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ISO 2846-4

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Graphic technology — Colour and transparency of printing ink sets for four-colour-printing —

Part 4: Screen printing

Technologie graphique — Couleur et transparence des gammes d'encre d'impression en quadrichromie —

Partie 4: Sérigraphie

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 2846 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 2846-4 was prepared by Technical Committee ISO/TC 130, *Graphic technology*.

ISO 2846 consists of the following parts, under the general title *Graphic technology — Colour and transparency of printing ink sets for four-colour-printing*:

— *Part 1: Sheet-fed and heat-set web offset lithographic printing*

— *Part 2: Coldset offset lithographic printing*

— *Part 3: Publication gravure printing*

— *Part 4: Screen printing*

— *Part 5: Flexographic printing*

Annex A forms a normative part of this part of ISO 2846. Annexes B, C and D are for information only.

Introduction

The demand for the screen printing process to become more consistent and predictable has required a means of standardizing the product to ensure the easy flow of business between the various parties involved in its production. An essential component in this process are the colorimetric characteristics of the ink set.

If a set of standard four-colour process inks suitable for screen printing is to be produced it is necessary to specify a number of parameters. It is the purpose of this part of ISO 2846 to describe those parameters which affect the colorimetric characteristics in such a manner that a standard set of inks can be supplied by any ink manufacturer to any printer who can then supply prints to a Print Buyer with confidence in the colour of the work produced.

This part of ISO 2846 will allow screen printers to obtain different sets of inks which will produce a similar colour when printed on the same substrate (paper, board, plastic or fabric etc.). In addition, it will allow colour separations for screen printing to be based on known colour standards. The colorimetric characteristics specified may only be obtained when the inks are printed on the reference substrate. However, similarity of two inks on a reference substrate will ensure similarity on another substrate.

Graphic technology — Colour and transparency of printing ink sets for four-colour-printing —

Part 4: Screen printing

1 Scope

This part of ISO 2846 specifies the colour and transparency to be produced by a process colour ink set, including extender, intended for four-colour screen printing when printed under specified screen printing conditions. It also describes the test method to ensure conformance. This part of ISO 2846 is applicable to screen inks for conventional drying and for radiation curing.

This part of ISO 2846 does not specify pigments (or spectral reflectance) in order not to preclude developments which may enable different pigment combinations to be used advantageously while still achieving the colorimetric requirements specified in this part of ISO 2846.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 2846. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 2846 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 535:1991, *Paper and board — Determination of water absorptiveness — Cobb method.*

ISO 536:1995, *Paper and board — Determination of grammage.*

ISO 2144:1997, *Paper, board and pulps — Determination of residue (ash) on ignition at 900 °C.*

ISO 6588:1981, *Paper, board and pulps — Determination of pH of aqueous extracts.*

ISO 8254-1:1995, *Paper and board — Measurement of specular gloss — Part 1: 75° gloss with a converging beam, TAPPI method.*

ISO 8791-4:1992, *Paper and board — Determination of roughness/smoothness (air leak methods) — Part 4: Print-surf method.*

ISO 13655:1996, *Graphic technology — Spectral measurement and colorimetric computation for graphic arts images.*

3 Terms and definitions

For the purposes of this part of ISO 2846, the following terms and definitions apply.

3.1
extension
addition of a transparent material (colorant-free ink) to the ink to reduce the pigment concentration without significantly influencing the rheological properties of the ink

3.2
press-ready ink
ink that has all necessary components and is at press viscosity

3.3
transparency
ability of an ink film to transmit and absorb light without scattering

NOTE It is generally expressed as some measure of the unwanted scattering.

4 Test method

4.1 Principle

Each ink shall be printed on the reference substrate described in annex A at a range of colorations obtained by varying the extension of the press-ready ink. The colours which result shall be measured colorimetrically and the colour difference between the sample and the pertinent value in Table 1 shall be plotted versus the percentage of press-ready ink. If one or more samples conform to the values and tolerances specified, and the ink, except black, also meets the transparency criteria, that ink complies to this part of ISO 2846.

