PD ISO/PAS 15339-1:2015

BSI Standards Publication

Graphic technology — Printing from digital data across multiple technologies

Part 1: Principles

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National foreword

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Graphic technology — Printing from digital data across multiple technologies —

Part 1: **Principles**

Technologie graphique — Impression à partir de données numériques via des technologies multiples —

Partie 1: Principes

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Contents

Page

Foreword

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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*.

ISO/PAS 15339 consists of the following parts, under the general title *Graphic technology — Printing from digital data across multiple technologies*:

— *Part 1: Principles* [Publicly Available Specification]

— *Part 2: Characterized reference printing conditions, CRPC1–CRPC7* [Publicly Available Specification]

Introduction

ISO/PAS 15339 is based on the premise that in the printing and publishing industries, electronic data are the intermediary for content storage and exchange throughout production including copy preparation, job assembly, proofing, and process colour printing. It further assumes that data preparation can be largely process independent and that choice of the printing process or processes to be used for final production will be based primarily on run length requirements and substrates to be used. There are various tools in place to both define the relationship of digital data to printed colour for specific instances of printing and to manipulate data such that similar results can be obtained between and among different printing processes (ISO/TS 10128). These specific instances of printing are typically described by colour characterization data, which is the relationship between CMYK input data and colour measured on the printed sheet. Where such a set of colour characterization data are used as a reference, it is referred to as a characterized reference printing condition (CRPC).

When producing printed colour reproductions it is important that the organizations responsible for material preparation, colour separation, proofing, and printing all working to a common set of parameters that uniquely define the intended visual characteristics of the final printed product. Such an agreement enables the correct production of suitable input data and subsequent production of proofs from these data. The purpose of a proof is to simulate the visual characteristics of the finished print product as closely as possible prior to production printing.

There is a unique relationship between ink, substrate, and printing process that limits the maximum chroma of the solids of the printing colorants and therefore limits the range of colours (colour gamut) that can be achieved for particular combinations. While special inks can be used, the commonly available ink pigments are used across all traditional ink processes. While toner and ink-jet systems have different colorant constraints than traditional ink processes, they tend to mimic traditional ink process aims and they will be treated as a variation of traditional ink processes. The achievable chroma range (gamuts) of ink-on-paper characterized reference printing conditions can generally be bracketed between cold-set printing on newsprint on the small end and by printing on gloss coated stocks (by a variety of processes) on the large end. Between these limits there is significant overlap of process/substrate combinations. The number of intermediate characterized reference printing conditions that are logical to define between smallest and largest is in part a function of the tolerances to which printing is expected to conform to the intended characterized reference printing condition. However, the intermediate characterized reference printing conditions also need to represent common widely used printing and that was the determining factor for the selection of the characterized reference printing conditions listed in ISO/PAS 15339-2. In addition, a characterized reference printing condition 7 is included to represent a possible exchange space for large gamut processes that exceed the colour gamut of characterized reference printing condition 6 and therefore need a larger reference gamut.

The data sets defined in ISO/PAS 15339-2 are those associated with the initial publication of ISO 15339. It is the intent of ISO/TC 130 that if changes in, or additions to, these data sets are needed in the future they will be documented in added parts of ISO/PAS 15339 so that changes in the data sets, or addition of data sets, are possible without losing traceability to earlier data sets.

A colour characterization data set is required for each characterized reference printing condition specified. Because the intent of ISO/PAS 15339 is that the data sets provided can be used as the reference for any printing process, they might not be aligned with the typical TVI and trapping associated with any specific printing process. The values selected need to represent a compromise between all potential processes to be used – in effect virtual printing on a virtual printing system.

It is important to realize that digital data can be encoded as already separated CMYK or can consist of un-separated data (typically in an RGB colour space) with supplementary information (ICC colour profiles, etc.) defining the colour intended on the printed sheet. Such unseparated data plus the associated supplementary data are sometimes referred to as “virtual CMYK” data. All data are to be encoded according to one of the PDF/X specifications (ISO 15930- series) to allow the necessary metadata which identifies the intended characterized reference printing condition to be included.

