
Information technology — Office equipment — Viewing environment guideline for office equipment

*Technologies de l'information — Équipements de bureau —
Visualisation de la directive d'environnement pour les équipements
de bureau*

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

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 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).

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This document was prepared by Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 28, *Office equipment*.

Introduction

Viewing conditions for imaging devices such as 2D and 3D printers/scanners, copiers, projectors, fax, displays and systems are specified in the various international standards and technical reports and can be categorized according to their objectives. Those objectives are colour assessment such as direct visual assessment and corresponding colorimetric measurements, defining colour space and colour comparison between display and print.

CIE 15 provides CIE recommendations for basic colorimetry which recommends CIE illuminant D65 used whenever possible and when D65 cannot be used, it is recommended that one of the daylight illuminants D50, D55 or D75 be used. ISO 13655 provides requirements for spectral measurements and colorimetric computations for graphic arts images and specifies CIE illuminant D50, which is used throughout the printing industry and provides a consistent and unambiguous framework for assessing colour.

ISO 3664 similarly provides requirements for the visual assessment of colour for graphic technology and photography and specifies CIE illuminant D50 for the same reasons as ISO 13655. IEC 61966-2-1 provides Default RGB colour space – sRGB which specified CIE illuminant D50 by referring ISO 3664. These and other international standards designed for graphic arts specify CIE illuminant D50 as the viewing illuminant ensuring consistent colour evaluation conditions.

The colour temperature of viewing illuminant in international standards specifying office lighting ranges from 5 000 K to 7 500 K. However, the colour temperature of the viewing illuminant where the product will be finally seen is largely a matter of personal taste. The general preference is to use cool colours for a business-like atmosphere (e.g. in offices, factories, shops) and warm colours for a social atmosphere (e.g. in hotels and homes). In office environment, popular viewing illuminants are F2 (4 230 K) and F6 (4 150 K) which are generally inexpensive and compromising business and social atmosphere.

End users have various requirements but in all cases it is beneficial to agree a reference viewing environment. A typical end user issue is where it is claimed that clouds and snows in original document have become too reddish in printed copy. Without having an agreed reference viewing illuminant the cause of such problems is hard to find and may be due, for example, to an incorrect assumption for the intended viewing environment.

For office equipment, reference viewing conditions are not specified or explained with relevant background information in any international standards. It is desirable to provide a guideline for selecting viewing conditions for office equipment colour assessment. This document provides an overview of an office viewing environment for the purpose of colour assessment, colorimetry and colour evaluation. It also provides a colour characterization guideline for use with office equipment. The objective of this document is to avoid misunderstanding of various viewing conditions recommended by many international standards and to help office equipment manufacturers selecting proper viewing conditions, so that they can provide products with suitable colour reproduction performance to satisfy user needs in various viewing environments.

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Information technology — Office equipment — Viewing environment guideline for office equipment

1 Scope

This document provides an overview of office viewing environment and colour characterization guidelines for use with office equipment, in particular colour printing devices that have digital imaging capabilities, including multi-function devices.

2 Normative references

There are no normative references in this document.

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:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

viewing environment

environment in which something is viewed

3.2

viewing conditions

description of the surrounding environmental conditions during the process of viewing

[SOURCE: ISO/TS 18173:2005, 2.28]

4 Viewing conditions

4.1 General

Information relating to viewing conditions are reviewed in this clause, including international standards, technical reports and web-based articles (as shown in [Annex A](#)). In general, colour assessment related standards specified viewing conditions. Colour assessment can be done basically in two ways. One is to use the human eyeball as a detector and the human brain to compute colour as a psychometric feeling – so called visual assessment. The other is to use an artificial sensor as a detector and a computer chip to compute colour coordinates – so called colorimetry. In multimedia systems and equipment, viewing conditions are specified for defining colour space. In graphic technology, viewing conditions are specified for proofing which involves colour comparison of the display and the printer.

4.2 Visual assessment

4.2.1 General

Viewing conditions for the visual assessment of colour are specified in several international standards. ISO 8995 applies to the lighting of indoor workplaces. ISO 3664 applies to viewing conditions for graphic

technology and photography. IEC 61966-2-1 applies to default colour space for multimedia systems and equipment. ISO 12646 applies to characteristics for displays for colour proofing.