Transparency T shall be evaluated by printing or applying each of the chromatic process inks on a black substrate at a range of ink extensions. The CIELAB colour difference ΔE^*_{ab} shall be determined for each sample, between the overprinted and unprinted black. The linear regression coefficient (slope of the regression line) between the percentage by mass of press-ready ink in each of the extended ink samples being tested and colour difference shall be calculated from a plot of ΔE^*_{ab} versus percentage press-ready ink over a range of extensions. An ink conforms to this requirement if the transparency T which is the reciprocal of the regression coefficient is negative or greater than the value specified. For further details, see annex D.

4.2 Test print preparation

4.2.1 Prints for colorimetric evaluation

For each ink to be evaluated, prepare an extension series with 50 %, 60 %, 70 %, 80 %, 90 % and 100 % of press-ready ink using extender diluted to press viscosity. Apply the series of extended inks to the reference substrate specified in annex A with a method that produces an even ink film thickness. Examples are printing with a flat-bed screen press or coating applicator. The wet ink film thickness used for the extension series shall be approximately equal.

The method chosen shall produce a curve that shows a pronounced minimum or a data point which is in conformance with Table 1 when ΔE^*_{ab} is plotted versus percentage of press-ready ink. If the extension series does not produce such a curve, produce another series of specimens with different ink film thicknesses. Produce a higher ink film thickness if the colour difference decreases with increasing percentage of press-ready ink. Produce a lower ink film thickness if the colour difference decreases with decreasing percentage of press-ready ink.

See annex D for further information.

4.2.2 Prints for transparency evaluation

Test prints for transparency evaluation shall be produced by printing or applying the inks to be tested over black. The black shall have a lightness (L^*) less than six when determined in accordance with ISO 13655.

One appropriate substrate is the contrast card[1)].

Prior to applying the chromatic ink the CIELAB-values of the black substrate are measured.

The ink to be tested shall then be applied on the substrate such that a range of samples is achieved, each with a different percentage of press-ready ink.

4.2.3 Drying of test prints

Prior to colour measurement all samples shall be thoroughly dried using a method simulating the production printing conditions.

4.3 Colour measurement procedure

Test prints shall be measured in accordance with ISO 13655, except that a substrate backing consisting of at least three sheets of the unprinted reference substrate in accordance with annex A shall be used.

NOTE The samples are measured spectrally, with a 0°/45° or 45°/0° geometry instrument. Calculation of CIELAB values and colour differences is performed in accordance with ISO 13655 using tristimulus values which are computed from the spectral data using the CIE 1931 (2°) standard colorimetric observer data together with CIE illuminant D_{50}.

5 Colour and transparency

5.1 Conformance

For an ink to conform to this part of ISO 2846, it shall meet the specification for colour given in 5.2 at some percentage of press-ready ink and the specification for transparency specified in 5.3.

5.2 Colorimetric values

To meet the specification for colour, an ink shall produce a colour that falls within the colour difference tolerances from the specified colorimetric values given in Table 1, when printed as specified in 4.2.1 at some percentage of press-ready ink.

NOTE 1 The aim values and tolerances given in Table 1 are consistent with those for offset printing, as defined in ISO 2846-1, and may therefore only be strictly applicable to screen printing inks based on similar pigments. For some applications screen printing inks may need to be based on different pigments and while in such circumstances the aim values are the same, the tolerances may need to be larger.

NOTE 2 Unlike some other parts of ISO 2846, this part does not specify limits for concentration or ink film thickness within which to meet the specified colour and tolerances, as such requirements are not applicable to the screen printing process.

NOTE 3 Typical spectral data for inks conforming to this part of ISO 2846 are provided in annex B. Reference spectral data for 8^{o}/diffuse or diffuse/8^{o} (specular included) geometry are also included in annex B.

NOTE 4 Data for CIELAB values calculated from the CIE 1931 (2°) standard colorimetric observer, together with CIE standard illuminant D_{65}, are included in annex C for both geometries. CIELAB data for 8^{o}/diffuse or diffuse/8^{o} (specular included) geometry and illuminant D_{50} are also included in that annex.