The colour of the printing substrate is a critical component of the colour appearance of a printed image (it behaves like a 5th colour). With the current widespread use of optical brightening agents (OBA)

substrate colour is defined in terms of its apparent reflectance under D50 illumination (see ISO 3664). For halftone images the colour of the substrate contributes mostly in the area not covered by ink. ISO 13655 provides a reasonably effective method to adjust tristimulus data of measured halftone areas for moderate changes in substrate colour. ISO/PAS 15339 is based on the assumption that the colour characterization data can be adjusted (fine-tuned) for the range of normal substrate colours expected and that different characterized reference printing conditions are not required for moderate differences in substrate colour.

Although density, tone value increase, grey balance, etc. are individually important tools for the printing and publishing industry, in ISO/PAS 15339 they are assumed to be part of process control and not printing definition. They need to be considered in developing reference colour characterization data sets and need to be used where applicable as part of local site ongoing process control.

Modern characterization data and profile evaluation tools allow identification of the colour of the solids, the colour and tone values of the single colour scales, and the CMY values associated with the neutral (achromatic) tone scale. Using the values derived from the colour characterization data, rather than any a priori values, is the recommended input for process control aims used to control a printing process intended to conform to a particular characterized reference printing condition.

Annex C provides a description of the process independent workflow that is the basis for the concepts embodied in ISO/PAS 15339.

PUBLICLY AVAILABLE SPECIFICATION **ISO/PAS 15339-1:2015(E)**

Graphic technology — Printing from digital data across multiple technologies —

Part 1: Principles

1 Scope

This part of ISO/PAS 15339 establishes principles for the use of colour characterization data as the definition of the intended relationship between input data and printed colour for copy preparation, job assembly, proofing, and graphic arts production printing. Additional parts of ISO/PAS 15339 specify a limited number of characterized reference printing conditions that span the expected range of colour gamuts used for the production of printed material from digital data, regardless of printing process used. The procedure to be used to adjust colour characterization data for the normally expected range of substrate colour is 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/TS 10128, *Graphic technology — Methods of adjustment of the colour reproduction of a printing system to match a set of characterization data*

ISO 12642-2, *Graphic technology — Input data for characterization of 4-colour process printing — Part 2: Expanded data set*

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

ISO 15076-1, *Image technology colour management — Architecture, profile format and data structure — Part 1: Based on ICC.1:2010*

ISO 15930 (all parts), *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
colour characterization data
tabulation of data that represents the relationship between device code values (e.g. CMYK) and the colour (CIELAB) produced on the printed sheet by those values in a specific printing process

3.2
colour profile
set of transforms, encoded according the rules of ISO 15076-1, that convert data between (to and from) device space and profile connection space

Note 1 to entry: The transforms contained within a colour profile can include manipulation of gamut compression/expansion, tone reproduction, colour separation, black printer creation, printing limitations (e.g. total area coverage), etc.

3.3
gamut
region of CIELAB colour space containing all printable colours

Note 1 to entry: For comparison purposes the CIELAB values of the primaries and secondaries along with the substrate are often an adequate, if sparse, definition of a colour gamut. The surface values of the measurements of a target such as that included in ISO 12642-2 can provide a more complete definition.

3.4
characterized reference printing condition
CRPC
identified printing condition and its colour characterization data used as the aim for a particular printing task (job)

3.5
process independent
independent of the printing process (offset, flexography, gravure, etc.), to be used for production of printed material

3.6
identified printing condition
printing condition documented in a national or international standard or industry publication in a way that allows it to be replicated by an industry practitioner

4 Requirements

4.1 Principles and assumptions

One of the key principles upon which ISO/PAS 15339 is based is that colour content data can be adjusted such that any printing processes, capable of achieving a specified colour gamut, can produce the within-gamut image colours specified by the appropriate reference colour characterization data. This allows printing aims to be process independent.

A second principle is that process control aims and tools should be based on (extracted from) the reference colour characterization data selected and not based on a priori assumptions. Many of the parameters used in process control such as tone value increase, grey balance, etc. are contained within, or can be derived from, the colour characterization data chosen as reference. Local site tools can also be used for initial setup processes, but these need to be based on the known differences between the colour characterization data aims and the colour characterization of the actual printing system being used.