4.2.2 Lighting of indoor workplaces

ISO 8995 specifies lighting requirements for indoor workplaces for people to perform visual tasks efficiently, in comfort and safety throughout the whole work period. Illuminance, glare limitation and colour quality are specified for various interiors (areas), tasks and activities. As described in ISO 8995, the "colour appearance" of a lamp refers to the apparent colour (lamp chromaticity) of the light it emits. It may be described by its correlated colour temperature. Lamps are usually divided into three groups according to their correlated colour temperature, such as warm, intermediate and cool. Correlated colour temperatures are below 3 300 K, 3 300 K to 5 300 K and above 5 300 K respectively. There are 260 different types of interior, task or activity and the distribution of number of types of interior, task or activity in terms of colour temperatures are:

- 13 belong to colour temperature of at least 4 000 K;
- one belongs to 5 000 K, which is for colour inspection in multi-coloured printing;
- two belong to 5 000 K or more, which are for operating cavity and colour inspection (laboratories);
- one belongs to more than 5 000 K, which is for art rooms in art schools;
- one belongs to 6 000 K or more, which is for white teeth matching;
- one belongs to 6 500 K or more, which is for colour inspection in the chemicals, plastics and rubber industries; and
- the other 241 belong to 'not specified'. More than 90 % have no colour temperature given.

4.2.3 Graphic technology and photography

For graphic technology and photography, the viewing conditions are specified in ISO 3664. The viewing illuminant is specified as CIE illuminant D50. Differences in illumination and viewing conditions can cause corresponding differences in the colour appearance of substrates, reproductions and artwork. The objective of specifying the viewing illuminant in ISO 3664 is to reduce errors and misunderstandings caused by such deficiencies and inconsistencies. But, viewing conditions in ISO 3664 for print are not common in the general office environment. As a result, sometimes the colour of print in a general office does not match the colour of print based on ISO 3664 viewing conditions.

Reference ambient illuminance level when comparing an image on reflective print and a colour monitor is specified as CIE illuminant D50 in ISO 3664 such as "Recommended ambient illumination for colour monitors: ≤ 32 lx." and "Required ambient illumination for colour monitors: ≤ 64 lx". But, it is difficult to set ambient illumination in an office to be the same as the one specified in ISO 3664 because that is too dark to see print in general working usage. As a result, the colour of prints do not match between ISO 3664 and the general office.

4.2.4 Multimedia systems and equipment

IEC 61966-2-1 adopted the viewing conditions specified in ISO 3664 as follows.

Specifications for the reference viewing environments are derived from ISO 3664 and shall be as follows:

- a) reference background for the background as part of the display screen, the background is 20 % of the reference display luminance level (16 cd/m²); the chromaticity should average to $x = 0,312\ 7$, $y = 0,329\ 0$ (D65);
- b) reference surround 20 % reflectance of the reference ambient illuminance level (12,8 lx); the chromaticity should average to $x = 0,345\ 7$, $y = 0,358\ 5$ (D50) illuminance level;
- c) reference proximal field 20 % of the reference display luminance level (16 cd/m²); the chromaticity should average to $x = 0,312\ 7$, $y = 0,329\ 0$ (D65);
- d) reference ambient illuminance level 64 lx;
- e) reference ambient white point $x = 0,345\ 7$, $y = 0,358\ 5$ (D50);
- f) reference veiling glare 1,0 %.

Furthermore, as described in IEC 61966-2-1:1999, Annex D, the typical ambient illuminance level in a typical office is 350 lx.

4.2.5 Displays for colour proofing

Comparison of monitor and hard copy images are specified in ISO 12646. At the centre of the white image defined in ISO 12646:2015, 5.3, the chromaticity of the display should be set to that of D50; namely $u' = 0,209\ 2$, $v' = 0,488\ 1$ (as specified in CIE Publication 15). The chromaticity obtained for the white point chosen by the software application vendor is within a circle of radius 0,005 from this point. The luminance of the monitor should be as high as necessary to visually match an unprinted sheet of white paper located close to the monitor having an illuminance of 500 lx, as specified in ISO 3664 for viewing condition P2. If that is not possible, the luminance should be at least 80 cd/m² but preferably 160 cd/m². The conditions within the viewing booth conform to viewing condition P2 of ISO 3664. An example of viewing conditions for image comparison between hardcopy and display is introduced in [Annex B](#).