1) Leneta paper or card (No. 105C) which can be purchased from Leneta Corp. Mahwah, N.J., USA. Leneta paper or card is the trade name of a product supplied by Leneta Corporation. This information is given for the convenience of the users of this part of ISO 2846 and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

Table 1 — Colorimetric values for 0°/45° and 45°/0° geometry, illuminant D_{50}, 2° observer

Ink	CIELAB values [a]			Tolerances			
	L^*	a^*	b^*	ΔE^*_{ab}	ΔL^*	Δa^*	Δb^*
Yellow	91,0	– 5,1	95,0	6,0	—	—	—
Magenta	50,0	76,0	– 3,0	7,0	—	—	—
Cyan	57,0	– 39,2	– 46,0	5,0	—	—	—
Black	18,0	0,8	– 0,56	—	+ 0,0 [b] – 18,0	± 1,5	± 3,0

[a] See 4.3.

[b] This means that for black there is no symmetrical tolerance for L^* but an upper limit.

5.3 Transparency characteristics

To meet the specification for transparency, an ink shall produce a value greater than that specified in Table 2 when determined in accordance with the principles and test methods outlined in clause 4.

Table 2 — Transparency requirements

Ink	Transparency, T
Yellow	4,0
Magenta	6,0
Cyan	5,0

For highly transparent inks, the slope of the regression line may be zero or negative. In such a situation the transparency value T is considered to be approaching infinity and therefore meets the specification.

NOTE For further information concerning transparency evaluation using instruments with different geometry, see clause D.2.

Annex A
(normative)

Reference substrate

For the purposes of this part of ISO 2846, a light-fast gloss coated wood-free paper free of optical brightener shall be used, the characteristics of which shall be as follows:

Colour

CIELAB values: L^* = 95,5 ± 2,0

a^* = – 0,4 ± 1,0

b^* = 4,7 ± 1,5

Method: ISO 13655 (except for substrate backing use at least three sheets of unprinted reference substrate)

Water absorptiveness

Specification: 2 g/m^2 to 5 g/m^2 after 10 s

Method: ISO 535

Gloss

Specification: 70 % to 80 %

Method: ISO 8254-1

Mass per area

Specification: (150 ± 3) g/m^2

Method: ISO 536

Ash content

Specification: 20 % to 30 %

Method: ISO 2144

pH

Specification: 8 to 10

Method: ISO 6588

Roughness

Specification: (1,0 ± 0,1) µm at a pressure of 1 N/mm^2

Method: ISO 8791-4

NOTE In practice there has been only one supplier of this material and this has become the de facto standard. This material is the gloss-coated wood-free paper Phoenix Imperial APCO II/II from Scheufelen, D-73250 Lenningen, Germany. This information is given for the convenience of the users of this part of ISO 2846 and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

Annex B
(informative)

Spectral data

For some applications, such as calculating CIELAB values for a different observer or illuminant, it is useful to have access to spectral data. As already stated it was deliberately decided not to standardize such data since it can be very restrictive for ink manufacturing and future development of ink with improved properties. However, the following data may be taken as "typical" of that which was obtained during development of this part of ISO 2846.

Two tables of data are presented: Table B.1 is for 0°/45° geometry and Table B.2 is for 8°/diffuse (specular included). These data have been used to compute the values in the tables of annex C.

For the purposes of this part of ISO 2846, the 0°/45° and 45°/0° geometries are deemed to be equivalent to each other as are the 8°/diffuse and diffuse/8° geometries.

The spectral data given in Tables B.1 and B.2 are consistent with those for offset printing, as defined in ISO 2846-1, and may therefore only be strictly applicable to screen printing inks based on similar pigments. For some applications screen printing inks may need to be based on different pigments and, in such circumstances, while the aim colorimetric values are the same, the spectral characteristics may well be different.

