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

**Part 1:**

Sheet-fed and heat-set web offset lithographic  
printing

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

ISO 2846-1:1997  
*Partie 1: Impression lithographique offset sur feuilles et à chaud*

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## Contents

	Page
1 Scope	1
2 Normative references	1
3 Definitions	2
4 Test method	2
5 Requirements for colour, transparency and ink film thickness ranges	5
<b>Annexes</b>	
<b>A</b> Reference substrate	7
<b>B</b> Original ISO 2846:1975 specification and the reasons for change	9
<b>C</b> Spectral data	11
<b>D</b> Tristimulus values for 8°/diffuse geometry and illuminant D <sub>65</sub>	14
<b>E</b> Extended explanation of the test procedures, including examples	16

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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.

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.

International Standard ISO 2846-1 was prepared by Technical Committee ISO/TC 130, *Graphic technology*.

It cancels and replaces ISO 2846:1975 and ISO 2845:1975, of which it constitutes a technical revision.

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

- *Part 1: Sheet-fed and heat-set web offset lithographic printing*
- *Part 2: Newspaper printing*

Annex A forms an integral part of this part of ISO 2846. Annexes B to E are for information only.

## Introduction

The original version of this part of ISO 2846 (ISO 2846:1975) was produced to allow lithographic printers to obtain different sets of inks (both for proof and production printing) which would produce a similar colour when printed on the same substrate at the appropriate film thickness. By doing this, it enabled colour separations for offset-lithographic printing to be based on known colour standards. It was accepted that the colorimetric characteristics specified would only be obtained when the inks were printed on the reference substrate. However, it was noted that similarity of two inks on a reference substrate would ensure similarity on another substrate, as described above, and thereby enable industry specifications or standards for all substrates to be developed when based on these inks. As time has passed, such specifications have become increasingly important, so the significance of this part of ISO 2846 has increased since its development.

The original specification was based on extensive measurements of commercial ink sets made in Europe during the 1960s. However, by the end of the 1980s it was clear that some changes in the colour of commercial inks had occurred and therefore the need for a revision of ISO 2846:1975 was required. This revision is based on input from the European Confederation of Paint, Printing Ink and Artists' Colour Manufacturers' Associations (CEPE) who measured a number of European commercial ink sets in recommending that a new standard (CIE 30-89) be prepared; colorimetric data of commercial process inks of seven German manufacturers collected by FOGRA; the National Association of Printing Ink Manufacturers (NAPIM) in the USA who used inks for SWOP<sup>®</sup> (Specifications for Web Offset Publications) as the basis of their ink data set and the Japan Printing Ink Makers' Association who also defined a set of standard colours based on measurements of commercial ink sets, known as Japan Colour Ink SF-90. More details on this are given in annex C.

A joint working group consisting of TC 130 process control and material experts examined the three inputs and found that a single set of colour coordinates could adequately represent all three proposals within reasonable tolerances. It was also agreed that other changes and extensions to the original International Standard ISO 2846:1975 were appropriate, including the inclusion of black ink, a new measure of transparency (and therefore no definition of secondaries), changes to the colorimetric references and explicit inclusion of inks requiring drying methods other than oxidation drying. (Inks for cold-set newspaper printing are considered in ISO 2846-2.)

In comparison with ISO 2846:1975 the following major changes were made for this revision:

- reduction of chroma for cyan and magenta;
- slight red hue shift for the yellow;
- slight green hue shift for the cyan;
- specification of the black ink;

- change of the normative colorimetric conditions to  $D_{50}$  illuminant (rather than illuminant C),  $2^\circ$  observer, CIELAB for specification and tolerances (rather than  $xyY$  and  $U^*V^*W^*$ ), and  $0^\circ/45^\circ$  (or  $45^\circ/0^\circ$ ) geometry;
- addition, for information only, of spectral data,  $D_{65}$  colorimetric data equivalent to those for  $D_{50}$  and specifications for  $8^\circ/\text{diffuse}$  (or  $\text{diffuse}/8^\circ$ ) measuring geometry equivalent to those for  $0^\circ/45^\circ$  (or  $45^\circ/0^\circ$ );
- choice of the perfect reflecting diffuser as the white reference;
- explicit inclusion of inks for heat-set web offset and radiation curing;
- specification of minimum transparency;
- no specification of secondaries;
- more specific details on test print preparation together with exclusive specification of a laboratory printability tester for test print preparation;
- specification of the reference substrate;
- upward extension of the ink film thickness range;
- no provisions for lightfastness and solvent resistance.

