving

4.4.2.1 General

A soft copy proofing system shall adjust incoming image content data so that the display colour, as measured with a spectroradiometer, displays the colorimetry defined by the characterization colour characterization data associated with the content data file. The colours shall be displayed and measured at the centre of the display sequentially. The centre is defined as the area which is at least 1/4 of the length of the display from the inside border including the innermost 1/4 of the display. To test display driving, the measurement device (spectroradiometer or colorimeter, both in contact or distance) used to calibrate and profile the system shall be used. If a system specific calibration is used, the corrected measurement (matched to a reference measurement device to reflect variations among normal sighted observer) values shall be recorded instead of the raw measurement data.

NOTE 1 Displays with a built-in colorimeter which measures off the centre of the display may be used providing that the colorimeter has been correlated to the measurement at the centre of display with reliable equipment and a means of re-correlation is provided.

NOTE 2 A system specific calibration refers to a correction that is applicable for a defined type of monitor and/or measurement device (to compensate for systematic effects). This is used by soft proofing systems such as those from KODAK or remote director.

4.4.2.2 Colorimetric accuracy

The colorimetric accuracy is evaluated by how well the display to be tested is characterized by its ICC display profile or other means of colour transformation. It consists of two tests.

First, the 318 RGB patches defined in Annex A should be directly displayed and measured. The colour differences between the measurements and values predicted by the profile (absolute colorimetric rendering) should conform to the tolerances defined in Table 1. Colours identified to be in gamut for the reference printing condition should be displayed and measured and should conform to $\Delta E_{00} \leq 2{,}5$.

Table 1 — Tolerances for profile accuracy based on the RGB set defined in Annex A

Criteria	RGB code values	Tolerance
Profile accuracy	All	Mean $\Delta E_{00} \leq 2{,}5$ 99 Percentile $\Delta E_{00} \leq 4{,}5$

Second, for each reference printing condition to be tested, the so-called outer gamut patches defined in ISO 12647-7 will be displayed and measured at the display sequentially. The tolerances are specified in Table 2.

Table 2 — Tolerances for outer gamut patches defined in ISO 12647-7

Criteria	Tone value patches	Tolerance
Gamut	226 outer gamut patches defined in ISO 12647-7	Maximum $\Delta E_{00} \leq 2{,}5$[a]
[a] If the colour differences exceed the tolerances, the soft proofing application should have an option to show a pixel-based gamut-warning.		

NOTE Tests of calibration (also known as driving accuracy) accuracy are not normative since only the profile accuracy is directly contributing to the performance of a soft proofing system. Its accuracy may be tested and reported because a specific display calibration can be beneficial for some soft proofing systems.

4.4.2.3 Uniformity evaluation

4.4.2.3.1 General

The uniformity of a soft proofing system is vital and be checked for solid colours and for tonality (gradation) changes of the screen. It shall be reported and if hardware based, look up table display corrections are turned on (if present).

4.4.2.3.2 Evaluation of tone uniformity

The CIELAB values of a uniform 5 × 5 grid are calculated using the measurement of the centre patch at maximum driving as the reference white illuminant. Note that this method may result in some CIEL* values being greater than 100. 24 readings are compared with the centre colour for three different driving levels namely white at the maximum driving level (R = G = B = 255 for 8-bit displays), grey at about half maximum driving level (R = G = B = 127 for 8-bit displays), and dark grey at about one fourth of maximum driving level (R = G = B = 63 for 8-bit displays) by means of the DE00 colour difference formulae.[2] For the white and the grey driving levels, the DE00 colour differences shall be equal or less than four and should be equal or less than two.

4.4.2.3.3 Tonality evaluation (uniformity)

Utilizing luminance (cd/m^2) measurements of grey at half maximum driving level (R = G = B = 127 for 8-bit displays) and white at max driving level (R = G = B = 255 for 8-bit displays), the grey/white ratio shall be calculated for the 25 regions. For the non-central regions, new ratios, T_i, with i = {1,..,24} shall be computed by dividing the individual grey/white ratios, R_i, with i = {1,...,24} by the grey/white ratio of the centre, R_c, and subtracting one and calculating the absolute value of the number. This measure of the deviation from uniform tonality shall be less than 10 %, i.e. max (T_i), i = {1,..,24} shall be less than 0,10.

$$T_i = abs(R_i / R_c - 1), (i = 1, ..., 24) \quad (1)$$

The uniformity of tonality determined as max (T_i) with i = {1,..,24} shall be less than 0,1.

4.4.3 Testing of the simulation

To test the reproduction (simulation) quality, measurements shall be made with either a telespectrophotometer or with a contact spectrophotometer where the influence of ambient light is taken into account. In the latter case, the model for stray light (flare) and associated uncertainty shall be reported. The receiving aperture of the sensing cone of a telespectrophotometer shall conform to ISO 12646.

Displayed patches (represented as image content with the tone values defined in Table B.1) shall be sequentially displayed and measured at the centre of the display. Then, printed patches shall be

sequentially placed and measured at the intended viewing plane. This procedure shall be conducted for all 72 patches (see Annex B).

