TECHNICAL SPECIFICATION

ISO/TS 23031

First edition
2020-08

Graphic technology — Assessment and validation of the performance of spectrocolorimeters and spectrodensitometers

This document is a preview generated by EVS

Reference number
ISO/TS 23031:2020(E)

© ISO 2020

This document is a preview generated by EVS

COPYRIGHT PROTECTED DOCUMENT

© ISO 2020

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

This document is a preview generated by EVS

© ISO 2020 – All rights reserved

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 130, *Graphic technology*.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

This document is a preview generated by EVS

© ISO 2020 – All rights reserved

Introduction

Instruments for the measurement of colour and colour difference have been in use since the middle of the 20th century. In the days before digital computers, converting spectral data into CIE tristimulus values was a difficult, manual operation. Additionally, the optics and electronic components were large and difficult to maintain. As a result, every instrument was supplied with a number of reference materials that could be used to assess the performance of the instrument or to adjust the operating parameters. These reference materials included coloured glass filters, rare earth glass filters, neutral density filters and porcelain on steel plaques. Concepts such as accuracy, precision, bias and reproducibility had special and unique applications to these instruments and reference materials.

As the optical and electronic technologies improved, the instruments became smaller, more precise and more affordable. At the same time, the science of metrology matured to the point that the colour-measuring instrument's performance out-paced the ability of the national testing laboratories to produce and certify standard materials suitable for testing. Modern optoelectronic instruments are more precise and more stable than the materials used to assess their performance. Thus, it has become problematic to determine if an instrument is within its factory specification or if two instruments produce results that are in agreement with each other.

Several industries that produce coloured products have chosen to address this situation by adopting and specifying a single brand and design of instrument. The paper and pulp industry have gone so far as to capture one particular design from the 1960s and enshrine it in an International Standard. ISO 2469 describes the optics, the geometry and the operation of an instrument that is ideally suited and specially designed for the measurement of the reflectance and colour of paper and pulp. Additionally, ISO/TC 6, has established a series of authorized laboratories which issue certified reference materials (CRM) for testing and calibrating the performance of an ISO 2469 compliant instrument. This was possible, in part, as the instrument captured in ISO 2469 was widely available on the market and it had no competitive designs and the authorized laboratories market sets of standards which are produced using materials with similar physical and optical properties as production papers or pulps. The authorized laboratories maintain a very close relationship to a single national standards laboratory and to each other. WG3 periodically audits these laboratories to verify that they have calibrated their instruments properly against the scale of radiance factor developed by the national standards laboratory.

In contrast, modern graphic reproduction has moved from the era of artistic interpretation into a time in which the image reproduction is driven by objective numerical assessments. With the availability of modern electro-optics, the number of companies providing instruments and the range of models of different size and capabilities has increased dramatically. Geometries utilized are nominally 45°:0° but may be uniplanar, biplanar, circumferential or annular. While referred to as bidirectional, they are always biconical and the sizes of the influx and efflux cones vary as much as the directionality.

Unfortunately, the national metrology laboratories have not been successful in defining a universally accepted scale of diffuse reflectance factor or diffuse radiance factor for these biconical instruments, especially when the sampling aperture is small. Without artefact standards that closely align with the properties to be measured in the printing industry, the result can easily be a match between two instruments on the reference material that does not correlate to a match on real world materials. As a result, colour-measuring instruments from different manufacturers or with different design intents do not provide adequate agreement on the determination of the colour values or methods for the assessment of the performance of an instrument system relative to its manufacturer declared performance specifications. Further, to make the instruments as simple as possible to operate, the end-user is given little to no access the underlying operation of the instrument. The operator can select an influx spectral quality (M0, M1, M2, M3) but has no way to determine or adjust the spectral quality of the influx. The realization of the scale of 45°:0° reflectance factor or radiance factor is different than that of hemispherical diffuse reflectance factor, even for nearly ideal materials. The operator only has the ability to request that instrument adjust the scale of the instrument using a single reference standard supplied with the instrument. The instrument scale is thus traceable only at the one point. Most do not even offer the ability to set or verify the mid-scale value or the optical null value. Today, optical metrologists refer to this process as standardization, since the instrument is forced to reproduce the values of the one standard.