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## 1 Scope

This part of ISO 2846 specifies a set of colours which will be produced by a series of inks intended for four-colour offset-lithography (both proof and production printing) when printed under specified conditions, on a defined substrate, using a laboratory printability tester. It also describes the method for testing to ensure conformance. Information is provided on inks for sheet-fed, heat-set web and radiation-curing processes.

This part of ISO 2846 does not apply to fluorescent inks and it does not specify pigments 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 standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 2846. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 2846 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

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

ISO 536:1976, *Paper and board - Determination of grammage.*

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

ISO 2834:—<sup>1)</sup>, *Graphic technology - Test print preparation for offset and letterpress inks.*

1) To be published. (Revision of ISO 2834:1981)

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

ISO/DIS 8254-1, *Paper and board - Measurement of specular gloss - Part 1: 75° gloss.*

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.*

ISO/CIE 10526: 1991, *CIE standard colorimetric illuminants.*

ISO/CIE 10527: 1991, *CIE standard colorimetric observers.*

CIE Publication 15.2: 1986, *Colorimetry.*

### 3 Definitions

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

**3.1 standard ink:** Ink, intended for four-colour printing, which when printed on the reference substrate and within the applicable range of ink film thicknesses complies to the colorimetric and transparency specifications of this part of ISO 2846.

**3.2 standard ink set:** Complete set of standard inks comprising yellow, magenta, cyan and black.

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**3.3 primary colours:** Colours of individual prints from yellow, magenta and cyan inks. If the prints are produced as specified in this part of ISO 2846 and conform to the colorimetric characteristics specified, they are standard primary colours.

**3.4 secondary colours:** Colours obtained by overprinting pairs of the three chromatic inks.

**3.5 transparency:** Ability of an ink film to transmit and absorb light without scattering. It is generally expressed as some measure of the unwanted scattering.

**3.6 transparency measurement values:** The reciprocal of the slope of the regression line between ink film thickness and colour difference for overprints of chromatic inks over black.

## 4 Test method

### 4.1 Principle

Each ink to be tested shall be printed on the reference substrate (as described in annex A) at a range of ink film thicknesses. The colours which result shall be measured colorimetrically. If one or more samples are found which conform to the values and tolerances specified in this part of ISO 2846, and the ink also meets the transparency criteria, that ink shall be deemed to be in compliance with this part of ISO 2846.



Transparency shall be evaluated by printing each of the three primary inks over black at a range of film thicknesses. The CIELAB colour difference shall be determined for each sample, between the printed and unprinted black, and the linear regression coefficient (slope of the regression line) between ink film thickness and colour difference shall be calculated for each colour. Inks conform to this part of ISO 2846 if the reciprocal of the coefficient is negative or greater than the value specified in this part of ISO 2846. (A more detailed description of these procedures, together with examples, is given in annex E.)

## 4.2 Test print preparation

### 4.2.1 Preparing prints for colorimetric evaluation

For each of the inks to be evaluated, a number of test prints shall be made, each produced at a different ink film thickness, according to the conditions specified below.

They shall be made on the reference substrate as specified in annex A. The range of ink film thicknesses produced shall encompass that specified for the process for which the ink is intended. (See 5.3.)

- The prints shall be made using a printability tester.
- Printing shall be directly from the forme to the substrate.
- The ambient temperature shall be  $(24 \pm 1)^\circ\text{C}$ .
- Prints shall be produced with a printing line pressure of  $(225 \pm 25)$  N/cm at a speed of  $(1 \pm 0,1)$  m/s.
- The printing forme, which shall be an elastomer or rubber blanket-covered roller, shall have a Shore A hardness of between 80 and 85.
- The distribution time and the inking time for volatile (heat-set) inks shall not be greater than 20 s each. This does not include weighing time. (See also 4.2.4.)
- The inking unit and the printing forme shall be cleaned and re-inked after each print.

NOTE - Solvent used to clean the forme may penetrate the material. Time shall be allowed to ensure full evaporation of the solvent. Using two formes alternately is recommended.

- The amount of ink transferred to the substrate shall be determined by measuring the difference in mass of the printing forme before and after printing and shall be expressed as  $\text{g/m}^2$ . Conversion to film thickness in micrometres shall be made by using the mass density of the ink and the area of the print.
- Separate distribution rollers and printing formes with suitable material properties shall be used for radiation-cured inks.

NOTE - For further information see ISO 2834.

#### 4.2.2 Preparing prints for transparency evaluation

Test prints for transparency evaluation shall be produced by printing the inks to be tested over black. The black shall have a lightness ( $L^*$ ) less than 6 when determined according to the principles of ISO 13655 (with the exception that a white backing shall be used when measuring the print) as described in 4.3.