Where similar characteristics, such as tone reproduction, are desired between different characterized reference printing conditions (different colour gamuts) these need to be built into the colour characterization data associated with these characterized reference printing conditions. Characterized reference printing conditions, and their associated colour characterization data, can be thought of as a virtual printing system (press) and as such the characterization data can be manipulated mathematically to fine tune results to achieve smoothness, uniformity and/or other characteristics.

The key requirement for successful application of these principals is that the reference colour characterization data and the characterization data for the printing system being used shall have the same gamut and be sufficient to allow the necessary data adjustment (see ISO/TS 10128 for recommended procedures to implement such data adjustment).

4.2 Data encoding

In the absence of other prior agreement, electronic colour content data to be used as the intermediate storage and exchange media between copy preparation, job assembly, proofing, and printing shall be encoded in accordance with ISO 15930. Any deviation from this, such as encoding in ISO 12639 or in some other format, shall be according to prior agreement by all parties, and shall include communication

of the reference characterization data of the intended printing condition and, as necessary, a colour profile to transform any data not supplied in the process colour model of the reference.

4.3 Data preparation

All print elements shall be prepared either as device code values or as colorimetrically defined data. However, both types of data if present in print elements shall be prepared for a single characterized reference printing condition. This condition shall be provided in the PDF/X output intent in the case of an ISO 15930 exchange, or shall be communicated by mutually agreed upon methods in other situations. Unless otherwise agreed between sender and receiver, the characterized reference printing condition shall be one of the data sets defined in ISO/PAS 15339.

4.4 Characterized reference printing conditions and colour characterization data

The characterized reference printing conditions associated with this part of ISO 15339 are contained in additional parts of ISO/PAS 15339. This approach was taken to allow ISO/TC 130 to change or update characterized reference printing conditions without revising or invalidating characterized reference printing conditions that might have been used as the basis for existing printing work.

The data sets defined in ISO/PAS 15339-2 (CRPC1–CRPC7) are those associated with the initial publication of ISO 15339.

NOTE If changes in, or additions to these data sets are needed in the future, they can be documented in added parts of ISO/PAS 15339 and carry new CRPC designations. When additional CRPCs are published in subsequent parts of ISO/PAS 15339, it is expected that they will follow the same sequential naming scheme to avoid confusion, i.e. ISO15339-CRPC8 would be the next named data set.

For alternate printing processes that do not use colorants that align with the hue angles of a characterization data set, the colour values may be simulated by the appropriate combination of the colorants available, assuming the colour gamut of those colorants encompasses the gamut of the characterized reference printing condition selected. For convenience this part of ISO/PAS 15339 will continue to refer to single-colour solids, two-colour overprints, etc. recognizing that alternate printing systems may simulate these values using appropriate combinations of available colorants.

All colorimetry should be measured according to ISO 13655, M1 with white backing. Where the substrate is non-fluorescent M1 data are identical to M0 data and M0 data may be used as M1 data. If M1 data are not available, M0 data converted to M1 is sufficient (see Annex A).

The measurement conditions and intended interpretation of all colorimetric data provided as part of ISO/PAS 15339 CRPCs (ISO/PAS 15339-2 and future parts) shall be defined in the part of ISO/PAS 15339 in which the data appears.

The characterized reference printing conditions shown in ISO/PAS 15339-2 have been selected to be near the middle of both the general class of printing that is expected to make use of each characterized reference printing condition and the colour of the substrates used. It is expected that adjustments for substrate colour (see 4.6) will allow each characterized reference printing condition to meet a wide variety of needs and be independent of the printing process to be used.

4.5 Use selection criteria for choice of characterized reference printing condition

It is anticipated that the printing industry (with support from the ink and paper organizations) will begin to develop tables of substrate types and printing processes that will support and/or be most appropriate for each of the characterized reference printing conditions. Where the same content is to be reproduced by more than one process or on more than one substrate a gamut common to the multiple needs should be selected. Where only a single substrate and printing system is to be used, the typical choice should be the largest gamut that choice will support.

The chosen characterized reference printing condition shall be used as the basis for design and content creation.