4.3 Colorimetry

4.3.1 General

Viewing conditions for colorimetry (the physical measurement of colour) are specified in several international standards and technical reports. CIE 15 is the recommendation of the CIE concerning basic colorimetry. The IEC 61966 series relates to colour characterization of multimedia systems and equipment. ISO 13655 is the colorimetry standard for graphic technology and photography.

4.3.2 Basic colorimetry

In CIE 15 it is recommended that the following illuminants, defined by relative spectral power distributions given ISO/CIE 10526:1999, Table 1,¹⁾ be used for general colorimetry.

- CIE standard illuminant A, CIE standard illuminant D65, illuminant B, illuminant C.
- It is recommended that, in the interest of standardization, D65 be used whenever possible.
- When D65 cannot be used, it is recommended that one of the daylight illuminants D50, D55, or D75 defined in ISO/CIE 10526:1999, Table 1 be used.

1) Withdrawn in 2007. Also published as CIE S005/E-1998. *CIE standard illuminants for colorimetry*, 1998.

4.3.3 Graphic technology and photography

For graphic arts images the viewing illuminant is specified in ISO 13655, for example, the spectral power distribution of the light flux incident on the specimen surface for the measurement should match CIE illuminant D50. To obtain consistency of instrumental measurement data and visual assessment data using viewing booths, it is desirable to adopt the same viewing illuminant, such as D50, for both instrumental measurement and visual assessment.

4.3.4 Multimedia systems and equipment

For colour printers the viewing illuminant is specified in IEC 61966-7-1, for example, default illuminants and colorimetric observers to derive Tristimulus values and CIELAB colour space is D50. IEC 61966-7-1 also specified D65, F11 and illuminant A as optional viewing illuminants.

4.4 Office equipment

4.4.1 General

As described in ISO 8995-1:2002, 4.6.1, the choice of colour appearance is a matter of psychology, aesthetics and of what is considered to be natural. The choice depends on illuminance, the colours of the room and furniture, the surrounding climate and the application. In warm climates a cooler light colour appearance is generally preferred, and in cold climates a warmer light colour appearance is preferred.

Current office environments contain many different use cases, from high-end graphic arts to low-end consumer products. Even though there is no standard which specifies how to choose suitable viewing conditions, end users have various requirements so there are several different viewing condition assumptions that are desirable in order to resolve each end user issue. If an end user issue, for example, claimed the clouds and snows in an original document became too reddish in the output copy, it can be assumed that the viewing illuminant selection of designing colour-matching functions of the corresponding colour copier was at too high a colour temperature, such as D65.

4.4.2 Office lighting for imaging

The colour temperature of viewing illuminant at which the product will be finally seen is largely a matter of personal taste. The general preference is to use cool colours for a business-like atmosphere (e.g. in offices, factories, shops) and warm colours for a social atmosphere (e.g. in hotels and homes). However there is considerable differences among countries in terms of the most popular light colour of fluorescent lamp which is commonly used in offices. The favourable colour temperature in both continental Europe and North America is 4 000 K Neutral White which strikes a balance between creating a professional atmosphere while providing a feeling of warmth for a friendly working environment. In the office environment, popular viewing illuminants are F2 (4 230 K) and F6 (4 150 K). According to ISO 8995-1, as described in 4.2.2, there are 260 different types of interior, task or activity and no colour temperature is specified for 90 % of those workplaces. F2 (4 230 K) and F6 (4 150 K) are generally inexpensive among other colour temperatures, and that is one of the biggest reasons these are popular light sources.

CIE Division 8 conducted worldwide data acquisition of spectral distribution of office lighting for imaging and distribution of the colour temperatures of office lighting. The data showed that the colour temperature range is 4 000 K – 5 000 K which is different from the colour temperatures specified in the above international standards, such as 5 000 K – 7 500 K.