Table B.1 — Typical spectral reflectance data for inks conforming to this part of ISO 2846, 0°/45° geometry

Wavelength	Reflectance factor				
nm	Cyan	Magenta	Yellow	Black	Substrate[a]
380	0,094	0,245	0,113	0,0197	0,720
390	0,200	0,219	0,087	0,0202	0,741
400	0,312	0,206	0,067	0,0208	0,759
410	0,409	0,208	0,053	0,0229	0,773
420	0,452	0,214	0,044	0,0247	0,787
430	0,522	0,228	0,041	0,0251	0,799
440	0,606	0,242	0,041	0,0255	0,808
450	0,664	0,237	0,045	0,0259	0,819
460	0,690	0,213	0,056	0,0261	0,828
470	0,699	0,181	0,060	0,0263	0,834
480	0,695	0,148	0,082	0,0265	0,840
490	0,679	0,119	0,168	0,0268	0,847
500	0,647	0,092	0,348	0,0269	0,869
510	0,597	0,068	0,584	0,0269	0,871
520	0,525	0,047	0,741	0,0265	0,880
530	0,436	0,038	0,803	0,0257	0,883
540	0,341	0,035	0,831	0,0250	0,886
550	0,245	0,029	0,848	0,0243	0,888
560	0,158	0,022	0,856	0,0237	0,892
570	0,102	0,018	0,864	0,0235	0,894
580	0,072	0,039	0,869	0,0235	0,894
590	0,057	0,177	0,874	0,0241	0,895
600	0,047	0,431	0,877	0,0248	0,898
610	0,041	0,653	0,881	0,0256	0,898
620	0,040	0,789	0,885	0,0264	0,899
630	0,041	0,852	0,889	0,0276	0,900
640	0,043	0,880	0,895	0,0289	0,900
650	0,051	0,895	0,900	0,0302	0,901
660	0,062	0,903	0,904	0,0316	0,901
670	0,068	0,907	0,906	0,0329	0,902
680	0,065	0,910	0,907	0,0341	0,903
690	0,060	0,914	0,909	0,0355	0,903
700	0,048	0,918	0,912	0,0373	0,903
710	0,043	0,921	0,914	0,0397	0,901
720	0,053	0,923	0,914	0,0423	0,899

[a] Reference substrate, see annex A.

Table B.2 — Typical spectral reflectance data for inks conforming to this part of ISO 2846, 8°/diffuse (specular included) geometry

Wavelength	Reflectance factor				
nm	Cyan	Magenta	Yellow	Black	Substrate[a]
380	0,137	0,271	0,187	0,088	0,730
390	0,249	0,247	0,159	0,090	0,750
400	0,360	0,234	0,137	0,091	0,767
410	0,454	0,233	0,120	0,095	0,781
420	0,498	0,238	0,108	0,099	0,795
430	0,565	0,250	0,105	0,101	0,806
440	0,644	0,261	0,105	0,102	0,815
450	0,696	0,258	0,112	0,104	0,826
460	0,717	0,240	0,127	0,104	0,835
470	0,723	0,213	0,133	0,104	0,841
480	0,714	0,186	0,161	0,104	0,848
490	0,691	0,164	0,257	0,106	0,855
500	0,652	0,145	0,432	0,108	0,876
510	0,598	0,122	0,640	0,108	0,879
520	0,530	0,099	0,774	0,108	0,889
530	0,451	0,088	0,826	0,107	0,893
540	0,368	0,085	0,850	0,106	0,896
550	0,280	0,076	0,866	0,104	0,900
560	0,197	0,066	0,875	0,103	0,905
570	0,141	0,058	0,883	0,102	0,909
580	0,111	0,091	0,887	0,104	0,908
590	0,096	0,253	0,890	0,112	0,908
600	0,086	0,503	0,893	0,120	0,909
610	0,079	0,705	0,895	0,126	0,909
620	0,079	0,825	0,898	0,130	0,909
630	0,080	0,880	0,902	0,133	0,910
640	0,083	0,904	0,906	0,136	0,910
650	0,094	0,917	0,911	0,138	0,911
660	0,107	0,924	0,914	0,141	0,910
670	0,114	0,927	0,915	0,143	0,911
680	0,111	0,930	0,916	0,145	0,912
690	0,105	0,934	0,918	0,148	0,912
700	0,089	0,939	0,920	0,151	0,913
710	0,083	0,942	0,922	0,155	0,911
720	0,096	0,942	0,922	0,159	0,908

[a] Reference substrate, see annex A.