Communication of the intended printing condition between all parties (preparation, proofing, and printing) only needs to identify ISO/PAS 15339 and the gamut to be used along with information relating to any limitations of the intended printing process that need to be considered during preparation, proofing, or printing.

Not all printing processes that can achieve the same colour gamut are subject to the same limitations. Offset, gravure, flexography, electrophotographic, ink-jet, etc., each have limitations that may have to be considered in the final data preparation for printing. These typically include limitations of total ink coverage, minimum and maximum printable dot sizes, etc.

NOTE If general guidance is needed, additional parts of ISO/PAS 15339 can be prepared to assist in the communication or standardization of the handling of such limitations.

4.6 Adjustment of data for substrate colour differences

The characterization data contained in ISO/PAS 15339-2 are all based on the CMYK characterization target defined in ISO 12642-2. The substrate colour is therefore given in data element 1 of each data set.

Where the printing substrate to be used has a colour that differs from that of the reference printing condition selected for data preparation and data exchange, correction of the data for such differences can be beneficial. The use of a single method to accomplish correction enhances the ability of different users to achieve similar results. Annex A provides one conversion method that produces reasonable results for halftone type images. Where substrate adjustment is done this fact, the method used (if other than Annex A), and the values of the intended substrate shall be communicated to all involved.

Where the printing substrate to be used has a colour that differs from that of the reference printing condition selected for data preparation and data exchange by less than 2 CIEDE2000 the user can elect to use the data without modification.

Where the printing substrate to be used has a colour that differs from the characterized reference printing condition selected for data preparation and data exchange by more than 2 but less than 5 CIEDE2000 the method defined in Annex A (see also ISO 13655) should be used to adjust the data before proofing and printing.

Where the difference in substrate colour is greater than 5 CIEDE2000, this correction may be used but the user is cautioned that special colour characterization data might be required which is beyond the scope of ISO/PAS 15339.

When data adjustment is done using the tristimulus correction technique defined in Annex A, the colour values of all data points in the colour characterization data set are changed, including the aim values for the single colour solids.

Where characterization data are exchanged that has been modified for changes in substrate colour, it can no longer be simply referenced as ISO 15339, CRPCx. Where the exchange between participants is not a blind exchange, agreements concerning the substrate to be used and the substrate correction can be exchanged and included in private metadata. For blind exchange it can be treated as an alternate printing reference (see 4.7).

4.7 Alternate printing reference

Where one of the sets of reference colour characterization data defined in the additional parts of ISO/PAS 15339 are not appropriate for the intended printing because of the inks, paper, or printing process to be used, prior agreement should be obtained between all parties involved before copy preparation work is started and the colour characterization data to be used and any colour management profiles shall be communicated with the job content files.

4.8 Colour profiles

The use of colour profiles is an important part of the data preparation process and colour profiles with specific characteristics are often specified by industry trade associations to restrict and provide more

commonality in user input. It is important that colour characterization data and colour management profiles are not confused. While profiles are based on characterization data they also contain additional data processing information. Profiles are required when data are transformed into, or from, CMYK and other working colour spaces. According to ISO 15076-1, an output device profile is required to contain tags that define the transforms between profile connection space and the device values (and reverse) for perceptual, saturation, and colorimetric intents. In addition the transforms include gamut mapping, colour separation methodologies, tone reproduction, and process limits such as tone value sum. These determine the device-space values that will be created from input data linked through profile connection space. Therefore many profiles can be created for the same characterized reference printing condition, and all are equally valid. Profiles also typically contain proprietary transforms and/or computational procedures. Therefore, profiles are not generally appropriate for standardization.

NOTE See http://www.color.org/profiles2.xalter for examples of colour profiles.

5 Process control

5.1 General

Although process control is considered to be the responsibility of the local facility, some basic principles are important and represent a change from traditional (before the widespread availability and use of electronic data for content interchange) practices.

In general the major steps in process control are:

a) Optimize the printing system performance to be as close as possible to the gamut of the characterized reference printing condition.

b) Determine the colour characterization of the printing system at the intended gamut.

c) Determine the content data adjustment required to allow printing system operating in a stable mode to match the input data to printed colour relationship defined by the selected CRPC. See ISO/TS 10128 for further guidance.

d) Maintain the performance of the running printing system consistent with conditions that produced the colour characterization data in b) using appropriate process control tools.

e) If necessary, provide job content specific adjustments as temporary variations of d).