CIE Division 8 data includes reference ambient illuminance level. The data showed that the average ambient illuminance level is approximately 350 lx, which is about 500 lx divided by square root of two. This value is 5,5 times the maximum limit of display (see 4.2.4).

4.4.3 Colour copying machines

ISO/IEC 15775 specifies D65 for colour copying machines for colour reproduction evaluation.

5 Guideline for office colour assessment

5.1 General

Graphic technology and photography adopted D50 for consistent data comparison. Office equipment manufacturers accumulate their base data using the same viewing condition as graphic technology and photography for designing their products for consistent data comparison. On the other hand, end users are in various viewing environments, so that it is difficult to pick one light source to know every end user's degree of satisfaction. A better approach to gain end user satisfaction is to use more light sources corresponding to each end user's viewing environment.

5.2 Visual assessment

Assessment operation involving multiple light sources requires a high workload and cost in visual assessment. An alternative approach is to pick an average light source for the office environment. If there is a significant mismatch with D50, use a light source to reflect regional and ethnic preferences appropriately. [Annex C](#) shows an actual office viewing environment.

5.3 Colorimetry

Once the spectral characteristics of object colour are available, it is easy to estimate colours of the same object with multiple light sources so the viewing illuminant can be selected to match each objective. Measurement data reporting requirements are available in ISO 13655, which includes required information, recommended information and electronic data reporting.

5.4 Recommendation

[Annex D](#) shows the availability of viewing conditions for evaluation. Currently there is no conventional visual assessment standard in an actual office user environment. In addition, LED light sources with variable colour temperature, are commercialized and spreading around the world in recent years. So, it is desirable to develop a viewing evaluation method for office equipment.

Annex A (informative)

International standards related to viewing conditions

Table A.1 — International standards related to viewing conditions

	Document reference number	Scope	Typical applications	Remarks	Related standards/benefits
1	ISO 13655	Measurements and colorimetric computations	Offset lithography, letterpress, flexography, gravure and screen printing.	Definition:D50 Most of office users don't use CIE illuminant D50 as a viewing condition.	ISO 5-2 ISO 5-4 ISO 3664 ISO 11664-1 ISO 11664-2 ISO 11664-4 ISO 28178
2	ISO 3664	Comparison and appraisal images	Prints (both photographic and photomechanical) and transparencies, Colour monitor projection.	Definition:D50 Most of office users don't use CIE illuminant D50 as a viewing condition.	ISO 5-2 ISO 5-3 ISO 13655 ISO 23603 CIE 13.3 CIE 15 CIE 69
3	ISO 22028-1	Photography and graphic technology	Digital photography Digital image storage, manipulation and/or interchange.	Most of office users don't use CIE illuminant D50, D65.	ISO 11664-1
4	ISO 8995-1	Lighting requirements for indoor workplaces	People to perform the visual tasks efficiently, in comfort and safety throughout the whole work period.		ISO 3864 ISO 6309 ^a ISO 6385 ISO 9241 CIE 13.3 CIE 16 CIE 17.4 CIE 19.2
^a Withdrawn in 2011. ^b Withdrawn in 2005. ^c Withdrawn in 2003. ^d Withdrawn in 2013. ^e Withdrawn in 2007. Also published as CIE S005/E-1998. <i>CIE standard illuminants for colorimetry</i> , 1998. ^f Withdrawn in 2007. Also published as CIE S002-1986. <i>CIE standard colorimetric observers</i> , 1986.					