Annex C
(informative)

Colorimetric values for non-normative conditions

For the purposes of this part of ISO 2846, the 8°/diffuse and diffuse/8° geometries are deemed to be equivalent to each other for both specular included and specular excluded conditions.

The values in the following tables have been calculated from the spectral values listed in annex B.

If data is to be communicated, the fact that the measurement geometry used is not normative should be explicitly included in the report.

Table C.1 — Colorimetric values for 8°/diffuse (specular included) geometry for illuminant D_{50}

Ink	CIELAB values		
	L^*	a^*	b^*
Yellow	92,2	– 5,4	78,1
Magenta	55,4	66,6	1,0
Cyan	59,8	– 32,2	– 43,8
Black	39,6	4,0	2,0
Ref. substrate	95,9	– 0,4	5,0

Table C.2 — Colorimetric values for 8°/diffuse (specular included) geometry for illuminant D_{65}

Ink	CIELAB values		
	L^*	a^*	b^*
Yellow	91,6	– 11,1	78,7
Magenta	53,8	65,0	– 2,1
Cyan	61,2	– 24,7	– 40,9
Black	39,5	3,4	2,0
Ref. substrate	95,9	– 1,0	5,0

Table C.3 — Colorimetric values for 0°/45° and 45°/0° geometry for illuminant D_{65}

Ink	CIELAB values		
	L^*	a^*	b^*
Yellow	90,4	– 11,2	96,2
Magenta	48,1	75,2	– 6,820
Cyan	58,6	– 30,6	– 42,8
Black	18,0	0,5	– 0,5
Ref. substrate	95,4	– 1,0	4,8

Annex D
(informative)

Detailed explanation of test method, including examples

D.1 Colorimetric verification

In order to evaluate whether an ink meets the standard, it is necessary to produce a number of test samples, using a press-ready ink with a range of extensions. When dry the samples are measured for colour in accordance with ISO 13655, except the sample is backed with 3 sheets of unprinted reference substrate. The colour differences between each sample and the colours specified in this part of ISO 2846 are then calculated and plotted as a function of percentage of press-ready ink as shown in Figure D.1. The ink meets the requirements if at some percentage of press-ready ink the colour difference falls below the tolerance specified in Table 2.

Figure D.1 shows the tolerance limit for a yellow ink and curve 1 shows an ink which conforms to this part of ISO 2846. Curve 2 shows an ink, that does not conform with the standard, most probably due to incorrect hue.

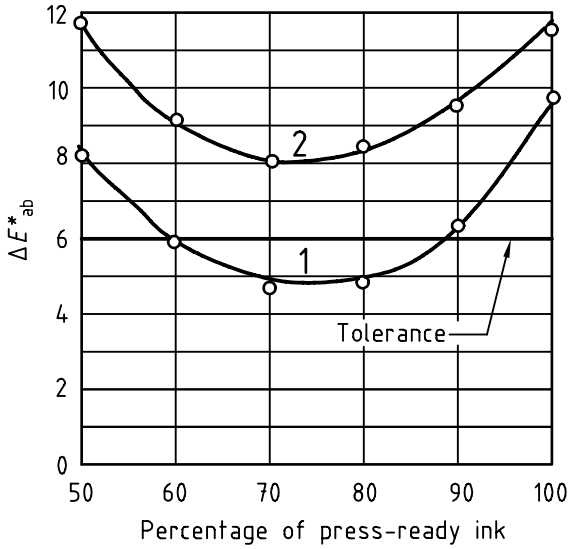

Figure D.1 — Assessment of conformance

D.2 Determination of transparency

Using the procedure described in clause D.1, a series of test samples is made covering at least the practical range of extension. For this test a black substrate is used such as Leneta card or any coated paper, of reasonable opacity, which has been pre-printed with an area of black ink that has an L^* value not greater than six. Such material may be purchased [see footnote 1) in 4.2.2] or produced by the user by printing the substrate with black ink, allowing sufficient time for the ink to dry.