Such a substrate may be obtained by purchasing pre-printed material such as Leneta paper or card<sup>2)</sup> (No. 105C) supplied by the Leneta Corporation or may be produced by printing the reference substrate, or a coated substrate of similar opacity, with one or more applications of black ink. A black shall be selected which exhibits minimal bronzing and provides a gloss which will not change significantly when overprinted by the test ink.

Sufficient time shall be allowed for the black ink to dry prior to the printing needed to test the transparency of the coloured inks.

Since the CIELAB values of the black print need to be established, both when unprinted and overprinted by the chromatic ink, the measurements of the black alone shall be made prior to overprinting.

The ink to be tested shall then be printed as described in ISO 2834, on the prepared substrate, such that a range of samples, each with a different ink film thickness, is achieved. The range should cover that defined in 5.3, namely 0,7  $\mu\text{m}$  to 1,3  $\mu\text{m}$ .

#### 4.2.3 Drying of test prints

Prior to colour measurement all samples shall be thoroughly dry. Inks formulated for oxidation drying shall be left for 24 h; those formulated for radiation curing shall be dried with an appropriate radiation source and heat-set inks shall be heat dried with appropriate drying equipment.

#### 4.2.4 Additional considerations for heat-set inks

If problems in ink transfer arise, due to evaporation of volatile mineral oils in heat-set inks, a small amount of oil (e.g. linseed oil) may be added to the ink prior to ink distribution. The amount of oil added shall be kept as low as possible and shall not exceed 5 %. The amount of oil added (by volume) shall be noted and used to correct the ink film thickness prior to assessment of the ink against this part of ISO 2846.

### 4.3 Colour measurement procedures

Test prints shall be measured in accordance with ISO 13655, except that a white backing consisting of at least 3 sheets of the unprinted substrate shall be used. For details concerning the colorimetric illuminants and observers see ISO/CIE 10526 and ISO/CIE 10527.

2) Leneta paper or card is the trade-name of a product supplied by the Leneta Corporation. This information is given for the convenience of 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.

Following ISO 13655 means that samples shall be measured spectrally, with a 0°/45° or 45°/0° geometry instrument, and for calculation of tristimulus values the CIE 1931 (2°) standard colorimetric observer data shall be used together with CIE standard illuminant D<sub>50</sub>. For calculating the colour difference from the reference values, CIELAB shall be used. For details concerning the CIELAB colour space see CIE Publication 15.2: 1986.

## 5 Requirements for colour, transparency and ink film thickness ranges

For an ink to conform to this part of ISO 2846 it shall meet the specifications for colour defined in 5.1, at some ink film thickness **within** the range specified in 5.3, **and** the specification for transparency defined in 5.2.

### 5.1 Colorimetric values

These are specified in two ways which are equivalent when calculated according to the procedures of ISO 13655. To meet the specification for colour, an ink shall produce a colour that falls within the defined colour difference tolerances from the  $L^*$ ,  $a^*$ ,  $b^*$  values specified in table 1, at some ink film thickness within the specified range when printed as described in clause 4.

Table 1 — Colorimetric values for 0°/45° geometry, illuminant D<sub>50</sub>, 2° observer

Ink	Tristimulus values			CIELAB values			Tolerances			
	X	Y	Z	$L^*$	$a^*$	$b^*$	$\Delta E_{ab}^*$	$\Delta a^*$	$\Delta b^*$	$L^*$
Yellow	73,21	78,49	7,40	91,00	-5,08	94,97	4,0	—	—	—
Magenta	36,11	18,40	16,42	49,98	76,02	-3,01	5,0	—	—	—
Cyan	16,12	24,91	52,33	56,99	-39,16	-45,99	3,0	—	—	—
Black	2,47	2,52	2,14	18,01	0,80	-0,56	—	± 1,5	± 3,0	≤ 18,0 <sup>2)</sup>

1) This means that for black there is no symmetrical tolerance for  $L^*$  but an upper limit.  
2) Two decimal places serve for correct conversion of the colorimetric values.

### NOTES

1 Typical spectral data for inks conforming to this part of ISO 2846 are provided in informative annex C. Reference spectral data for 8°/diffuse or diffuse/8° (specular included) geometry are also included in informative annex C.

2 Reference data for tristimulus values calculated from the CIE 1931 (2°) standard colorimetric observer, together with CIE illuminant D<sub>65</sub>, are included in informative annex D for both geometries. Tristimulus data for 8°/diffuse or diffuse/8° (specular included) geometry and illuminant D<sub>50</sub> are also included in annex D.

### 5.2 Transparency characteristics

To meet the specification for transparency, an ink shall produce a value greater than that specified in table 2 when determined by the procedures and principles outlined in clause 4.