International Standard

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# Graphic technology and photography — Viewing conditions

*Technologie graphique et photographie — Conditions d'examen visuel*

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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.

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 document 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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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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 42, *Photography*, in collaboration with Technical Committee ISO/TC 130, *Graphic technology*.

This fourth edition cancels and replaces the third edition (ISO 3664:2009), which has been technically revised.

The main changes are as follows:

— adding new viewing conditions P3/P4 for prints using CIE standard illuminant D50 with UV excluded;

— changing some tolerances according to the advance in lighting technology;

— introduced a colour fidelity index in response to the spread of LED lighting;

— removing the conditions for appraisal of images displayed on colour monitors.

This revision of ISO 3664:2009 meets the current needs of the Graphic Technology and Photographic industries and minimizes differences between viewing equipment. It is noted that this revision contains multiple specifications, each of which is appropriate to specific requirements. Users need to ensure that they employ the specification which is appropriate to their application.

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.

# Introduction

While colour and density measurements play important roles in the control of colour reproduction, they cannot replace the human observer for final assessment of the quality of complex images. Colour reflection artwork, photographic transparencies, photographic prints, and photomechanical reproductions such as on-press and off-press proofs, or press sheets, are commonly evaluated for their image and colour quality, or compared critically with one another for fidelity of colour matching. Paper and other substrates contribute to the colour appearance and controlling the colour of these is equally critical. However, it is noted that other industries, such as the textile industry and the paper industry for unprinted paper, have their own set of international standards which differ in illumination conditions from those recommended in this document.

There is no doubt that the best viewing condition for the visual assessment of colour is that in which the product will be finally seen. Where this is known, and it is practical to do so, the various people in the production chain can agree to use this viewing condition for all evaluation and comparison. However, it is important that this is properly agreed upon in advance and that it is specified that such a viewing condition is not ISO-defined.

Unfortunately, such agreement is often not practical. Even if a particular end-use condition is known, it can be impractical to provide everybody in the production chain with sufficiently consistent viewing apparatus. Differences in illumination and viewing conditions can cause corresponding differences in the colour appearance of substrates, reproductions, and artwork. Such differences are likely to cause misunderstandings about colour reproduction and processing. This document provides specifications for illumination and viewing conditions that, when properly implemented, will reduce errors and misunderstandings caused by such deficiencies and inconsistencies.

The illumination used to view colour photographic prints, photomechanical reproductions, and transparencies needs to provide adequate amounts of radiant power from all parts of the spectrum to avoid distorting their appearance from that observed under natural sources of illumination such as daylight. The ultraviolet content is important where fluorescent samples, which are excited in this region, are encountered and where the intended viewing environment includes UV; a phenomenon associated with many of the paper substrates on which images are reproduced as well as with some of the dyes and pigments themselves.

To ensure consistency with previous editions of this document, as well as most of the equipment in current use, reference spectral power distributions specified in this document are based on CIE standard illuminant D50. Many of the reasons for the selection of CIE standard illuminant D50 in the first edition in 1974, as opposed to any other CIE daylight illuminant, are equally applicable today. In this edition, the illumination conditions of CIE standard illuminant D50 excluding the UV component are newly added as viewing conditions P3 and P4 for prints. In practice, P3 and P4 can be achieved by turning off the energy below 420 nm to meet the P1 and P2 requirements.

Since the third edition was published, technological innovations have greatly improved the lighting quality of LED lamps and lowered their cost. The Minamata Convention on Mercury came into effect in 2017, and efforts to reduce the amount of mercury used have been promoted worldwide. Many manufacturers have discontinued producing fluorescent lamps that use mercury and so the fluorescent lamps used for indoor lighting have been rapidly replaced by LED lamps. Modern LED lamps have been commercially developed which contain a short wavelength (440 nm to 470 nm) LED pump source and a broadband long wavelength fluorescent emitter that together can produce a range of white lamp lights. Such sources contain very little radiation that excites optical brightening agents used in most modern papers that serve as the substrates for the printing of images for signs, packages, labels and publications. Therefore, in the case of print products viewed in an indoor environment, optical brightening agents contained in the substrate don't fluoresce significantly. For print products that are expected to be used in such an environment, colour evaluations with the M1 measurement condition of ISO 13655 and visual assessments under the P1/P2 reference viewing conditions (CIE standard illuminant D50) of this document overestimate the effect of fluorescence compared to that observed in the expected viewing environment. The P3/P4 reference viewing conditions (CIE standard illuminant D50 excluding UV) are designed to evaluate print products that are expected to be mainly viewed in an indoor environment. These viewing conditions correspond to the M2 measurement condition of ISO 13655. Just as visual (colorimetric) assessments under P1/P2 conditions are consistent with M1 measurements, visual assessments under P3/P4 conditions are consistent with M2 measurements.