5.2 Printing to intended gamut

At this step in the process control setup, stable printing at the intended gamut is the most important criteria.

The goal is that the apexes of the outer gamut of the printing system to be used match the apexes of the characterized reference printing condition. Where hue differences of the colorants make this impossible, the usual procedure is to adjust the printing system so that the apexes of the characterized reference printing condition are contained within the outer gamut of the printing system. In this way, it is possible to print the values at the apex of the CRPC using colour management or other techniques.

NOTE A spreadsheet is available at

http://www.npes.org/Programs/StandardsWorkroom/ToolsBestPractices.aspx

which extracts process control aims from a characterization data set and performs calculations related to substrate correction.

Where none of the reference colour characterization data sets of ISO/PAS 15339 is appropriate for the intended printing because of the inks, paper, or printing process to be used, a user selected printing condition shall be used. The printing condition selected shall be based on prior agreement between all parties involved. The colour characterization data of the selected printing condition shall be used

to define the gamut and other printing parameters. The data points of the ISO 12642-2 target and the CRPC data that define the apexes of the printing gamut in CIELAB are listed in Table 1.

Table 1 — Data points of the ISO 12642-2 target that describe the printing gamut apexes

Colour	Patch ID number	Tone value %			
		Cyan	Magenta	Yellow	Black
Paper	1	0	0	0	0
Cyan	73	100	0	0	0
Blue	81	100	100	0	0
Magenta	9	0	100	0	0
Red	657	0	100	100	0
Yellow	649	0	0	100	0
Green	721	100	0	100	0
Black	1260	0	0	0	100
3-colour solid	729	100	100	100	0
4-colour solid	1286	100	100	100	100

5.3 Determine colour characterization

Once the conditions are established that both achieve the desired gamut and also represent a repeatable and stable printing condition, the ISO 12642-2 colour characterization target and any other process control targets to be used shall be printed.

It is important that the test targets and process control elements are similar to the image structure of the intended work. For offset this includes colour separation, screening, and tone value sum. For gravure the cylinder engraving parameters are critical. For flexography, the engraving of the ink transfer rollers plays a key role. Both industry trade associations and industry groups, such as the Ghent Workgroup, BVDM, ECI, FOGRA, WAN-Ifra and IDEAlliance provide guidelines that facilitate consistent work across various classes of printing.

The test printing condition (including printing forme making and any other imaging transfer step) should not include any adjustment curves or other data manipulation except for plate-making linearization. The plate-making conditions shall be repeatable and all data necessary to allow consistent making of plates to the same tonal conditions shall be recorded.

The colorimetric values of the appropriate patches of the ISO 12642-2 target shall be measured. One of the three procedures described in ISO/TS 10128 should be used to determine the data adjustment necessary to allow the selected printing condition to create printed images that are close to the corresponding values in the reference colour characterization data.

If used, these data adjustments (single channel curves or multi-dimensional transforms) shall be recorded and used to prepare subsequent work for that aim condition.

5.4 Maintain running characteristics of the printing device

5.4.1 Tools and procedures

Once the preferred operating condition of a printing device is determined colorimetrically, it often makes more sense to use traditional process control tools to maintain those conditions. Density, TVI, grey balance, etc. can be more sensitive tools and more familiar to the operators involved. The printing of the intended process control targets along with the colour targets allows these to be measured with other instrumentation (e.g. densitometers, dot meters, etc.) to establish aims in these data spaces for subsequent process control.

Again such process control is not part of ISO/PAS 15339 but is the responsibility of the printing establishment involved.

5.4.2 Tolerances

The difference between the intended (as evidenced by the characterization data set selected) and actual colours of the printed job are often the measures that differentiate between printers, and strongly influence the cost of a print run. From a macro perspective, these can be grouped into three basic sets of measures and/or tolerances. These are:

— the ability of the printing operation to achieve the aim colour characterization data,

— the colorimetric variation of similar input data within a single sheet, and

— the variation of key parameters (often dictated by available process control targets) within the run.