Table A.1 (continued)

	Document reference number	Scope	Typical applications	Remarks	Related standards/benefits
					CIE 40 CIE 58 CIE S 008/E-2001 CIE 60 CIE 62 CIE 96 CIE 97 CIE 103/5 CIE 117 CIE 129
5	ISO/IEC 15775	Implementation and application of test charts for colour copying machines	Testing of reproduction properties of colour copying machines.	Most of office users don't use CIE illuminant D65.	ISO 216 ISO 536 ISO 554 ISO 2469 ISO 2471 ISO 2846-1 ISO 5627 ISO 5651 ^b ISO 5737 ^c ISO 7724-1 ^d ISO 7724-3 ^d ISO 8596 ISO 8597 ISO 12641 ISO/CIE 10526 ^e ISO/CIE 10527 ^f CIE 13.3 CIE 15.2 DIN 6160 DIN 33866-2 DIN 58220-5 ITU-R BT.709-2
^a Withdrawn in 2011. ^b Withdrawn in 2005. ^c Withdrawn in 2003. ^d Withdrawn in 2013. ^e Withdrawn in 2007. Also published as CIE S005/E-1998. <i>CIE standard illuminants for colorimetry</i>, 1998. ^f Withdrawn in 2007. Also published as CIE S002-1986. <i>CIE standard colorimetric observers</i>, 1986.					

Table A.1 (continued)

	Document reference number	Scope	Typical applications	Remarks	Related standards/benefits
6	IEC 61966-2-1	RGB colours used in computer systems	Applicable to the encoding and communication.	Most of office users don't use CIE illuminant D50, D65.	IEC 60050-845 ISO 9358 ISO/CIE 10527 CIE 15.2 CIE 122 ITU-R BT.709-3
7	IEC 61966-7-1	Reflective colour prints	Non-impact colour printers.	Illuminant D50 as default, D65, F11 and illuminant A as optional.	IEC 60050-845 ISO/CIE 10526 ISO/CIE 10527 CIE 15 ISO 216
8	CIE 15	Basic colorimetry,	Basic colorimetric data and practices.		ISO/CIE 10526 ISO/CIE 10527 CIE DS 014-2.2
a	Withdrawn in 2011.				
b	Withdrawn in 2005.				
c	Withdrawn in 2003.				
d	Withdrawn in 2013.				
e	Withdrawn in 2007. Also published as CIE S005/E-1998. <i>CIE standard illuminants for colorimetry</i> , 1998.				
f	Withdrawn in 2007. Also published as CIE S002-1986. <i>CIE standard colorimetric observers</i> , 1986.				

Annex B (informative)

Example of viewing conditions for image comparison between hardcopy and display

B.1 Viewing conditions

B.1.1 Viewing conditions for graphic technology and photography

ISO 3664 specifies viewing conditions P1 for critical comparison between different copies of a print (including the original and its reproduction), viewing conditions P2 for practical appraisal of prints (including routine inspection) and viewing conditions for appraisal of images displayed on colour monitors etc., parts of which are as follows.

- a) (P1, P2) The illumination at the plane of viewing shall approximate that of CIE standard illuminant D50.
- b) (P1, P2) The illuminance at the centre of the illuminated viewing surface area shall be $(2\,000 \pm 500)$ lx, and should be $(2\,000 \pm 250)$ lx for P1, shall be (500 ± 125) lx for P2.
- c) (P1, P2) For a viewing area up to 1 m^2 , the illuminance at any point within the illuminated area shall not be less than 75 % of the illuminance at the centre.
- d) (P1, P2) The surround and backing shall be neutral and matt.
- e) The level of ambient illumination shall **(should)** be sufficiently low that the luminance of a perfect reflecting diffuser, placed at the position of the faceplate of the monitor, with the monitor switched off, is not greater than $1/4$ (**1/8**) of the monitor white point luminance. Recommended ambient illumination for colour monitors: ≤ 32 lx. Required ambient illumination for colour monitors: ≤ 64 lx.

B.1.2 Characteristics of displays for colour proofing

ISO 12646 specifies requirements for two conformance levels for the characteristics of displays to be used for soft proofing of colour images. Included are requirements for uniformity and variations of electro-optical properties with viewing direction for different driving signals, parts of which are as follows.