This document is a preview generated by EVS

This document has been prepared to provide the users of portable spectrocolorimeters and spectrodensitometers with guidance on the methods for validation of the performance of those instruments. Since calibration is not possible, the use of a series of certified reference materials (CRM) or a series of stable, idealized reference materials is required. ISO 15790 provides guidance on the development of CRM standards for the scale of optical density. But optical density is a more forgiving measurement than tristimulus colorimetry. Measurement of colour is inherently more complicated than the measurement of optical density, since the logarithmic function compresses the measurement scale and the associated errors. Computing colorimetric tristimulus values from spectral data requires the use of the entire range of reflectance factor values while ISO status density is based on the response of the spectral product. Bright colours, useful for producing a large gamut of colour in image reproduction, possess large differences between the spectral regions of absorption and non-absorption of light but density is only assessing the spectral regions of maximum absorbance. While the human visual system has broad spectral responses, in terms of the cone fundamentals, the post receptor processing allows an observer to perceive hue differences as small as 1 nm. So, the instrumentation for colour assessment needs to have an accuracy several times small than the human visual system.

There is a need to use a set of 10 to 20 physical standards to sample the visible spectrum with materials possessing both high and low reflectance levels and that transition between the two extremes over a very small range of wavelengths. Those materials are stable and nearly opaque to avoid the problems of lateral diffusion observed when the sampling aperture are small. The procedures described here have been shown to provide end-users with methods to quantify the performance of spectrocolorimeters on the day it arrives from the manufacturer or distributor until the day it is retired from service. The methods may also be used to validate the instrument system against manufacturer’s specifications and against the requirements for product quality.

National measurement laboratories (NML) continue to develop new scales and new methods of assessing artefacts with the goal of providing certified standard materials for establishing the level of traceability and reproducibility of commercial instruments. Unfortunately, these standards have historically been too expensive for routine use. Only recently have the NMLs began developing automated methods for characterizing reference colours or even user supplied materials. Currently, only large corporations or instrument makers can afford to own such materials. Practical users rely on secondary laboratories and reference standards designed specifically for the end use case. In the graphic arts, that should be some form of printed material with a relatively short duty lifetime.

Finally, even after the CRM has been obtained, the methods for assessing the measurement data are not well described. A spectral reflectance factor curve should include 31, 36, 40 or more measurements. Trying to assign values, tolerances and uncertainties to the individual wavelengths is a challenge. For example, it is possible that measurements of an artefact are consistent for 28 wavelengths and inconsistent at 3 others. Should these instruments be considered as acceptable or failures? Converting the measured data to colorimetric values (XYZ or L*a*b*) improves the situation slightly, but the dilemma of comparing 3 individual readings from one lab or instrument to 3 individual values from another lab, remains a problem not conveniently described in the standards literature. It is the intent of this document to document and describe objective ways of assessing and comparing the performance of a colour-measuring instrument with the ultimate goal of identifying an optimum method for application in the graphic reproduction workflow.

This document is a preview generated by EVS

 © ISO 2020 – All rights reserved

Graphic technology — Assessment and validation of the performance of spectrocolorimeters and spectrodensitometers

This document is a preview generated by EVS

1 Scope

This document describes procedures for the assessment and validation of the performance of an optical spectrometer intended for use in capturing the spectral reflectance factor or the spectral radiance factor of printed areas comprised of non-fluorescent or fluorescent materials, respectively. While it does not describe the application to transmitting materials directly, many of the procedures can be applied to transmitting systems by backing them with a reflective white backing material.

This document does not address spectral measurements appropriate to other specific application needs, such as those used during the production of materials (e.g. printing paper and proofing media), which are well described by ISO standards under the jurisdiction of ISO/TC 6. It does not describe the special requirements for testing instruments that make in-process or online colour measurements.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 13655:2017, *Graphic technology — Spectral measurement and colorimetric computation for graphic arts images*

ISO 15790:2004, *Graphic technology and photography — Certified reference materials for reflection and transmission metrology — Documentation and procedures for use, including determination of combined standard uncertainty*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
accuracy
closeness of agreement between a test result and an accepted reference value

Note 1 to entry: The qualitative term accuracy, when applied to a set of observed values, is a combination of a random precision component and a systematic error or bias component. Since, in routine use, random components and bias components cannot be completely separated, the reported "accuracy" is interpreted as a combination of these two elements.

[SOURCE: ASTM E 284]

© ISO 2020 – All rights reserved