It is the responsibility of the buyer and producer of a printed product to agree on the characterization data set to be used and the degree to which the actual colours of the printed job match this data set, with or without substrate correction of the data. Annex B provides several tolerance schema that could be used. The organization accepting work to be printed in accordance with characterization data as outlined in this part of ISO/PAS 15339 shall be responsible for documenting the tolerances to be used to indicate a satisfactory match between the printed job and the agreed upon characterization data.

5.5 Job content specific adjustments

Within the printing industry it is not unusual for a customer to require colour adjustment beyond that defined by the selected colour characterization data. This may be required to achieve a closer match to physical references, products, or simply buyer preferences. This is often referred to as the OK press sheet. This cannot be avoided.

Where the values defined in the agreed upon characterized reference printing condition are changed based on buyer instructions, the values used shall be recorded and become the new aims for process control for that printing job.

Annex A
(normative)

Correction of colorimetric data for variation in substrate colour

Although there are a number of computational techniques used or proposed for the correction of colorimetric data for variation in substrate colour, the consistent use of a single method enhances the ability of different users to achieve similar results.

One conversion method that produces reasonable results for halftone type images is based on the observation that if the differences of CIE *X*, CIE *Y*, and CIE *Z* between measurements made of identical images on substrates having different colours are plotted versus CIE *X*, CIE *Y*, and CIE *Z* for measurements on either substrate, the best fit result is approximately a straight line. This leads, as an approximation, to a linear conversion.

For CIE *X:*

$$X_c = X_d \times (1 + C) - X_{min} \times C \tag{A.1}$$

with

$$C = \frac{X_{sn} - X_{sd}}{X_{sd} - X_{min}} \tag{A.2}$$

where

X_d is the value of *X* of a specimen in the data set;

X_c is the computed value of *X* of the specimen on the new substrate;

C is a constant;

X_{sd} is the value of *X* of the substrate in the data set;

X_{sn} is the value of *X* of the new substrate;

X_{min} is the minimum value of *X* in the data set.

In practice, the X, Y, and Z values of the 4-colour solid (ID 1286 in ISO 12642-2) are very close to, or equal to, the minimum values and may be used as a reference black point.

Conversion of CIE *Y* and CIE *Z* is accomplished in an analogous manner and new CIE *L*, a** and *b** CIELAB values are computed.

This colorimetric conversion method is referred to as the tristimulus correction method.

NOTE 1 This is similar to, but not necessarily identical to, the International Color Consortium method referred to as media relative colorimetric transforms.

To use this method to adjust M0 data to approximate M1 data, it is necessary to have a valid M1 measurement of the substrate. The method does not correct all of the effects of the fluorescence from the substrate in a halftone print but it does compensate for the majority of the errors.

NOTE 2 Printing substrates vary not only in colour but also in physical properties. Changes in physical properties impact ink/substrate interaction and light scattering. Changes in ink/substrate interaction and light scattering often result in changes in the tone values of the printed material for the same ink laydown. Therefore, a change in a printing substrate usually requires changes in colorimetric aims (due to paper colour) and changes in tone reproduction and process control aims to correct for the changes in tone value (resulting from changes in physical characteristics). The correction technique described in this Annex only accounts for the changes in substrate colour.

NOTE 3 A spreadsheet which performs these calculations is available at http://www.npes.org/Programs/StandardsWorkroom/ToolsBestPractices.aspx

Annex B
(informative)

Tolerancing schema

B.1 Introduction

Historically, two approaches have been used to define the acceptable colour difference between the specifications used to define the intended printing and the results achieved. For printing specified in terms of the associated process control parameters, this has typically been the difference in the density or colour of the solids and the difference in tone value increase of the process colours (ISO 12647-2, ISO 12647-3, ISO 12647-4, and ISO 12647-5). Where the intended printing result is specified in terms of characterization data, the degree of colorimetric match between the characterization data and the printed results is the more common approach (ISO 12647-6, ISO 12647-7, ISO 12647-8).

ISO/PAS 15339 does not explicitly specify tolerances, it does require that the organizations involved in buying and accomplishing printing agree upon and specify the range of acceptable results. This Annex provides sample schemes that can be used. The use of any one of these schemes is not required nor are the options provided the only possibilities available.