- a) The CIELAB values of a 5×5 grid are calculated using the measurement of the centre patch at maximum driving as the reference white illuminant. 24 readings are compared with the centre colour for three different driving levels, namely white, at maximum driving level ($R=G=B=255$ for 8-bit displays), grey at about half maximum driving level ($R=G=B=127$ for 8-bit displays), and dark grey at about fourth of maximum driving level ($R=G=B=63$ for 8-bit displays) by means of the DE00 colour difference formulae. For the white and the grey driving levels, the DE00 colour differences should be equal or less than four.
- b) Utilizing luminance (cd/m^2) measurements of grey at half maximum driving level ($R=G=B=127$ for 8-bit displays) and while at maximum driving level ($R=G=B=255$ for 8-bit displays) the grey/white ratio should be calculated for the 25 regions. For the non-central regions, new ratios, T_i , with $i=\{1,..,24\}$ should be computed by dividing the individual grey/white ratios, R_i , with $i=\{1,..,24\}$ by the grey/white ratio of the centre, R_c , subtracting one and calculate the absolute value of

thenumber. This measure of the deviation from uniform tonality should be less than 10 %, i.e. $\max(T_i)$, $i=\{1,...,24\}$ should be less than 0,10.

B.1.3 Office viewing conditions

There is no international standard for office equipment colour. It is desirable to select viewing conditions from such standards as ISO 3664 and ISO 12646 for image comparison between hardcopy and display in the general office. For example, the viewing conditions P2 specified in ISO 3664 are for the appraisal of tone reproduction or judgement of prints under illumination levels that correspond to an office.

B.2 Example of viewing conditions P2 in ISO 3664 for the general office

B.2.1 Table B.1 gives the correlated colour temperatures (T_{cp}) and illuminances in a general office and a colour assessment cabinet in another general office, corresponding to the viewing conditions P2 listed in B.1.1 a), b), c), d).

Table B.1 — Example of viewing conditions in general office

Item	Measured value	
	Fluorescent lamps in office ($T_{cp} = 5\,330\text{ K}$)	Light source D50 at colour assessment cabinet ($T_{cp} = 4\,828\text{ K}$)
Illuminance at the centre and specified points ^a of the viewing surface ^b /lx	234 256 273	1056 1080 841
	237 250 273	1081 1121 934
	231 233 259	996 1048 878
Illuminance at other points ^c in 1 m ² area of the viewing surface/lx	187 179 164	702 1021 638
	202 258	731 690
	201 203 238	665 858 649
surround and backing	white office walls, a window with varying sunlight etc.	neutral and matt for three cabinet walls and inner bottom surface, no light shield at the open door
ambient illumination for colour monitors/lx	174~357 ^d	/
^a The positions of the centre and the other 8 points of the viewing surface are shown in Figure B.1. ^b The viewing surface of this example for office is a desktop which is at the left side of the office room and the fluorescent lamps are at the centre of the room ceiling, the viewing surface for colour assessment cabinet is the inner bottom surface which is right below the D50 light tube. ^c The other points in 1 m² area of the viewing surface are at the middle and the ends of the four sides of the inner bottom surface of the colour assessment cabinet (678 mm × 332 mm) and the same size points for desktop. ^d 174 lx was the illuminance on the desktop below a monitor (turning off) and 357 lx was the illuminance above the monitor, about 480 mm high above the desktop.		

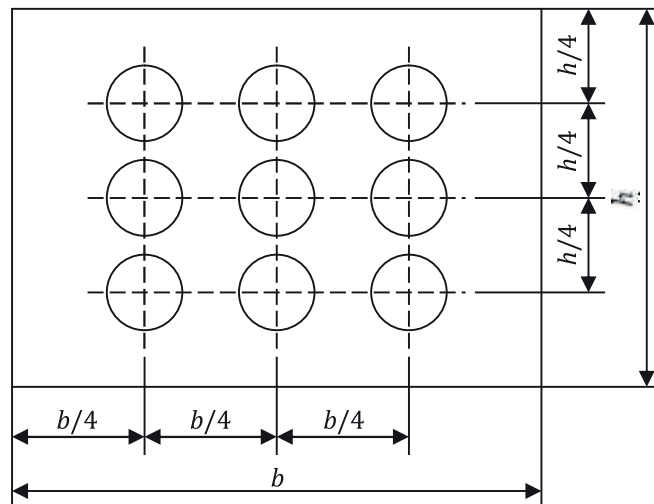


Figure B.1 — Positions for illuminance

B.2.2 The data shown in [Table B.1](#) illustrate that the actual viewing conditions do not comply with those described in [B.1.1](#).