Therefore, the viewing condition is selected to correspond with the measurement condition used to assess the sample (P1/P2 for M1 and P3/P4 for M2).

Because it was very difficult to produce artificial sources of illumination which closely match the spectral power distribution of natural daylight in the past, especially when fluorescent lamp technology was used as the main light source for daylight simulators, it was important that the tolerances specified within this document provided a compromise between that required for lamp manufacturing purposes and that for consistent viewing. At present, fluorescent lamp technology is still used in the market, so the requirements of previous edition are retained, but the criteria for higher precision matching that can be achieved with new LED technology are added as recommendations. In this document three constraints which define the characteristics of the light falling on the viewing plane apply, one directly and two indirectly, and all three need to be met simultaneously if a viewing apparatus is to be considered as in conformance to this document.

Visual environments for colour inspections have been developed with arrays of LED emitters and fluorescent coatings that will blend together to produce almost any desired spectral power distribution at the viewing area of the inspection cabinet. The ability to set and control the luminous and spectral characteristics of these clusters of LED emitters equals or in some cases exceeds the ability of the radiometric instruments designed to characterize them. Where it is reasonable, the aims and tolerances have been adjusted to better accommodate such solid-state lamp lights. The three requirements shown in the third edition are still required in this fourth edition.

The chromaticity, which directly defines the colour of the illumination at the viewing surface, is specified as that for CIE standard illuminant D50 and the tolerance by a circle in the CIE 1976 Uniform Chromaticity Scale (UCS) diagram having a specified radius around that value.

It is important to establish spectral power distribution of the illumination conformance to that of CIE standard illuminant D50 (including or excluding UV). As in the previous edition of this document, the methods defined in CIE 13.3 to evaluate the colour rendering quality of a lamp and in ISO/CIE 23603 to evaluate its ability to correctly predict metamers are used. These requirements continue to be important to the graphic technology and photographic industries. In this edition, the method defined in CIE 224 which evaluates the colour fidelity of a lamp has been added. The colour fidelity index was based on the fidelity index of the Illuminating Engineering Society of North America and defined in TM-30-20.[9] The colour fidelity index has improved correlations with visual evaluations; however, it has not yet been widely used in the market. It is expected that the colour fidelity index will become a requirement in a future revision, but this edition includes it as a recommendation. The virtual metamers for CIE standard illuminant D50 from ISO/CIE 23603 are used to assess the ultraviolet (UV) spectral fit and the visible (VIS) spectral fit separately. The evaluation procedure for CIE standard illuminant D50 excluding UV is specified in Annex D. This test verifies that the UV content of the light source corresponds to the M2 measurement condition. Tolerances for the evaluation indices described above were validated using commercially available LED lamps and the results are shown in Annex B.

The perceived tonal scale and colours of a print or transparency can be significantly influenced by the chromaticity and luminance of other objects and surfaces in the field of view. For this reason, immediate surround and ambient conditions, which will possibly affect the state of visual adaptation, need to be designed to avoid any significant effects on the perception of colour and tone. Such specifications are provided in this document.

This document is premised on a single viewing condition. In the case of multiple reference viewing conditions, chromatic adaptation of an observer to multiple light sources can be insufficient, so a stricter match of the chromaticity of the light sources between the viewing conditions will be necessary. Considerations for simultaneous comparison of samples between multiple reference viewing environments are provided in Annex E.

Experience in the industries covered by this document has revealed the need for two levels of illumination; a high level for critical evaluation and comparison, and a lower level for appraising the tone scale of an individual image under illumination levels similar to the levels under which it will be finally viewed. This document specifies these two levels of illumination.