B.2 Tolerance schemes based on process control

Because characterization data contains all of the information necessary to define traditional process control aims, some organizations might wish to specify printing requirements based on process control aims. A scheme based on use of traditional process control aims addresses both the colour of the solids and TVI.

Table B.1 shows suggested tolerances for the deviation between the average values (measured over the run) and the aim of the characterization data set chosen, including any substrate correction. Also included are suggested variation tolerances between the individual samples and the average of the run.

Table B.1 — Suggested CIELAB tolerances for the solids of the process colours

Process colour	Deviation tolerance	Variation tolerance
	CIEDE2000	CIEDE2000
Black	5,0	4,0
Cyan	3,5	2,8
Magenta	3,5	2,8
Yellow	3,5	3,5

Table B.2 shows suggested tolerances for the deviation of TVI between the average values (measured over the run) and the aim of the characterization data set chosen. Also included are suggested variation tolerances between the individual samples and the average of the run.

Table B.2 — Suggested tolerances for tone value

Tone value	Deviation tolerance	Variation tolerance
< 30	3	3
30 to 60	4	4
> 60	3	3
Mid-tone spread	5	5

NOTE 1 For evaluation of set-up sheets or OK-sheets the deviation tolerance can be used by comparing the measured values to the aim characterization data rather than the average of the run.

NOTE 2 Additional information on process control based tolerances can be found in ISO 12647-2 and ISO 12647-3.

B.3 Tolerance schemes based on colorimetry

B.3.1 Background

For those standards that use characterization data as the specification of the intended printing condition, the evaluation of the difference between the specifications used to define the intended printing and the results achieved have often been divided into two groups. These are (1) evaluations of production printing based on a limited sampling of either job content and/or samples included in control targets and (2) evaluations of printing capabilities based on the printing of a test form with the full ISO 12642-2 (or other) target. These two cases will be treated separately because in real world situations either or both can be selected for use by the organizations involved.

B.3.2 Running work

For the evaluation of running work it is suggested that the colour difference between the average of the measured values of at least 20 samples selected over the run and the values of the aim characterization data (including substrate correction) fall within the tolerances shown in Table B.3. These are referred to as deviation tolerances. Three levels are shown to allow the organizations involved to select tolerances appropriate to the type of printing being done and the degree to which colour is critical for the application involved. It is suggested that the same level be chosen for all elements.

Table B.3 — Suggested tolerances for colorimetric deviation

Target description		Production deviation tolerance (CIEDE2000)		
		Level A	Level B	Level C
Solid	**100C**	1,5	2,4	4,0
	100M			
	100Y			
	100K	2,4	3,6	6,0
50 % input tint	**50C**	1,5	2,0	2,5
	50M			
	50Y			
	50K			
Near-neutral	**50C/40M/40Y**	3,0	3,5	5,0

In addition it is suggested that the 95th percentile of the estimated cumulative probability of the colour difference between the printed sheets and the values of the aim characterization data (including substrate correction) be equal to or less than the tolerances shown in Table B.4. These are referred to as variation tolerances. Again, three levels are shown to allow the organizations involved to select tolerances appropriate to the type of printing being done and the degree to which colour is critical for

the application involved. For consistency the same tolerance level would be selected from both Table B.3 and Table B.4.

Table B.4 — Suggested tolerances for colorimetric variation

Target description		Production variation tolerance (CIEDE2000)		
		Level A	Level B	Level C
Solid	100C	1,5	2,4	4,0
	100M			
	100Y			
	100K	2,4	3,6	6,0
50 % input tint	50C	1,5	2,0	2,5
	50M			
	50Y			
	50K			
Near-neutral	50C/40M/40Y	3,0	3,5	5,0

NOTE For evaluation of set-up sheets or OK-sheets the variation tolerance can be used as absolute limits rather than as statistical tolerances of a printing run.

B.3.3 Test form evaluation

Where it is possible (or desirable) to conduct an evaluation of printing capabilities based on the printing of a test form, a more extensive evaluation is suggested. With data for a full test target available, two additional evaluations can be performed.