- The correlated colour temperatures at the planes of viewing (desktop in office or inner bottom surface of the assessment cabinet) were 5 330 K and 4 828 K respectively; these do not comply with the illumination requirement D50 (5 000 K) described in [B.1.1 a](#)).
- The illuminances at the centres of the illuminated viewing surface areas (desktop in office or inner bottom surface of the assessment cabinet) were 250 lx and 1 121 lx respectively; these do not comply with the illuminance requirement (500 ± 125) lx for P2 described in [B.1.1 b](#)).
- The minimum illuminances at other points of the illuminated viewing surface areas (desktop in office or inner bottom surface of the assessment cabinet) in 1 m² area were 164 lx and 638 lx, 66 % and 57 % of the illuminances at the centres respectively; these do not comply with the illumination uniformity requirement ≥ 75 % described in [B.1.1 c](#)).

NOTE Although the illuminance at the centre of the viewing surface of the assessment cabinet for light source D65 tube was 2 140 and complied with the requirement $(2\ 000 \pm 500)$ lx described in [B.1.1 b](#)), the minimum illuminance at other points in 1 m² area (678 mm $\times$ 332 mm) was 1 243 lx, 58 % of the illuminance at the centre, which did not comply with the illumination uniformity requirement ≥ 75 % described in [B.1.1 c](#)).

- The surrounds and backings of the illuminated viewing surface areas (desktop in office or inner bottom surface of the assessment cabinet) did not comply with the neutral and matt requirement described in [B.1.1 d](#)).
- The ambient illumination (174 lx $\sim$ 357 lx) for colour monitors in a general office was not sufficiently low (≤ 64 lx or ≤ 32 lx) as described in [B.1.1 e](#)).

B.3 Applicability of viewing conditions for image comparison between hardcopy and display for a general office

From the example provided in [B.2](#) it is observed that it is unpractical for a general office to comply with the viewing conditions specified in ISO 3664 and to have characteristics of display to comply with ISO 12646.

- There is no comparability between hardcopy with D50 illumination and (500 ± 125) lx illuminance at the centre of the illuminated viewing surface areas, as described in [B.1.1 a](#)), [B.1.1 b](#)), and display with sufficiently low (≤ 64 lx or ≤ 32 lx) ambient illumination, as described in [B.1.1 e](#)).

- There are no such viewing conditions as specified in ISO 3664 existing in a general office, e.g. sufficiently low the level of ambient illumination for monitor as described in [B.1.1](#) e).
- It is difficult to set such viewing conditions as specified in ISO 3664; in other words, a lot of effort (including professional knowledge) and cost (including measuring devices) will be needed.
- There are too many requirements or too many procedures to verify the consistency of viewing conditions with ISO 3664 and characteristics of display with ISO 12646 before image comparison between hardcopy and display for a general office, e.g. 24 readings are compared with the centre colour for three different driving levels described in [B.1.2](#) a) (from ISO 12646:2015, 4.2.2).

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Annex C (informative)

Actual office viewing environment

Table C.1 — Actual office viewing environment

Colour Temp	Name	Effects on colours	Typical applications
>6 500 K			
5 000 K – 6 500 K	Daylight White	Strongly enhances blues Flattens reds Bluish tint to whites and greens	Graphic arts studios Winter goods shops e.g. furriers Seasonal Affective Disorder
5 000 K	Cool White		
4 000 K – 5 000 K	Mid Range	Enhances blues Flattens reds Bluish tint to whites and greens	Offices Hospitals Manufacturing
3 500 K – 4 000 K	Warm White	Neutral appearance Enhances most colours equally Does not favour yellow or blue	Retail stores Supermarkets Showrooms
2 700 K – 3 000 K	Extra Warm	Enhances red and orange Blues appear darker Yellow tint to whites and green	Residential lighting Restaurants Hotel lobbies
2 000 K – 2 500 K		Strongly enhances red and orange Blues appear almost black Whites appear strongly orange	Bread and meat displays City beautification Not for general lighting
<2 000 K	Name	Bluish tint to whites and greens	