A visual match might be present, but the CIEXYZ values may not be identical. There are many reasons for such a mismatch reported in the literature.[7] [8] [10] [13] In the case of an instrumental mismatch, the telespectroradiometer readings of the display shall be corrected utilizing a suitable correction method. This correction shall only be applied when the colour difference between the print white patch and the simulated white is smaller than DE00 ≤ 5 and the luminance difference is smaller than 15 %. The percentage difference shall be computed by dividing the larger value by the smaller one. When either of the differences exceeds the tolerances and there are no options to adjust, the system shall be deemed not to satisfy the requirements of this Clause. The soft copy display and the printed sheets shall achieve the (simulation) colorimetric accuracy specified in Table 3 between the measured data of the print samples and the measured data of the monitor.

A typical correction method is the scaling of the CIEXYZ values of the corresponding white points. The exact method used shall be reported. To calculate the CIELAB values of the readings, the CIEXYZ values[1] [5] of the printed white patch (CMYK = 0,0,0,0) shall be used as the white reference for normalizing the tristimulus values both for the display readings and for the printed reference patches. Table 3 shows the colorimetric requirements that shall be attained in terms of computed DE00 colour differences. A possible lack of uniformity within the viewing cabinet shall be addressed by averaging the measurements from nine equally spaced locations on the printed patches. The CIEY* contrast ratio between the paper white patch and the black patch (CMYK = 0,0,0,100) of the contract proof and of the soft proof shall be calculated and reported. The ratio of the two contrast ratios shall be between 0,5 and 2,0.

Table 3 — Colorimetric accuracy: DE00 tolerances between reference prints and soft proof reproduction

Mean	Maximum	Maximum (primaries)	Composed grey patches
$\Delta E_{00} \leq 4$	$\Delta E_{00} \leq 6{,}5$	$\Delta E_{00} \leq 5$	$\Delta E_{00} \leq 3$

In case of spot colour reproductions, this International Standard is limited to isotropic spot colours being used as solids in contrast to tint values or overprints with other colours. The reference shall be a physical sample such as a swatch book. The reproduction of solid spot colours shall be within a colour difference of $\Delta E_{00} \leq 2{,}5$ where the spot colour is achievable within the colour gamut of the soft proofing display.

4.4.4 Visual

In addition to the objective evaluation of the device driving and the simulation, a visual-based assessment should be conducted. Here, appropriate test forms such as the images and vignettes defined in ISO 12640 or provided by research institutes should be used for checking the overall appearance simulation.[9] The visual scrutiny should be made with respect to smoothness, white point, uniformity and the visual match with a reference print.

NOTE 1 The tonal gradation of a display is important and can be checked visually. When new methods are developed, this is subjective to become a normative criteria with measurable tolerances.

NOTE 2 Test images are available and free of charge from some research institutes.[7]

Annex A
(informative)

Reference set of RGB triplets

File ISO 14861_AnnexA.txt tabulates a set of 318 RGB triplets that can be used as described in 4.4.2.2 to evaluate colorimetric accuracy and the smooth rendition of vignettes. This Annex is provided as an electronic file according to ISO 28178 because these data are intended for use in preparing files to be used to test display driving of a display and as such, are required as electronic data. More information on the used set of RGB values can be found in Reference [11].

Annex B
(normative)

Test patches for display driving and simulation requirements

The patches listed in Table B.1 are used as defined in 4.4.1 for evaluation of display driving and simulation requirements. The patches represent a subset of ISO 12642-2 and conform to ISO 12647-7 requirements for a control wedge.

Table B.1 — Patches for display driving and simulation

Patch #	C	M	Y	K		Patch #	C	M	Y	K
1	100	0	0	0		37	40	0	40	0
2	70	0	0	0		38	20	0	20	0
3	40	0	0	0		39	10	0	10	0
4	20	0	0	0		40	10	6	6	0
5	10	0	0	0		41	20	12	12	0
6	0	100	0	0		42	40	27	27	0
7	0	70	0	0		43	60	45	45	0
8	0	40	0	0		44	80	65	65	0
9	0	20	0	0		45	100	85	85	0
10	0	10	0	0		46	100	0	0	100
11	0	0	100	0		47	20	100	70	60
12	0	0	70	0		48	70	0	70	80
13	0	0	40	0		49	100	100	100	0
14	0	0	20	0		50	70	70	70	0
15	0	0	10	0		51	40	40	40	0
16	0	0	0	10		52	20	20	20	0
17	0	0	0	20		53	10	10	10	0
18	0	0	0	40		54	20	70	70	0
19	0	0	0	60		55	40	70	70	20
20	0	0	0	80		56	40	100	100	20
21	0	0	0	100		57	40	100	40	20
22	0	100	0	100		58	40	40	100	20
23	0	70	70	60		59	100	40	100	20
24	0	0	70	80		60	100	40	40	20
25	100	100	0	0		61	100	100	40	20
26	70	70	0	0		62	10	40	40	0
27	40	40	0	0		63	0	40	100	0
28	20	20	0	0		64	0	100	40	0
29	10	10	0	0		65	40	100	0	0
30	0	100	100	0		66	40	0	100	0
31	0	70	70	0		67	100	0	40	0