The higher illumination level is essential to graphic technology where a comparison is being made, such as between original artwork and proof, or to evaluate small colour differences between proof and press sheet, to control a printing operation. It is effective in these situations because it enhances the visibility of any

differences. The high level of illumination is also appropriate in photography when comparing transparencies or when critically evaluating a single image to assess the darkest tones that can be reproduced.

Since, despite adaptation, the level of illumination has quite a significant effect on the appearance of an image, the lower level is required to appraise the image at a level similar to that in which it will be finally viewed. Although, it is recognized that quite a wide range of illumination levels can be encountered in practical viewing situations, the lower level was chosen to be representative of the range encountered. For this reason, it is applicable to aesthetic appraisal, including the conditions for routine inspection of prints.

As a special use-case, a viewing condition for judging and exhibiting photographs is considered and some guidelines are provided in Annex C.

The viewing of transparencies is specified for direct viewing. Additional conditions are also specified for cases where transparencies are viewed by projection and where transparencies are to be compared to a print. The surround specified for transparency viewing recognizes the way that a transparency needs to be viewed for optimum visibility of the dark tones but acknowledges that practical viewing equipment is likely to have ambient conditions that introduce some viewing flare. This problem is made worse by the light grey walls of the viewing cabinet, that are intended to redirect the diffuse lamp light from incandescent and fluorescent lamps back down onto the bottom of the cabinet. The combination of surround and flare produce an appearance that is not always representative of how the transparency would look in a typically lighted room. Solid-state, LED, lamps tend to produce more directional light fluxes and thus, it is possible to produce the required illumination levels without the need for the diffusely reflecting walls. This reduces the viewing flare and provides a more useful viewing environment for higher contrast images such as transparencies.

Small transparencies are commonly evaluated in graphic technology by direct viewing. When it is necessary to view transparencies directly, they need to be viewed according to the conditions specified for that situation. However, for some purposes, smaller transparencies are not viewed directly because the viewing distance for correct perspective and perception of detail is too small for visual comfort. Furthermore, when small transparencies are reproduced for publication or other purposes, they are usually enlarged. To ease comparison, it is helpful to enlarge the transparency image when comparing it to the print. For these reasons, a viewing condition can be required which provides a magnified image when viewed at an appropriate distance.

Colour image displays are increasingly being used to view digital images in graphic technology and photography. The setup and control of digital colour displays are now standardized in ISO and IEC documents from technical committees, including ISO/TC 130 and ISO/TC 159, and IEC/TC 110.

The specifications for images viewed on colour monitors are no longer provided in this document, as this process is beyond the scope of this document and reference documents are provided in the Bibliography.

# Graphic technology and photography — Viewing conditions



## 1 Scope

This document specifies viewing conditions for images on both reflective and transmissive media, such as prints (both photographic and photomechanical) and transparencies.

This document applies to

— critical evaluation of and comparison between transparencies, backlighted signs, reflection photographic or photomechanical prints and/or a reference object or image,

— appraisal of the tone reproduction and colourfulness of prints and transparencies at illumination levels similar to those for practical use, including routine inspection, and

— critical appraisal of transparencies which are viewed by projection, for comparison with prints, objects, or other reproductions.

This document is not applicable to soft-proofing displays, for paper manufacture, and other applications outside of graphic technology and photography.

## 2 Normative references

The following referenced documents are indispensable for the application 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 5-2, *Photography and graphic technology — Density measurements — Part 2: Geometric conditions for transmittance density*

ISO 5-3, *Photography and graphic technology — Density measurements — Part 3: Spectral conditions*

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

ISO/CIE 23603, *Standard method of assessing the spectral quality of daylight simulators for visual appraisal and measurement of colour*

CIE 13.3, *Method of measuring and specifying colour rendering properties of light sources*

CIE 15, *Colorimetry, 4th Edition*

CIE 224, *Colour Fidelity Index for accurate scientific use*

ISO/CIE 19476, *Characterization of the performance of illuminance meters and luminance meters*

## 3 Terms and definitions

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

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

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

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