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

Part 1:

**Sheet-fed and heat-set web offset lithographic
printing**

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

Partie 1: Impression lithographique offset sur feuilles et à chaud



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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[®] (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° 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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Graphic technology — Colour and transparency of ink sets for four-colour-printing —

Part 1:

Sheet-fed and heat-set web offset lithographic printing

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:—¹⁾, *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.

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 ± 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 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 card²⁾ (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 μm to 1,3 μm .

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 D₅₀. 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 D₅₀, 2° observer

Ink	Tristimulus values			CIELAB values ¹⁾			Tolerances			
	X	Y	Z	L^*	a^*	b^*	ΔE_{ab}^*	Δa^*	Δb^*	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 ²⁾

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 D₆₅, are included in informative annex D for both geometries. Tristimulus data for 8°/diffuse or diffuse/8° (specular included) geometry and illuminant D₅₀ 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.

Table 2 - Transparency requirements

Ink	Transparency measurement value <i>T</i>
Magenta	0,12
Yellow	0,08
Cyan	0,20

NOTES

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

2 Transparency data for inks conforming to this part of ISO 2846, but measured with 8°/diffuse or diffuse/8° (specular excluded) geometry, cannot be provided in an informative annex as has been done for colorimetric parameters. This is due to the higher sensitivity of the results from instruments with such geometries to surface effects, such as bronzing or gloss changes, as discussed in annex E. However, the procedure can prove useful for ranking inks of similar gloss and so a brief description is also provided in annex E.

5.3 Ink film thickness

The range of ink film thicknesses (in micrometres), within which a standard ink shall conform, is provided in table 3 for the different ink drying processes specified in this part of ISO 2846.

Table 3 - Range of ink film thicknessesValues in μm

Ink type	Cyan	Magenta	Yellow	Black
Drying by oxidation/setting	0,7-1,1	0,7-1,1	0,7-1,1	0,9-1,3
Radiation curing	0,7-1,3	0,7-1,3	0,7-1,3	0,9-1,3
Heat-set web	0,7-1,3	0,7-1,3	0,7-1,3	0,9-1,3

Annex A (normative)

Reference substrate

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

Colorimetric values

Tristimulus values	CIELAB values
$X = 85,32$	$L^* = 95,46 \pm 2,0$
$Y = 88,71$	$a^* = -0,40 \pm 1,0$
$Z = 67,96$	$b^* = 4,70 \pm 1,5$

Method: ISO 13655:1996, *Graphic technology — Spectral measurement and colorimetric computation for graphic arts images*; clauses 4 and 5 (0°/45°, D₅₀, 2°, but white backing)

Water absorptiveness

Specification: 2 g/m² to 5 g/m² after 10 s

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

Gloss

Specification: 70 % to 80 %

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

Mass per area

Specification: (150 ± 3) g/m²

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

Ash content

Specification: 20 % to 30 %

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

pH

Specification: 8 - 10

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

Roughness

Specification: 0,9 μm - 1,1 μm at a pressure of 1 N/mm²

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

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/II³⁾ from Scheufelen, D-73250 Lenningen, Germany.

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3) Phoenix Imperial APCO II/II is an example of a suitable product available commercially. This information is given for the convenience of users of this part of ISO 2846 and does not constitute an endorsement by ISO of this product.

Annex B (informative)

Original ISO 2846:1975 specification and the reasons for change

ISO 2846:1975 was based on work carried out by the European Confederation of Paint, Printing Ink and Artists' Colour Manufacturers' Association (CEPE) to specify letterpress printing inks (CIE document No. 12-66). This was later extended to offset printing inks (CIE document No. 13-67). Ten European national standards institutions adopted the contents of CIE documents 12-66 and 13-67 as national standards. The ink set colours so defined became known as the European Colour Scale; they were modelled around a set of readily available pigments which combined sufficient fastness values with favourable coloristic properties. Subsequently, ISO 2845:1975 for letterpress and ISO 2846:1975 for offset printing inks were based on the European Colour Scale.

Some 15 years later it had become apparent that, for many commercial inks, the chroma of cyan and, to a lesser extent, magenta had decreased and yellow had shifted slightly in hue towards the red and to a higher chroma. In response, a new standard proposal was published by CEPE in 1989 as CIE document No. 30-89. The three new specifications in that document individually addressed sheet-fed, heat-set web and newspaper offset printing. The first two of these served as input to this part of ISO 2846.

In the United States, the "Specifications for Web Offset Publications", later also known as SWOP[®], were first proposed in 1975. They encompassed printed ink on paper standards (which were defined densitometrically) and a well-defined printing ink for proofing on sheet-fed presses. In 1986, the specifications were extended to production printing. Later, a colorimetric definition of SWOP[®] ink set colours was worked out in cooperation with NAPIM, the National Association of Printing Ink Manufacturers in the US. This served as the second input to this part of ISO 2846.

The Japanese Printers Association and the Japan Printing Ink Makers' Association jointly established a set of standard process colours in 1964. However, it was not adopted as a national standard at that time. In 1990, a task force of the Japan Printing Ink Makers' Association established a set of standard colours named "Japan Colour Ink SF-90" which were based on typical, commercially available ink sets from the eight major ink manufacturers in Japan. This served as the third input to this part of ISO 2846.