When evaluating a test form it is suggested that the evaluations of the difference between the specifications used to define the intended printing and the results achieved described in B.3.2 be performed. In addition it is suggested that the evaluation of deviation be supplemented by a similar evaluation of all patches of the target used. The 95th percentile of the cumulative probability of the average colour difference between the aim data and measured data for all printed samples selected would be expected to meet the tolerances shown in Table B.5.

Again, three levels are shown to allow the organizations involved to select tolerances appropriate to the type of printing being done and the degree to which colour is critical for the application involved. For consistency the same tolerance level would be selected from Table B.5 as was selected from Tables B.3 and B.4.

Table B.5 — Suggested tolerances for colorimetric deviation of all patches

Target description	Production variation tolerance (CIEDE2000)		
	Level A	Level B	Level C
95th percentile of all patches of ISO 12642-2	3.0	4.0	5.0

Because the ISO 12642-2 test form has 29 redundant patches (same CMYK values), these can be used to evaluate within sheet variability. Table B.6 shows the 29 duplicate patches and the associated ID numbers (as defined in ISO 12642-2).

The suggested evaluation is to pool the colour differences between the duplicate patches for all printed sheets selected for evaluation. The suggested tolerance for the 95th percentile of these pooled colour differences is shown in Table B.7.

Again, three levels are shown to allow the organizations involved to select tolerances appropriate to the type of printing being done and the degree to which colour is critical for the application involved.

For consistency the same tolerance level would be selected from Table B.7 as was selected from Tables B.3, B.4 and B.5.

Table B.6 — Duplicate Patches in ISO 12642-2 Target

#	C	M	Y	K	ID 1	ID 2		#	C	M	Y	K	ID 1	ID 2
1	0	0	0	0	1	1367		**16**	10	0	0	0	10	1302
2	0	0	10	0	82	1342		**17**	20	0	0	0	19	1300
3	0	0	20	0	163	1340		**18**	30	0	0	0	28	1298
4	0	0	30	0	244	1338		**19**	40	0	0	0	37	1297
5	0	0	40	0	325	1337		**20**	70	0	0	0	55	1294
6	0	0	70	0	487	1334		**21**	85	0	0	0	64	1291
7	0	0	85	0	568	1331		**22**	100	0	0	0	73	1287
8	0	0	100	0	649	1327		**23**	100	85	85	0	647	1368
9	0	10	0	0	2	1322		**24**	0	0	0	10	1362	1486
10	0	20	0	0	3	1320		**25**	0	0	0	20	730	1360
11	0	30	0	0	4	1318		**26**	0	0	0	40	946	1357
12	0	40	0	0	5	1317		**27**	0	0	0	60	1071	1355
13	0	70	0	0	7	1314		**28**	0	0	0	80	1096	1352
14	0	85	0	0	8	1311		**29**	0	0	0	100	1260	1347
15	0	100	0	0	9	1307								

Table B.7 — Within-sheet metrics and tolerances

Target description	**Within-sheet variation tolerance (CIEDE2000)**		
95th percentile of redundant patches	**Level A**	**Level B**	**Level C**
	1,0	1,5	3,0

Annex C
(informative)

Process independent workflow

The seven characterized reference printing conditions, proposed in ISO/PAS 15339-2, are expected to be used as a means to communicate intent between design, proofing, printing preparation and printing. The designer selects a profile based on a characterized reference printing condition that describes the range of colour that is suitable for the work. The colour characterization data associated with this characterized reference printing condition would be used to set-up the device that would be used to produce validation prints (see ISO 12647-8).

When the design was complete and the printing substrate to be used identified, the colour characterization data could be adjusted for any difference between the "colour" of the substrate and the colour of the substrate in the colour characterization data. This substrate modified colour characterization data would be associated with the content data and used to produce contract proofs (see ISO 12647-7) if those were required. In addition both the content data and the substrate modified colour characterization data would be used by the printer to produce the finished printed product.

Where the printing equipment being used did not match the provided colour characterization data (once the correct solids and solid overprints were achieved) one of the techniques described in ISO/TS 10128 could be used to allow the printed product to be closer to the substrate modified colour characterization data.

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