For the determination of transparency, each strip of the black substrate should be coded and the colour of the black measured on each, in a defined area, prior to application of the ink to be tested.

After the samples have been allowed to dry, their colour should be measured in accordance with 4.3 in the area defined before (see also clause D.3).

The colour difference between the two measurements is then calculated for each sample and is plotted as a function of the percentage of press-ready ink as shown in Figure D.2. The slope of the linear regression line through the data points is calculated. The reciprocal of this value is then computed and this is the transparency value T.

Providing the value achieved from this calculation is negative or greater than that specified in this part of ISO 2846 the ink is in conformance with this specification.

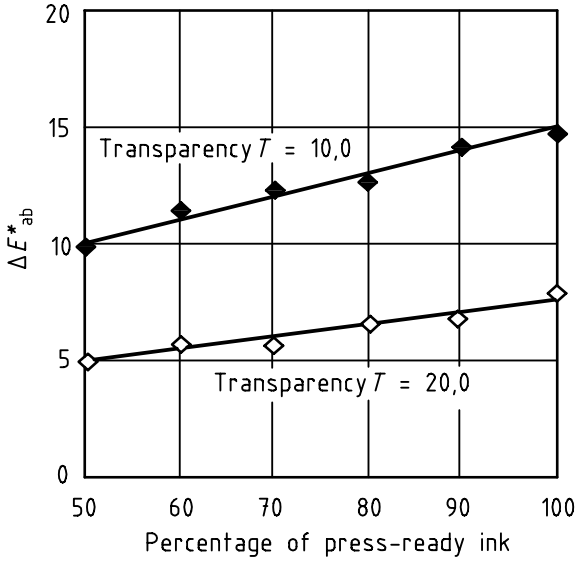

Figure D.2 — Assessment of transparency

D.3 Issues to be noted when preparing and measuring samples for transparency assessment

D.3.1 Selection and printing of the black ink

If transparency is measured using samples on which a black ink has been pre-printed on the reference substrate by the user, care needs to be taken in the selection of the black ink used. A black must be selected which exhibits little or no bronzing and which exhibits a similar level of gloss to the same sample when overprinted by the test ink. Even the pre-printed contrast card can give rise to anomalous results if the gloss change is significant. Any measure of transparency could be affected by such surface phenomena and care needs to be taken to select materials which minimize them. If this is not done, erroneous results may well be obtained. In severe cases this may even arise with a 0°/45° or 45°/0° geometry. Such results are normally obvious from simple visual assessment of the samples.

It is possible to have an ink with such a high degree of transparency that the resultant overprint reflects less light than the black substrate alone. It is with such an ink that the graph obtained as shown in Figure D.2 will have a negative or zero slope.

D.3.2 Use of sphere instruments for measuring transparency

It is because the variation in surface effects is more likely to influence results obtained on a sphere instrument (even with the specular component excluded) that figures for transparency, equivalent to those obtained using a 0°/45°geometry instrument, have not been provided.

Results obtained with sphere instruments give different values of T to those obtained with a 0°/45° geometry instrument but are ranked in the same order and with similar differences between them.

For a more extensive discussion of the transparency issue the reader is referred to a paper entitled "A method for the measurement and specification of process ink transparency" by Bassemir and Zawacki, see bibliography reference [5].

Bibliography

[1] ISO 2846-1:1997, *Graphic technology — Colour and transparency of ink sets for four-colour-printing — Part 1: Sheet-fed and heat-set web offset lithographic printing*.

[2] ISO 12637-2:1997, G*raphic technology — Multiligual terminology of printing arts — Part 2: Screen printing terms.*

[3] ISO 12647-1:1996, *Graphic technology — Process control for the manufacture of half-tone colour separations, proof and production prints — Part 1: Parameters and measurement methods.*

[4] ISO 12647-5:—[2)], *Graphic technology — Process control for the manufacture of half-tone colour separations, proof and production prints — Part 5: Screen printing.*

[5] BASSEMIR, R and ZAWACKI, W. *A method for the measurement and specification of process ink transparency*. TAGA (Technical Association of the Graphic Arts) Proceedings (1994), pp. 297-312.

2) To be published.

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