In Germany, a colorimetric evaluation of typical, commercially available ink sets from the major seven ink manufacturers undertaken by FOGRA in 1992 showed that cyan is greener, and yellow less chromatic, than proposed in CIE 30-89. The average values from this served as the fourth input to this part of ISO 2846.

Old ISO 2846:1975 specification

For comparative purposes the values of the original ISO 2846:1975 specification are shown in table B.1. They have been recalculated to facilitate the comparison, as shown in the notes.

Table B.1 - Original ISO 2846:1975 Colorimetric specification

Ink	Tristimulus values			Tolerances
	X	Y	Z	ΔE_{CIE}
Yellow	72,40	77,79	8,24	2,3
Magenta	36,46	18,13	14,86	5,0
Cyan	13,40	20,22	49,59	3,0
Yellow + Magenta	34,60	17,57	2,40	7,3
Yellow + Cyan	5,91	15,99	6,65	5,3
Magenta + Cyan	3,87	2,53	13,23	8,0

NOTES

- 1 The values specified in ISO 2846:1975 were derived for the 2° observer and illuminant C using magnesium oxide as the reference white. The above values have been recalculated for the perfect diffuser and illuminant D₅₀, to enable a better comparison with the new values of this part of ISO 2846.
- 2 The tolerances are expressed in the 1964 CIE-UCS system (U^*, V^*, W^*).
- 3 The reference substrate was not specified in ISO 2846:1975 but reference was made to ISO 2834:1981, *Printing Inks - Preparation of standardized prints for determination of resistance to physical and chemical agents*.

Annex C (informative)

Spectral data

For some applications, such as calculating tristimulus values for a different observer or illuminant, it is useful to have recourse 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 the future development of ink with improved properties. However, the following data may be taken as 'typical' of that which was obtained when the European, Japanese and American inks were averaged. Since most inks are currently based on the same pigments, any differences at the present time are likely to be small. It must be stressed that this definition is informative and is not a normative entity of this part of ISO 2846; inks cannot be assumed to be close to this data for standardization purposes. It must also be remembered that these values are derived from measurements made on samples printed on the reference substrate backed by white.

Two tables of data are presented: Table C.1 is for $0^\circ/45^\circ$ geometry and table C.2 is for $8^\circ/\text{diffuse}$ (specular included). This data has been used to compute equivalent tristimulus values to those provided in 5.1 for $8^\circ/\text{diffuse}$ geometry and for D_{65} (both geometries). These tristimulus values are given in annex D.

NOTE — For the purposes of this part of ISO 2846, the $0^\circ/45^\circ$ and $45^\circ/0^\circ$ geometries are deemed to be equivalent to each other as are the $8^\circ/\text{diffuse}$ and $\text{diffuse}/8^\circ$ geometries for both specular-included and specular-excluded conditions. Thus, whilst only one of the equivalent geometries is specified in the tables of this annex it may be interpreted that either is acceptable. Of course, the values obtained with each geometry are different and specular-included measurement results are different from those obtained with specular-excluded measurements.

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

Wavelength nm	Reflectance factor				
	Cyan	Magenta	Yellow	Black	Substrate ¹⁾
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

1) Reference substrate, see annex A.

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

Wavelength nm	Reflectance factor				
	Cyan	Magenta	Yellow	Black	Substrate ¹⁾
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

1) Reference substrate, see annex A.

Annex D
(informative)

Tristimulus values for 8°/diffuse geometry and illuminant D₆₅

NOTE — 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. Thus, whilst only one of the equivalent geometries is specified in the tables of this annex it may be interpreted that either is acceptable. Of course, the values obtained with specular-included measurements are different from those obtained with specular-excluded measurements.

The values in tables D.1 and D.2 have been calculated from the spectral values listed in table C.2.

Table D.1 - Colorimetric values for 8°/diffuse (specular-included) geometry for illuminant D₅₀

Ink	Tristimulus values			CIELAB values		
	X	Y	Z	L*	a*	b*
Yellow	75,44	81,03	13,13	92,15	-5,41	78,08
Magenta	40,46	23,32	18,76	55,40	66,57	1,04
Cyan	19,70	27,88	54,72	59,78	-32,15	-43,75
Black	11,17	11,02	8,53	39,61	4,03	2,02
Substrate	86,39	89,83	68,56	95,93	-0,42	4,96

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

Table D.2 - Colorimetric values for 8°/diffuse (specular-included) geometry for illuminant D₆₅

Ink	Tristimulus values			CIELAB values		
	X	Y	Z	L*	a*	b*
Yellow	70,53	79,78	16,57	91,59	-11,06	78,71
Magenta	37,27	21,82	25,02	53,84	64,95	-2,09
Cyan	22,24	29,50	71,80	61,22	-24,74	-40,94
Black	10,88	10,97	11,23	39,53	3,42	1,95
Substrate	84,72	89,70	90,26	95,87	-1,01	5,01

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